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**Environmental Engineering (EE);
Green Abstraction Layer (GAL);
Power management capabilities of the future
energy telecommunication fixed network nodes;
Enhanced Interface for power management in
Network Functions Virtualisation (NFV) environments**

Reference

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Foreword

This final draft ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE), and is now submitted for the ETSI Membership Approval Procedure.

Modal verbs terminology

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

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Introduction

Green Abstraction Layer (GAL), specified in ETSI ES 203 237 [1], provides means of exchanging information about capabilities and parameter settings between energy-aware networking devices and their network management primitives. It allows hiding the specificities of devices and their internal operations by means of an abstract interface, through which only a description of energy-related parameters can be conveyed, read and configured.

The scenario introduced by the advent of Network Functions Virtualisation (NFV) possibly accompanied by the further increase in flexibility and programmability brought forth by Software Defined Networking, is changing the network paradigms and the associated GAL design. With NFV, network functionalities become virtualised network functions which can be automatically deployed, migrated, re-configured. The same physical machines of a provider's infrastructure may well serve the needs of different VNFs. In this NFV context, establishing a mapping between the Energy-Aware States of logical entities (e.g. virtualised network functions) and the energy consumption of the hardware hosting the virtualisation containers (e.g. virtual machines, OS containers) that execute these logical entities is a challenging task. There is therefore the need to adapt ETSI ES 203 237 [1] to the NFV environment, and to address its use in the ETSI NFV architectural framework ETSI GS NFV 006 [i.1].

The present document specifies the impact on the NFV architecture of providing virtual energy-aware states capabilities for VNFs.

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5. It is published respectively by ITU and ETSI as ETSI ES 203 682 (the present document) and Recommendation ITU-T L.1362 [i.7].

1   Scope

The present document specifies an evolved version of the Green Abstraction Layer capable of operating within ETSI NFV environments.

2   References

2.1   Normative references

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

Referenced documents which are not found to be publicly available in the expected location might be found at https://docbox.etsi.org/Reference/.

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The following referenced documents are necessary for the application of the present document.

[1]   ETSI ES 203 237: "Environmental Engineering (EE); Green Abstraction Layer (GAL); Power management capabilities of the future energy telecommunication fixed network nodes".

[2]   ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

[3]   ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Network Service Templates Specification".

[4]   ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

[5]   ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[6]   ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".

[7]   ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[8]   ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[9]   ETSI GS NFV-IFA 027: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Performance Measurements Specification".

2.2   Informative references

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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 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Architectural Framework Specification".

[i.2]   ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on TOSCA specification".

[i.3]   ETSI GR NFV-IFA 029: "Network Functions Virtualisation (NFV) Release 3; Architecture; Report on the Enhancements of the NFV architecture towards "Cloud-native" and "PaaS"".

[i.4]   Speed Select Technology (SST) - Intel.

[i.5]   ETSI GS NFV-IFA 040: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".

[i.6]   ETSI GS NFV-SOL 018: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Profiling specification of protocol and data model solutions for OS Container management and orchestration".

[i.7]   Recommendation ITU-T L.1362: "Power management capabilities of the future energy telecommunication fixed network nodes. Enhanced Interface for power management in Network Function Virtualization (NFV) environments.

3   Definition of terms, symbols and abbreviations

3.1   Terms

For the purposes of the present document, the following terms apply:

Container Infrastructure Service (CIS) instance: instance providing runtime execution environment for container

NOTE: In Kubernetes® this is a node, which consists of three components: container runtime, kubelet and kube-proxy.

Container Infrastructure Service Management (CISM): function that manages one or more Container Infrastructure Services

Energy-Aware Entity (EAE): network entity that can adapt its energy consumption such as network performance levels are satisfied

NOTE: Examples include central processing unit (CPU), virtual CPU, virtual machine, virtualised network function.

Energy-Aware State (EAS): data structure containing power, network performance, available functionalities, and responsiveness information characterizing an Energy-Aware Entity

NOTE: It can be configured by control plane processes through the Green Standard Interface.

Green Abstraction Layer (GAL): interface between data and control planes for exchanging data regarding the power of a device

Green Standard Interface (GSI): GAL interface designed to exchange power management data in a simplified way among data-plane elements and processes realizing control plane strategies

hypervisor: piece of software which partitions the underlying physical resources, creates Virtual Machines, and isolates them from each other

NOTE: In essence, the hypervisor can emulate every piece of the hardware platform even in some cases, completely emulating a CPU instruction set such that the Virtual Machine believes it is running on a completely different CPU architecture from the actual CPU on which it is running. Such emulation, however, has a significant performance cost. The number of actual CPU cycles needed to emulate virtual CPU cycle can be large.

network performance: ability of a network or network portion to provide the functions related to communications between users.

NOTE 1: Network performance applies to the network provider's planning, development, operations and maintenance and is the detailed technical part of Quality of Service offered.

NOTE 2: Network performance parameters are meaningful to network providers and are quantifiable at the part of the network which they apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the following abbreviations apply:

BSS	Business Support System
CCM	Container Infrastructure Service Cluster Management
CD	Compute Domain
CIR	Container Image Registry
CIS	Container Infrastructure Service
CISM	Container Infrastructure Service Management
CPU	Central Processing Unit
CPUID	Central Processing Unit Identification
DF	Deployment Flavour
EAE	Energy-Aware Entity
EAS	Energy-Aware Entity
EM	Element Management
GAL	Green Abstraction Layer
GSI	Green Standard Interface
IP	Internet Protocol
LCM	LifeCycle Management
MANO	Management and Orchestration
MCIO	Managed Container Infrastructure Object
NFD	Network Function Descriptor
NFV	Network Functions Virtualisation
NFVI	Network Functions Virtualisation Infrastructure
NFVO	Network Functions Virtualisation Orchestrator
NS	Network Service
NSD	Network Service Descriptor
NsDf	Network Service Deployment Flavour
OS	Operating System
OSS	Operation Support System
PM	Performance Management
PNF	Physical Network Function
PNFD	Physical Network Function Descriptor
PoP	Point of Presence
vCPU	virtual CPU

VDU	Virtual Deployment Unit
VIM	Virtualised Infrastructure Manager
VM	Virtual Machine
VNF	Virtualised Network Function
VNFC	VNF Component
VNFD	VNF Descriptor
VnfDf	VNF Deployment Flavour
VNFM	Virtualised Network Function Manager
WAN	Wide Area Network
WIM	Wide area network Infrastructure Manager

4 Foreground

4.1 Green Abstraction Layer

Green Abstraction Layer provides means of exchanging information about capabilities and parameter settings between energy-aware networking devices and their network management primitives. It allows hiding the specificities of devices and their internal operations by means of an abstract interface through which only a description of energy-related parameters can be conveyed, read and configured. At the same time, a hierarchical structure is defined in order to propagate a similar abstract representation throughout the component parts of devices (chassis, subsystems, electronic boards, etc.) at the proper level of detail and granularity.

In this respect ETSI ES 203 237 [1] contains:

- The definition of the GAL general architecture.

- The definition of the Energy-Aware States (EASs) describing the different power configurations and corresponding network performance of an Energy-Aware Entity.

- The definition of the Green Standard Interface used to discover Energy-Aware Entities, their autonomic provisioning and manual configuration, their monitoring and their decommissioning.

4.2 NFV architectural framework

ETSI GS NFV 006 [i.1] describes the high-level functional architectural framework for the Management and Orchestration part of the NFV architectural framework. It is composed of the following functional blocks and functions realizing management and orchestration capabilities:

- Network Functions Virtualisation Orchestrator (NFVO).

- Virtualised Network Function Manager (VNFM).

- Virtualised Infrastructure Manager (VIM).

- Wide area network Infrastructure Manager (WIM).

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

- Element Management (EM).

- Virtualised Network Function (VNF).

- Operation Support System (OSS) and Business Support System functions (BSS).

- NFV Infrastructure (NFVI), including the Container Infrastructure Service (CIS) and Wide Area Network (WAN).

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

- Os-Ma-nfvo, a reference point between OSS/BSS and NFVO.

- Or-Vnfm, a reference point between NFVO and VNFM.

- Or-Vi, a reference point between NFVO and VIM.

- Ve-Vnfm-em, a reference point between EM and VNFM.

- Ve-Vnfm-vnf, a reference point between VNF and VNFM.

- Vi-Vnfm, a reference point between VIM and VNFM.

- Nf-Vi, a reference point between NFVI and VIM.

- Or-Or, a reference point between NFVOs in different administrative domains.

- Or-Wi, a reference point between an NFVO and a WIM.

The following functions shall be part of the NFV-MANO architectural framework:

- Container Infrastructure Service Management (CISM);

- Container Image Registry (CIR);

- Container Infrastructure Service Cluster Management (CCM).

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

- The NFVO consumes management service interfaces produced by the CISM.

- The VNFM consumes management service interfaces produced by the CISM.

- The NFVO consumes management service interfaces produced by the CIR.

- The VNFM consumes management service interfaces produced by the CIR.

- The NFVO consumes management service interfaces produced by the CCM.

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

- The CCM consumes management interfaces produced by the NFVO.

- The CCM consumes management interfaces produced by the VIM.

- The CCM consumes management service interfaces produced by the CISM.

- The CISM consumes management interfaces produced by the VIM.

The functions and service interfaces introduced for support of containerized deployments are shown in Figure 4.2-1.
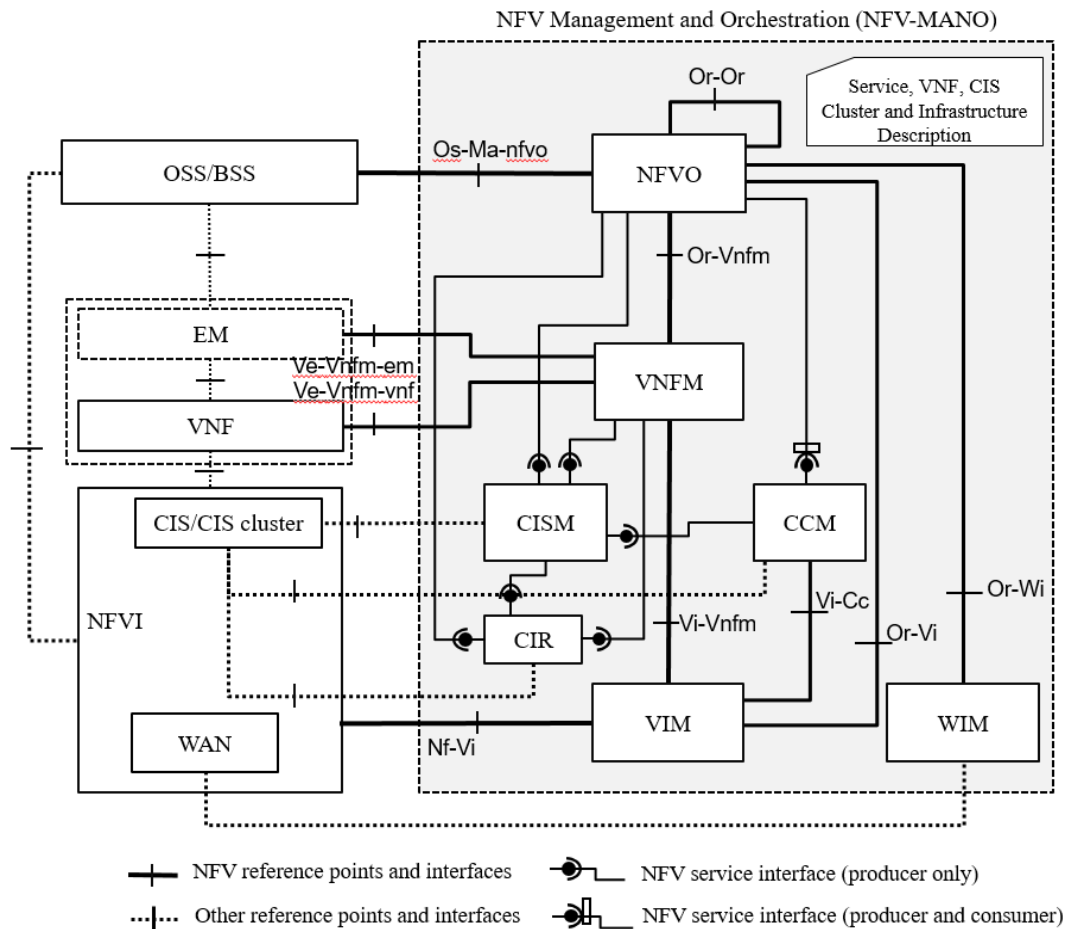
Figure 4.2-1: NFV-MANO architectural framework

5   Use case

5.1   Foreground - Virtualised Network Function scaling

Different aspects of a VNF can be scaled independently. For example a VNF could be designed to provide static capacity such as database nodes and dynamic capacity such as call processing nodes. Such a VNF might be scaled with regard to two separate aspects: the 'static capacity' aspect can be scaled by adding database VNFCs, and the 'dynamic capacity' aspect can be scaled by adding call processing VNFCs.

When scaling a VNF for a particular aspect, the number of scaling steps to apply to that aspect can be provided as a parameter. A scaling step is the smallest unit by which a particular aspect of a VNF can be scaled, and is mapped by the VNFM to the addition (or removal) of a certain number of resources based on one or more Virtual Deployment Units (VDUs) that describe the VNFCs' resource requirements and their operational behaviour [2].

For each scaling aspect, the maximum scale level is defined in the VNF Descriptor (VNFD) [2], whereas the minimum scale level is assumed to be zero; the maximum scale level corresponds to the maximum number of steps that can be performed within this aspect, starting at the minimum scale level. At each point in time between the completed VNF instantiation and the VNF termination, the size of the VNF with regard to a particular aspect can be expressed by the current scale level with regard to that aspect. Figure 5.1-1 illustrates the concepts described above.
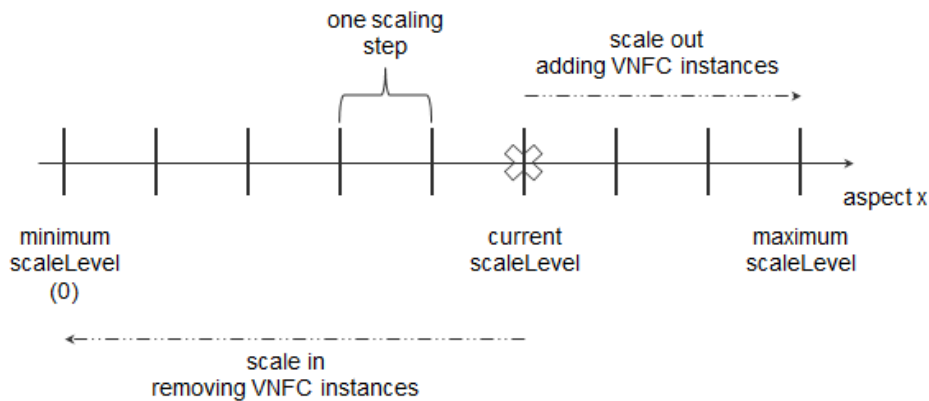
Figure 5.1-1: Concepts of scale level and scaling steps for a given aspect

Figure 5.1-2 illustrates a VNF with two scaling aspects ("database" and "call_proc") [i.2]. The square filled boxes represent individual VNFC instances, the blue frame rectangles group these VNFC instances into scaling deltas, and the colour of the squares denotes the applicable VDU for the VNFC instance. The initial delta "delta_initial" marks the smallest size of the VNF that can be instantiated. It is used as the baseline for any scaling operation and needs to be instantiated before any scaling delta can be added.

When the VNF is instantiated, the current scale level is initialized with values that are defined as part of the instantiation level in the VNFD for the associated aspect. In the illustrated example, when the instantiation level is set to "instantiation_level_2", the scale level of the "call_proc" aspect is set to "3", and the one of the "database" aspect is set to "2".
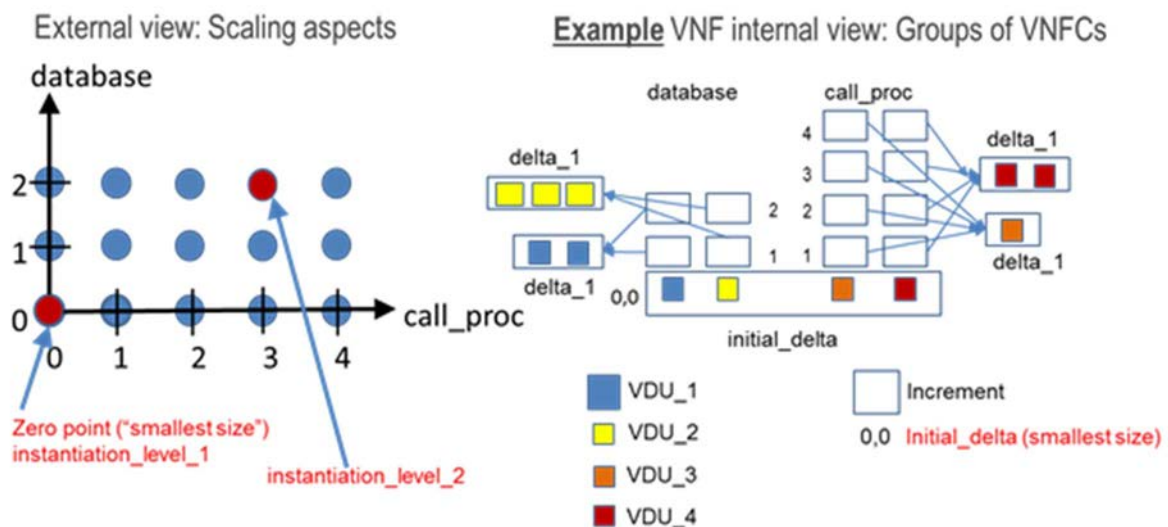
Figure 5.1-2: ScalingAspect and InstantiationLevels concepts

5.2 Scenario illustrating a VNF Energy-Aware States

In the proposed scenario based on VNFC in container on bare metal depicted in ETSI GR NFV-IFA 029 [i.3], the VNF is deployed on a bare metal server whose processor has three guaranteed base frequencies as depicted in [i.4]. The instantiation level is the initial level, i.e. "instantiation_level_1" according to Figure 5.1-2.

In the scenario, the VNF instantiation level is the initial level, i.e. "database=0, call_proc=0", composed of four VNFC instances: two instances for the "database" aspect and two instances for the "call_proc" aspect. The energy-aware states number of each instance are supposed to be equal to three.

For each aspect level, the energy-aware states are a combination of the energy-aware states of their VNFC instances.

At the VNF level, the energy-aware states are a combination of the energy-aware states of the two aspects (Figure 5.2-1).
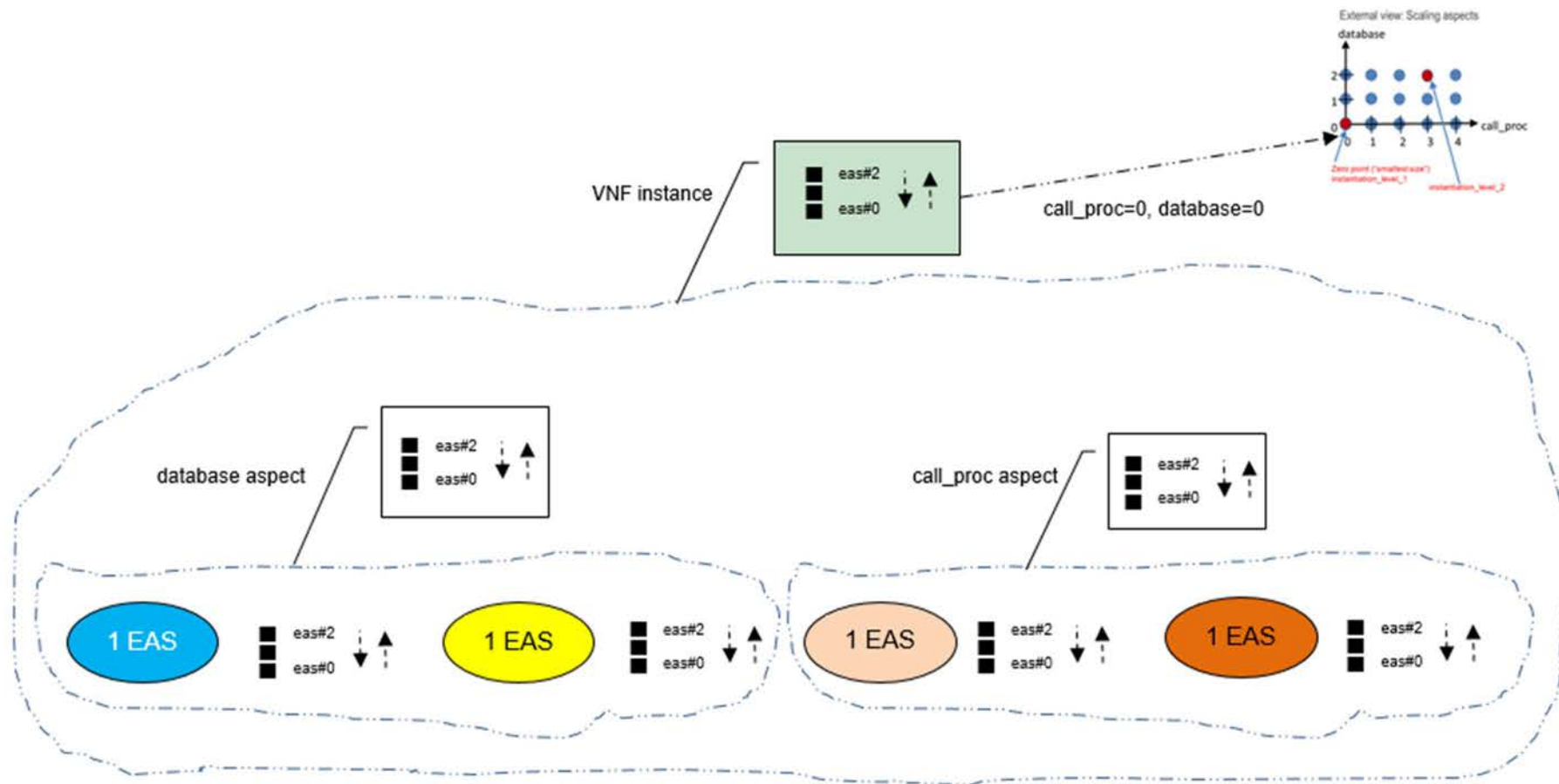
Figure 5.2-1: VNF energy-aware states at the instantiation level "database=0, call_proc=0"

At the instantiation level "database=2, call_proc=2", the VNF is composed of twenty VNFC instances: twelve instances for the "database" aspect and eight instances for the "call_proc" aspect. The energy-aware states number of each instance are supposed to be equal to three.

For each aspect level, the energy-aware states are a combination of the energy-aware states of their VNFC instances.

At the VNF level, the energy-aware states are a combination of the energy-aware states of the two aspects (Figure 5.2-2).
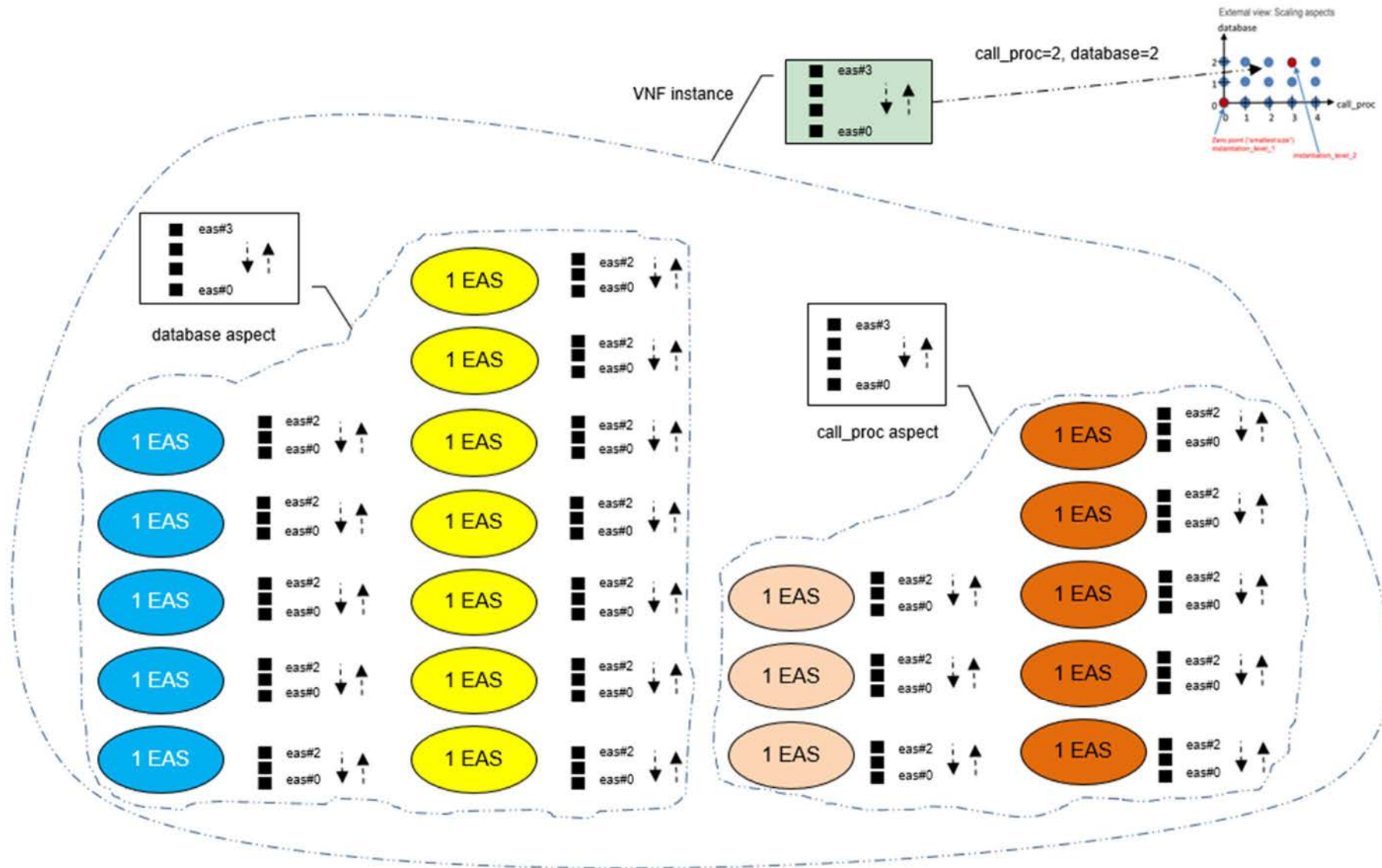
Figure 5.2-2: VNF energy-aware states at the instantiation level "database=2, call_proc=2"

5.3   Actors and roles

Table 5.3-1 describes the use case actors and roles.

**Table 5.3-1: VNF run-time virtual EAS at the instantiation level
"database=0, call_proc=0" actors and roles**

#	Role	Description
1	NFV-MANO	NFV Management and Orchestration functional blocks including the NFVO, the VNFM and the VIM without the Container Infrastructure Service Management functionality.
2	Container Infrastructure Service Management	Management of the containers and their runtime environment. This can be a separate functional block or be integrated in an NFV-MANO component.
3	NFVI Virtualisation Layer	Contains the runtime environment for containers, which includes the OS.

5.4   Pre-conditions

Table 5.4-1 describes the use case pre-conditions.

**Table 5.4-1: VNF run-time virtual EAS at the instantiation level
"database=0, call_proc=0" pre-conditions**

#	Pre-condition	Additional description
1	NFVI Virtualisation Layer provides the container runtime environment.	The run-time virtual energy-aware states of an OS container are based on the configuration of underlying hardware capabilities performed at the CIS instance level. The run-time virtual energy-aware states of a group of OS containers, e.g. Kubernetes® pod, are chosen by applying a designed policy rule that maps the run-time virtual energy-aware states of the OS containers to the run-time virtual energy-aware states of the group of OS containers. The run-time virtual energy-aware states of one VNFC instance are chosen by applying a designed policy rule, i.e. a (1:1) relation, that maps the run-time virtual energy-aware states of a group of OS containers to the run-time virtual energy-aware states of the VNFC instance.
2	NFV templates (e.g. VNFD, VDU) provide all information necessary for the deployment of container images.	This might include dependencies on OS types or specific drivers. Requirements about virtual energy-aware states of VNFs, VNFCs, scaling aspects, are included.

5.5   Post-conditions

Table 5.5-1 describes the use case post-conditions.

**Table 5.5-1: VNF run-time virtual EAS at the instantiation level
"database=0, call_proc=0" post-conditions**

#	Post-condition	Additional description
1	The VNF can use the VNFCs deployed in the containers on bare metal. See ETSI GR NFV-IFA 029 [i.3]. The instantiation level is the initial level, i.e. "database=0, call_proc=0".	The run-time virtual energy-aware state of each VNFC instance is known by NFV-MANO. The run-time virtual energy-aware state of each aspect of the VNF instance is known by NFV-MANO. The run-time virtual energy-aware state of the VNF instance is known by NFV-MANO.

5.6   Flow description

Table 5.6-1 describes the use case flow.

**Table 5.6-1: VNF run-time virtual EAS at the instantiation level
"database=0, call_proc=0" flow description**

#	Actors and role	Action description
Begins when	NFV-MANO	NFV-MANO needs to instantiate a VNF in a given required virtual energy-aware state, the VNF being implemented as VNFC instances in containers on bare metal.
Step 1	NFV-MANO -> Container Infrastructure Service Management	NFV-MANO provides the container images and requests the Container Infrastructure Service Management to instantiate the containers using these images. For each VNFC, its VDU provides the required virtual energy-aware states of the group of OS containers for use by the Container Infrastructure Service Management.
Step 2	Container Infrastructure Service Management -> Virtualisation Layer	The Container Infrastructure Service Management instantiates the containers using the container images. The CIS instance in which the group of OS containers are deployed provides the run-time virtual energy-aware state of the group to the CISM. NOTE: the relation between the virtual energy-aware states of the group of OS containers and the virtual energy-aware states of each container is done according to policy rules.
Step 3	Container Infrastructure Service Management -> NFV-MANO	The Container Infrastructure Service Management responds to NFV-MANO the successful instantiation of the containers.
Step 4	NFV-MANO	NFV-MANO completes the instantiation of the VNF by using the instantiated containers as VNFCs.
Ends when	NFV-MANO	NFV-MANO has completed the instantiation of the VNF and is aware of the run-time virtual energy-aware states of the VNFC(s), the scaling aspect(s), and the VNF.

6   Virtual energy-aware states definition

6.1   Identification of the ETSI NFV components

6.1.0   NFV components

The components that are in the scope of the present document are the Compute Domain (CD), Managed Container Infrastructure Object (MCIO), VNFC, VNF and Network Service (NS).

6.1.1   Identification of a Network Service

The identification of a given Network Service "a" is done according to the following notation: $NS{\sim}a, with\ a\ \epsilon\ [a0, a1, a2, a3, ...,]$.

The ith instance of NS~a deployed according to a given NS Deployment Flavour, noted $DF\text{-}X$, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is identified with the following notation: $NS{\sim}a\#i_{DF\text{-}X\#l_{DF\text{-}X}}, with\ i\ \epsilon\ [1, 2, 3, ...,]$.

6.1.2   Identification of a Virtualised Network Function

The identification of a given Virtualised Network Function "b" is done according to the following notation: $VNF{\sim}b, with\ b\ \epsilon\ [b0, b1, b2, b3, ...,]$.

The jth instance of VNF~b deployed according to a given VNF Deployment Flavour, noted $DF\text{-}X$, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is identified with the following notation: $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}, with\ j\ \epsilon\ [1, 2, 3, ...,]$.

The jth instance of VNF~b belonging to $NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}$, and deployed according to a given VNF Deployment Flavour, noted $DF\text{-}X$, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is identified with the following notation: $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ Ì $NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}$.

When the NS~a Deployment Flavour supports scaling, the jth instance of VNF~b deployed according to a given VNF Deployment Flavour in a given instantiation level, that belongs to the ASPECT-Ym in a given scale level l_{Ym}, is identified with the following notation: $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ Ì $NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}$.

6.1.3   Identification of a Virtualised Network Function Component

The identification of a given Virtualised Network Function Component is done according to the following notation: $VNFC\sim c$, with $c \in [c0, c1, c2, c3, \dots,]$.

The kth instance of VNFC~c is identified with the following notation: $VNFC\sim c\#k$, with $k \in [1, 2, 3, \dots,]$.

The kth instance of VNFC~c belonging to $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ is identified with the following notation: $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$.

When the VNF~b Deployment Flavour supports scaling, the kth instance of VNFC~c, that belongs to the ASPECT-Ym in a given scale level l_{Ym}, is identified with the following notation: $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}$.

6.1.4   Identification of a managed container infrastructure object

The identification of a given managed container infrastructure object, in which the kth instance of VNFC~c ($VNFC\sim c\#k$) is deployed, is done according to the following notation: $MCIO_{VNFC\sim c\#k}$.

6.1.5   Identification of a compute domain

The identification of the compute domain used to deploy the managed container infrastructure object, in which the kth instance of VNFC~c ($VNFC\sim c\#k$) is deployed, is done with a function that takes $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ as an argument and returns the compute domain identifier: $cd(VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}})$.

NOTE: Anti-affinity rules make possible the deployment of the kth instance of VNFC~c on a compute domain and the deployment of the k'^{th} instance of VNFC~c on a different compute domain.

6.1.6   Identification of a VNFC instance energy-aware state

The identification of a VNFC instance energy-aware state is done according to the following notation: $(EAS_x)^{VNFC\sim c\#k}$ Ì $^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}$, with x being a real number.

NOTE: The xth EAS depends on the compute domain used to deploy the managed container infrastructure object in which the kth instance of VNFC~c ($VNFC\sim c\#k$) is deployed.

6.1.7   Identification of a VNF instance energy-aware state

The identification of a VNF instance energy-aware state is done according to the following notation: $(EAS_y)^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}$ Ì $^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}$, with y being a real number.

NOTE: The yth EAS depends on the compute domain used to deploy the managed container infrastructure objects.

6.1.8   Identification of a NS instance energy-aware state

The identification of a NS instance energy-aware state is done according to the following notation: $(EAS_z)^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}$, with z being a real number.

NOTE: The zth EAS depends on the compute domain used to deploy the managed container infrastructure objects.

6.2   VNFC virtual energy-aware states definition

6.2.1   When the Vdu is realized by a virtual compute resource

6.2.1.1   Virtual compute resource required virtual energy-aware states

When a virtual compute resource realizes the Vdu, Table 7.1.9.2.2.2-1 in ETSI GS NFV-IFA 011 [2] contains the attributes of the VirtualComputeDesc information element for supporting the CPU, memory, and acceleration requirements. In this table, a new attribute, representing the Virtual Energy-Aware States descriptor of the virtual compute resource, is added. The name of the attribute is "virtualComputeDescRequiredVirtualEnergyAwareState", its qualifier shall be M, the cardinality shall be 0 .. 1, the content shall be VirtualEnergyAwareStatesData.

The attributes of the VirtualEnergyAwareStatesData information element are listed in Table 6.2.1.1-1.

Table 6.2.1.1-1: Attributes of the VirtualEnergyAwareStatesData information element

Attribute	Qualifier	Cardinality	Content	Description
cpuIdentification	Mandatory	0..N	String	For x86 architecture, information is obtained through the CPU Identification (CPUID) instruction. The cardinality can be 0 during the allocation request if there is no requirement on the architecture, therefore if there is no requirement neither on the base frequency, nor on the power states.
cpuBaseFrequencyRequirements	Mandatory	0..N	Not specified	Array of key-value pair requirements on the base frequency of the compute (CPU) for the VDU.
cpuPowerStatesRequirements	Mandatory	0..N	Not specified	Array of key-value pair requirements on the power states of the compute (CPU) for the VDU.
virtualCpuPinning	Mandatory	0..1	VirtualCpuPinningData	The VirtualCpuPinningData information element supports the specification of requirements related to the virtual CPU pinning configuration of a virtual compute resource. See clause 7.1.9.2.4 in ETSI GS NFV-IFA 011 [2].
virtualEnergyAwareStatesCpuPolicy	Mandatory	0..1	Enum	Indicates the policy for the allocation of the virtual Energy-Aware States based on the CPU power states. See note. The values are: "STATIC", "DYNAMIC". In case of "STATIC", the virtual required Energy-Aware States are allocated based on the CPU power states according to the rules provided in virtualEnergyAwareStatesRules. In case of "DYNAMIC", the allocation of the virtual required Energy-Aware States is decided by the VIM.
virtualEnergyAwareStatesRules	Mandatory	0..N	Not specified	List of rule(s) that should be considered during the allocation of the virtual required Energy-Aware States in case of "STATIC" virtualEnergyAwareStatesCpuPolicy.
NOTE: The virtual energy aware states are ranked according to the rule defined in ETSI ES 203 237 [1].				

6.2.2   When the Vdu is realized by a set of OS Containers resource

6.2.2.1   OS Container and MCIO resource required virtual energy-aware states

6.2.2.1.1   Resources association can be done at two different levels

In the case of VNF with containerized components, information exchanges associated to resources is performed at two different levels: OS container and MCIO. As specified in clause 5.2.1.2 of ETSI GS NFV-IFA 040 [i.5], the properties of Compute MCIO and Storage MCIO are specified in the VDU of the VNFD, and there is a "1:1" relationship between an instantiated VNFC of a VNF and the Compute MCIO.

NOTE: Association of a specific instance of a Pod in a Deployment/StatefulSet to a specific instance of a VNFC is done by the VNFM. There are two types of association: the one is "Free" association (i.e. any Pod can be associated to any VNFC instance) which assumes that all Pod replicas in a Deployment/StatefulSet are all the same and therefore, VNFM can freely associate any of these to a VNFC instance and the other is "Guided" association which assumes that some specific metadata/characteristics of the Pod (e.g. its Internet Protocol (IP) address) can be used to associated to a specific VNFC instance [i.6].

6.2.2.1.2   OS Container resource required virtual energy-aware states

When a set of OS Containers resource realizes the Vdu, Table 7.1.6.13.2-1 in ETSI GS NFV-IFA 011 [2] contains the attributes of the OsContainerDesc information element for supporting the requirements and limits of the CPU, of the memory, and the software images of the OS Containers. In this table, a new attribute, representing the Virtual Energy-Aware States descriptor of the virtual compute resource, is added. The name of the attribute is "osContainerDescRequiredVirtualEnergyAwareState", its qualifier shall be M, the cardinality shall be 0 .. 1, the content shall be VirtualEnergyAwareStatesData.

6.2.2.1.3   MCIO resource required virtual energy-aware states

The attributes of the Vdu information element shall follow the indications provided in ETSI GS NFV-IFA 011 [2], Table 7.1.6.2.2-1. In this table, a new attribute, representing the Virtual Energy-Aware States descriptor of the virtual compute resource, is added. The name of the attribute is "mcioDescRequiredVirtualEnergyAwareState", its qualifier shall be M, the cardinality shall be 0 .. 1, the content shall be VirtualEnergyAwareStatesData.

The attributes of the VirtualEnergyAwareStatesData information element are listed in Table 6.2.2.1.3-1.

Table 6.2.2.1.3-1: Attributes of the VirtualEnergyAwareStatesData information element

Attribute	Qualifier	Cardinality	Content	Description
cpuIdentification	Mandatory	0..N	String	For x86 architecture, information is obtained through the CPUID instruction. The cardinality can be 0 during the allocation request if there is no requirement on the architecture, therefore if there is no requirement neither on the base frequency, nor on the power states.
cpuBaseFrequencyRequirements	Mandatory	0..N	Not specified	Array of key-value pair requirements on the base frequency of the compute (CPU) for the VDU.
cpuPowerStatesRequirements	Mandatory	0..N	Not specified	Array of key-value pair requirements on the power states of the compute (CPU) for the VDU.
virtualCpuPinning	Mandatory	0..1	VirtualCpuPinningData	The VirtualCpuPinningData information element supports the specification of requirements related to the virtual CPU pinning configuration of a MCIO resource. See Table 6.2.2.1.3-2.

Attribute	Qualifier	Cardinality	Content	Description
virtualEnergyAwareStatesCpuPolicy	Mandatory	0..1	Enum	Indicates the policy for the allocation of the virtual Energy-Aware States based on the CPU power states. See note. The values are: "STATIC", "DYNAMIC". In case of "STATIC", the virtual required Energy-Aware States are allocated based on the CPU power states according to the rules provided in virtualEnergyAwareStatesRules. In case of "DYNAMIC", the allocation of the virtual required Energy-Aware States is decided by the CISM.
virtualEnergyAwareStatesRules	Mandatory	0..N	Not specified	List of rules that should be considered during the allocation of the virtual required Energy-Aware States in case of "STATIC" virtualEnergyAwareStatesCpuPolicy.
NOTE: The virtual energy aware states are ranked according to the rule defined in ETSI ES 203 237 [1].				

The VirtualCpuPinningData information element in Table 6.2.2.1.3-2 supports the specification of requirements related to the virtual CPU pinning configuration of a virtual compute resource.

Table 6.2.2.1.3-2: Attributes of the VirtualCpuPinningData information element

Attribute	Qualifier	Cardinality	Content	Description
virtualCpuPinningPolicy	Mandatory	0..1	Enum	Indicates the policy for CPU pinning. The values are: "STATIC", "DYNAMIC". In case of "STATIC" the virtual CPU cores are requested to be allocated to logical CPU cores according to the rules defined in virtualCpuPinningRules. In case of "DYNAMIC" the allocation of virtual CPU cores to logical CPU cores is decided by the CISM.
virtualCpuPinningRule	Mandatory	0..N	Not specified	List of rules that should be considered during the allocation of the virtual CPUs to logical CPUs in case of "STATIC" virtualCpuPinningPolicy.

6.2.3 VNFC required virtual energy-aware states in the VduProfile information element

The VduProfile information element, provided in Table 7.1.8.3.2-1, ETSI GS NFV-IFA 011 [2], shall contain the minVnfcRequiredVirtualEnergyAwareState attribute and maxVnfcRequiredVirtualEnergyAwareState attribute.

6.3 VNF virtual energy-aware states definition

6.3.1 VNF required virtual energy-aware states in the VNFD information element

Table 7.1.2.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the Vnfd information element shall contain the VNF required virtual energy-aware states.

The name of the attribute is "vnfdRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData.

6.3.2   VNF required virtual energy-aware states in the VnfDf information element

Table 7.1.8.2.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the Vnf Deployment Flavour (VnfDf) information element shall contain the VNF required virtual energy-aware states.

The name of the attribute is "vnfRequiredDfVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the VNF.

With respect to the default instantiation level, the name of the attribute is "defaultInstantiationLevelRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor of the default instantiation level supported by this Deployment Flavour of the VNF.

6.3.3   VNF required virtual energy-aware states in the InstantiationLevel information element

Table 7.1.8.7.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the InstantiationLevel information element shall contain the VNF required virtual energy-aware states.

The name of the attribute is "instantiationLevelRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor of the instantiation level supported by this DF of the VNF.

6.3.4   VNF required virtual energy-aware states in the VduLevel information element

Table 7.1.8.9.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the VduLevel information element shall contain the VNF required virtual energy-aware states.

The name of the attribute is "vduLevelRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor of the vdu level supported by this DF of the VNF.

6.3.5   VNF required virtual energy-aware states in the ScalingAspect information element

Table 7.1.10.2.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the ScalingAspect information element shall contain the VNF required virtual energy-aware states. For each scaling step, from the minimum scale level (i.e. scale level zero) to the maximum scale level defined by the maxScaleLevel attribute, the "scalingAspectRequiredVirtualEnergyAwareStateId" attribute shall contain the identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], of the required virtual energy aware state(s). The qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s) to reference VirtualEnergyAwareStatesData.

6.3.6   VNF required virtual energy-aware states in the AspectDeltaDetails information element

Table 7.1.10.3.2-1 in ETSI GS NFV-IFA 011 [2] containing the attributes of the AspectDeltaDetails information element shall contain the VNF required virtual energy-aware states.

The name of the attribute is "aspectDetailsRequiredVirtualEnergyAwareState", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be VirtualEnergyAwareStatesData, ranked according to the rule defined in ETSI ES 203 237 [1]. It declares the different sets of virtual energy-aware states, each set being related to one or more scaling steps of the aspect.

Each set of required virtual energy-aware states shall be declared in the scalingAspectRequiredVirtualEnergyAwareState attribute.

The aspectDetailsRequiredVirtualEnergyAwareStateId attribute references the set of required virtual energy-aware states to be applied for each scaling step, starting from scale level "0". The qualifier shall be M, the cardinality shall be 0 .. N, the content shall be an identifier of a set of virtual energy-aware states provided in the aspectDetailsVirtualEnergyAwareState attribute. The first entry in the array shall correspond to the identifier of the set of virtual energy-aware states of the first scaling step (from scale level "0" to scale level "1") and the last entry in the array shall correspond to the identifier of the set of virtual energy-aware states in the last scaling step (from scale level "maxScaleLevel-1" to scale level "maxScaleLevel").

6.4 NS virtual energy-aware states definition

6.4.1 NS required virtual energy-aware states in the NSD information element

Table 6.2.2.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the Network Service Descriptor (NSD) information element shall contain the NS required virtual energy-aware states.

The name of the attribute is "nsdRequiredVirtualEnergyAwareStateId", its the qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData.

6.4.2 NS required virtual energy-aware states in the Network Service Deployment Flavour information element

Table 6.3.2.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the Network Service Deployment Flavour (NsDf) information element shall contain the Network Service required virtual energy-aware states.

The name of the attribute is "nsDfRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the Network Service.

6.4.3 NS required virtual energy-aware states in the NsScalingAspect information element

Table 6.7.2.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the Network Service Scaling Aspect information element shall contain the NS required virtual energy-aware states.

The name of the attribute is "nsScalingAspectRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the NS for this Network Service Scaling Aspect.

6.4.4 NS required virtual energy-aware states in the NsLevel information element

Table 6.3.9.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the Network Service Level (NsLevel) information element shall contain the NS required virtual energy-aware states.

The name of the attribute is "nsLevelRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the NS for this Network Service Level.

6.4.5   NS required virtual energy-aware states in the VnfToLevelMapping information element

Table 6.7.4.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the VnfToLevelMapping information element shall contain the NS required virtual energy-aware states.

The name of the attribute is "vnfToLevelMappingRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the NS for this VnfToLevelMapping.

6.4.6   NS required virtual energy-aware states in the VnfProfile information element

Table 6.3.3.2-1 in ETSI GS NFV-IFA 014 [3] containing the attributes of the VnfProfile information element, specifying a profile for instantiating VNFs of a particular NS DF according to a specific VNFD and VNF DF, shall contain the NS required virtual energy-aware states.

The name of the attribute is "vnfProfileRequiredVirtualEnergyAwareStateId", its qualifier shall be M, the cardinality shall be 0 .. N, the content shall be identifier(s), ranked according to the rule defined in ETSI ES 203 237 [1], to reference VirtualEnergyAwareStatesData. It represents the identifier(s) of the Virtual Energy-Aware States descriptor supported by this Deployment Flavour of the NS for this VnfProfile.

The minVnfRequiredVirtualEnergyAwareStateId attribute and the maxVnfRequiredVirtualEnergyAwareStateId attribute shall be included.

7   GAL Green Standard Interface

7.0   NFV-MANO architectural framework

The NFV-MANO architectural framework, with the functions and service interfaces introduced for support of containerized deployments, is illustrated in ETSI GS NFV 006 [i.1] and reproduced in Figure 4.2-1.

7.1   Provisioning operations

7.1.0   Generality

The present clause specifies the GAL Green Standard Interface supported over the reference points of the NFV MANO architectural framework as well as the information elements exchanged over those interfaces. GAL Provisioning configures EASs of virtualised resources.

7.1.1   Os-Ma-Nfvo reference point

7.1.1.1   Instantiate NS operation

7.1.1.1.1   Description

This operation instantiates an NS in the NOT_INSTANTIATED state. The operation allows for references to existing VNF instances and NS instances that are to be used in the new NS (i.e. the NS being instantiated) and additional parameterization for new VNFs and NSs. The hierarchy of nested NS and VNFs below the NS being instantiated shall be acyclic (i.e. no loops), see ETSI GS NFV-IFA 013 [4].

Table 7.1.1.1.1-1 lists the information flow exchanged between OSS/BSS and NFVO, described in ETSI GS NFV-IFA 013 [4].

Table 7.1.1.1.1-1: Instantiate NS operation

Message	Requirement	Direction
InstantiateNsRequest	Mandatory	OSS/BSS → NFVO
InstantiateNsResponse	Mandatory	NFVO → OSS/BSS

7.1.1.1.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.3.2-1.

The energyAdditionalParamForNs parameter provided in Table 7.1.1.1.2-1 shall be added, allowing OSS/BSS to provide an additional parameter during the instantiation of this NS according to the selected NsDf. It shall contain the identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by this NsDf.

**Table 7.1.1.1.2-1: energyAdditionalParamForNs attribute in
Instantiate NS operation information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForNs	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by this NsDf.

7.1.1.1.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.3.3-1.

7.1.1.1.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.3.3.4.

7.1.1.2 Scale NS operation

7.1.1.2.1 Description

This operation will scale an NS instance. Scaling an NS instance can be performed by explicitly adding/removing existing VNF instances to/from the NS instance, by leveraging on the abstraction mechanism provided by the NS scaling aspects and NS levels information elements declared in the NSD, or by scaling individual VNF instances that are part of the NS itself. When adding VNFs and nested NSs - already existing or not - to the NS to be scaled, the NFV shall follow the indications provided by the dependencies attribute, as specified in the corresponding NSD, see ETSI GS NFV-IFA 013 [4].

Table 7.1.1.2.1-1 lists the information flow exchanged between OSS/BSS and NFVO described in ETSI GS NFV-IFA 013 [4].

Table 7.1.1.2.1-1: Scale NS operation

Message	Requirement	Direction
ScaleNsRequest	Mandatory	OSS/BSS → NFVO
ScaleNsResponse	Mandatory	NFVO → OSS/BSS

7.1.1.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [7], Table 7.3.4.2-1.

The scaleNsData parameter provides the information to scale the referenced NS instance. The ScaleNsData information element, provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.6.2-1, describes the information needed to scale the instance either by explicitly adding/removing existing VNF instances or by leveraging on the abstraction mechanism provided by the NS scaling aspects and NS levels information elements declared in the NSD:

- The energyAdditionalParamForNs attribute provided in Table 7.1.1.2.2-1 shall be added, allowing OSS/BSS to provide additional parameter(s) necessary for the scaling at the NS level. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the NsDf used to deploy the NS instance whose identifier is nsInstanceId.

Table 7.1.1.2.2-1: energyAdditionalParamForNs attribute in ScaleNsData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForNs	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the NsDf used to deploy the NS instance whose identifier is nsInstanceId.

- The energyAdditionalParamForVnf attribute provided in Table 7.1.1.2.2-2 shall be added, allowing OSS/BSS to provide additional parameter(s) per VNF instance that is to be created by NFVO as part of the NS scaling. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstance.

Table 7.1.1.2.2-2: energyAdditionalParamForVnf attribute in ScaleNsData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

The scaleVnfData parameter provides the information to scale a given VNF instance that is part of the referenced NS instance. The ScaleVnfData information element, provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.9.2-1, describes the information needed, either to scale a given VNF instance to a given level (ScaleToLevelData information element), or to scale a VNF instance by steps (ScaleByStepData information element).

The ScaleToLevelData information element, provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.10.2-1, describes the information needed to scale the VNF instance to a given level, either expressed as an instantiation level of a given Deployment Flavour, or as a list of scale levels, one per scaling aspect of that Deployment Flavour. The energyAdditionalParam attribute provided in Table 7.1.1.2.2-3 shall be added, allowing OSS/BSS to provide additional parameter(s) specific to the VNF instance being scaled. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.2.2-3: energyAdditionalParam attribute in ScaleToLevelData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

The ScaleByStepData information element, provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.11.2-1, describes the information needed to scale the VNF instance by steps. The energyAdditionalParam attribute provided in Table 7.1.1.2.2-4 shall be added, allowing OSS/BSS to provide additional parameter(s) specific to the VNF instance being scaled. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.2.2-4: energyAdditionalParam attribute in ScaleByStepData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

7.1.1.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.4.3-1.

7.1.1.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.3.4.4.

7.1.1.3   Update NS operation

7.1.1.3.1   Description

This operation updates an NS instance. Only one type of update shall be allowed per operation. This operation is also used to embed VNF LifeCycle Management operations in support of fine grained NS LCM approach, see ETSI GS NFV-IFA 013 [4].

Table 7.1.1.3.1-1 lists the information flow exchanged between OSS/BSS and NFVO ETSI GS NFV-IFA 013 [4].

Table 7.1.1.3.1-1: Update NS operation

Message	Requirement	Direction
UpdateNsRequest	Mandatory	OSS/BSS → NFVO
UpdateNsResponse	Mandatory	NFVO → OSS/BSS

7.1.1.3.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.5.2-1:

- If updateType=AddVnf: the addVnfInstance parameter specifies an existing VNF instance to be added to the NS instance. The VnfInstanceData specifies existing VNF instances to be used in the NS instance and if needed, the VNF Profile to use for this VNF instance. The attributes of the VnfInstanceData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.3.2-1. The energyAdditionalParam attribute provided in Table 7.1.1.3.2-1 shall be added, allowing OSS/BSS to provide energy additional parameter(s) specific to the VNF being added. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.3.2-1: energyAdditionalParam attribute in VnfInstanceData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

- If updateType=InstantiateVnf: the instantiateVnfData parameter specifies the new VNF to be instantiated. The InstantiateVnfData information element specifies the parameters that are needed for VNF instantiation when the OSS/BSS explicitly requests VNF instantiation for a given NS. When the NFVO invokes the Instantiate VNF operation a set of these parameters are then passed by the NFVO to the VNFM. The attributes of the InstantiateVnfData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.12.2-1. The energyAdditionalParam attribute provided in Table 7.1.1.3.2-2 shall be added, allowing OSS/BSS to provide energy additional parameter(s) specific to the VNF being instantiated, as declared in the VNFD. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.3.2-2: energyAdditionalParam attribute in InstantiateVnfData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

- If updateType=ChangeVnfDf: the ChangeVnfFlavourData specifies existing VNF instance for which the DF needs to be changed. This specifies the new DF, the instantiationLevel of the new DF that may be used and the additional parameters as input for the flavour change. The attributes of the ChangeVnfFlavourData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.15.2-1. The energyAdditionalParam attribute provided in Table 7.1.1.3.2-3 shall be added, allowing OSS/BSS to provide additional parameter(s) to the flavour change process, specific to the VNF being modified, as declared in the VNFD. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.3.2-3: energyAdditionalParam attribute in ChangeVnfFlavourData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

- If updateType=OperateVnf: the operateVnfData parameter specifies the state of the VNF instance to be changed. The attributes of the OperateVnfData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.16.2-1. The energyAdditionalParamInOperateVnfData attribute provided in Table 7.1.1.3.2-4 shall be added, allowing OSS/BSS to provide additional parameter(s) as input to the operate VNF process, specific to the VNF being operated, as declared in the VNFD. It shall require virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.1.3.2-4: energyAdditionalParamInOperateVnfData attribute in OperateVnfData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamInOperateVnfData	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

- If updateType=ModifyVnfInformation: the modifyVnfInfoData parameter specifies the VNF Information parameters and/or the configurable properties of VNF instance to be modified. The attributes of the ModifyVnfInfoData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.17.2-1. The attribute newValues contains the set of attributes to update. The key in the KeyValuePair indicates the name of an attribute that is writable through the interface whose value is to be updated. The value in the KeyValuePair indicates the new attribute value. This attribute shall be used to modify the vnfConfigurableProperty attribute in the VnfInfo information element (ETSI GS NFV-IFA 013 [4], Table 8.3.3.3.2-1). This attribute contains additional VNF-specific attributes that provide the current values of the configurable properties of the VNF instance. These attributes represent values that are stored persistently in the VnfInfo information element and that correspond to configuration parameters of the VNF instance. Modifying the values of these attributes directly affects the configuration of the VNF instance if it exists. OSS/BSS uses this attribute to modify the set of the EASs available for the VNF instance (e.g. to shrink the available EASs at run-time).

- If updateType=ChangeNsDf: the changeNsFlavourData parameter specifies the new DF to be applied to the NS instance. The attributes of the ChangeNsFlavourData operation information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.27.2-1. The energyAdditionalParamInChangeNsFlavourData attribute provided in Table 7.1.1.3.2-5 shall be added, allowing OSS/BSS to provide additional parameter(s) to the flavour change process, specific to the NS being modified, as declared in the Network Function Descriptor (NFD). It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the NsDf used to deploy the NS instance whose identifier is nsInstanceId.

Table 7.1.1.3.2-5: energyAdditionalParamInChangeNsFlavourData attribute in ChangeNsFlavourData operation information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamInChangeNsFlavourData	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the NsDf used to deploy the NS instance whose identifier is nsInstanceId.

- If updateType=AddPnf: the addPnfData parameter specifies information of the Physical Network Functions (PNF(s)) that are being added into the NS instance. The attributes of the AddPnfData information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.4.32.2-1. The energyAdditionalParam attribute provided in Table 7.1.1.3.2-6 shall be added, allowing OSS/BSS to provide additional parameter(s) specific to the PNF being instantiated, as declared in the PNF Descriptor (PNFD).

Table 7.1.1.3.2-6: energyAdditionalParam attribute in AddPnfData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam	Mandatory	0..1	Identifier (reference to an energy aware state)	Identifier of a required energy-aware state chosen among the Energy-Aware States supported by the PNF instance.
NOTE: The content of the energy-aware state should be defined with GALv1 ETSI ES 203 237 [1].				

7.1.1.3.3   Output parameters

The output parameter returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.5.3-1.

7.1.1.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.3.5.4.

7.1.1.4   Query NS operation

7.1.1.4.1   Description

This operation will enable the OSS/BSS to query from the NFVO information on one or more NS(s). The operation also supports querying information about VNF instance(s) that is (are) part of an NS. The operation also supports querying information about available Snapshots of VNF instance(s) that is (are) part of an NS ETSI GS NFV-IFA 013 [4].

Table 7.1.1.4.1-1 lists the information flow exchanged between OSS/BSS and NFVO ETSI GS NFV-IFA 013 [4].

Table 7.1.1.4.1-1: Query NS operation

Message	Requirement	Direction
QueryNsRequest	Mandatory	OSS/BSS → NFVO
QueryNsResponse	Mandatory	NFVO → OSS/BSS

7.1.1.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.6.2-1.

7.1.1.4.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.3.6.3-1.

The attributes of the NsInfo information element, containing information on the NS and VNF instances part of the NS and Snapshots matching the input filter, are provided in ETSI GS NFV-IFA 013 [4], Table 8.3.2.2-1. It shall contain the nsDfVirtualEnergyAwareStateId attribute, provided in Table 7.1.1.4.3-1, identifying the virtual EAS of the Network Service that has been deployed with the flavour identified in the flavourId attribute.

Table 7.1.1.4.3-1: nsDfVirtualEnergyAwareStateId attribute in NsScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
nsDfVirtualEnergyAware StateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the virtual EAS of the Network Service that has been deployed with the flavour identified in the flavourId attribute.

The attributes of the NsScaleInfo information element, representing for each NS scaling aspect declared in the applicable DF, how "big" the NS instance has been scaled with respect to that aspect, are provided in ETSI GS NFV-IFA 013 [4], Table 8.3.3.16.2-1. It shall contain the nsScalingAspectVirtualEnergyAwareStateId attribute, provided in Table 7.1.1.4.3-2, identifying the virtual EAS of the NS scaling aspect that has been scaled to a NS scale level.

Table 7.1.1.4.3-2: nsLevelVirtualEnergyAwareStatesId attribute in NsScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
nsScalingAspectVirtualEnergy AwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the virtual EAS of the NS scaling aspect that has been scaled to a NS scale level

The attributes of the VnfInfo information element, containing information on the constituent VNFs of the Network Service, are provided in ETSI GS NFV-IFA 013 [4], Table 8.3.3.3.2-1.

The attributes of the InstantiatedVnfInfo information element, in ETSI GS NFV-IFA 013 [4], Table 8.3.3.4.2-1, provide run-time information specific to an instantiated VNF instance. The identifier of the run-time virtual energy-aware state of the Deployment Flavour of the instantiated VNF instance, noted vnfDfVirtualEnergyAwareStateId, and provided in Table 7.1.1.4.3-3, shall be added.

**Table 7.1.1.4.3-3: vnfDfVirtualEnergyAwareStateId attribute in
InstantiatedVnfInfo information element**

Attribute	Qualifier	Cardinality	Content	Description
vnfDfVirtualEnergyAwar eStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the Deployment Flavour of the instantiated VNF instance.

The ScaleInfo information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.3.16.2-1. The identifier of the run-time virtual energy-aware state of the scale level of the scaling aspect of the instantiated VNF instance, noted scalingAspectVirtualEnergyAwareStateId, and provided in Table 7.1.1.4.3-4, shall be added.

**Table 7.1.1.4.3-4: scalingAspectVirtualEnergyAwareStateId attribute in
ScaleInfo information element**

Attribute	Qualifier	Cardinality	Content	Description
scalingAspectVirtualEne rgyAwareStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the scale level of the scaling aspect of the instantiated VNF instance.

The ResourceHandle information element, in ETSI GS NFV-IFA 013 [4], Table 8.3.3.8.2-1, of the VnfcResourceInfo information element, in ETSI GS NFV-IFA 013 [4], Table 8.3.3.5.2-1, provides information on virtualised compute used by a VNFC in a VNF instance. Depending on the form of the virtualisation container of the VNFC:

- For a VNFC based on VM, a reference to the corresponding VirtualCompute is provided.

- For a VNFC based on OS container(s), a reference to the Compute MCIO is provided. Hence, exposure of information by the VNFM to the NFVO is at the MCIO level.

The ResourceHandle information element shall contain the identifier of the run-time energy-aware state of the instantiated VNFC instance, noted virtualComputeDescVirtualEnergyAwareStateId, when the instantiated VNFC instance is realized by a virtual compute, noted mcioDescVirtualEnergyAwareStateId when the instantiated VNFC instance is realized by a set of OS Containers, and provided in Table 7.1.1.4.3-5.

Table 7.1.1.4.3-5: energyAwareStateId attribute in ResourceHandle information element

Attribute	Qualifier	Cardinality	Content	Description
virtualComputeDescVirtualEner gyAwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a virtual compute.
mcioDescVirtualEnergyAwareSt ateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a set of OS Containers.

7.1.1.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.3.6.4.

7.1.1.5   Notify (NsLcmOperationOccurenceNotification) operation

7.1.1.5.1   Description

This operation notifies OSS/BSS about events related to notifications about lifecycle operation occurrences on NS instance, lifecycle operation occurrences impacting NS components, as well as the creation/deletion of NS instance identifiers and the associated NsInfo information element instances. It is a one-way operation issued by NFVO that cannot be invoked as an operation by OSS/BSS.

The following notifications can be notified by this operation: NsLcmOperationOccurrenceNotification, NsChangeNotification, NsIdentifierCreationNotification, NsIdentifierObjectDeletionNotification ETSI GS NFV-IFA 013 [4].

Table 7.1.1.5.1-1 lists the information flow exchanged between NFVO and OSS/BSS ETSI GS NFV-IFA 013 [4].

Table 7.1.1.5.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFVO → OSS/BSS

7.1.1.5.2 NsLcmOperationOccurrenceNotification

7.1.1.5.2.1 Description

This notification informs the receiver of changes in the NS lifecycle caused by NS LifeCycle Management operation occurrences, which may be manually triggered by OSS/BSS or automatically triggered by NFVO. The automatic trigger inside NFVO includes auto-scaling, auto-healing and impact on the nested NS instances triggered by the NS lifecycle operation on its composite NS. The support of the notification is mandatory ETSI GS NFV-IFA 013 [4].

7.1.1.5.2.2 Trigger conditions

This notification is produced when there is a change in the NS lifecycle caused by NS LifeCycle Management operation occurrences, including ETSI GS NFV-IFA 013 [4]:

- Instantiation of the NS (start and result).

- Scaling of the NS (start and result, including the auto-scaling).

- Update of the NS (start and result).

- Termination of the NS (start and result).

- Healing of the NS (start and result, including the auto-healing).

- Impact on the nested NS instances triggered by the NS lifecycle operation on its composite NS.

If this is a notification about the start of an LCM operation occurrence, the notification shall be sent before any action is taken, however, after acknowledging the LCM operation request to the consumer.

If this is a notification about the result of an LCM operation, the notification shall be sent after all other actions of the LCM operation have been executed.

7.1.1.5.2.3 Attributes

The attributes of the NsLcmOperationOccurenceNotification notification shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.2.2.3-1.

When the notification represents the result of a LifeCycle Management operation occurrence, the affectedVnf attribute contains information about VNF instances that were affected during the execution of the LifeCycle Management operation.

The AffectedVnf information element shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 8.3.2.3.2-1. The vnfProfileId attribute references the VnfProfile which is used by the affected VNF instance. The attributes of the VnfProfile information element provided in ETSI GS NFV-IFA 014 [3], Table 6.3.3.2-1 shall contain the vnfProfileVirtualEnergyAwareState attribute.

7.1.2   Or-Vnfm reference point

7.1.2.1   Grant VNF Lifecycle Operation operation

7.1.2.1.1   Description

This operation allows the VNFM to request a grant for authorization of a VNF lifecycle operation. When requesting resource creation or modification, the VNFM references the resource definitions that are available to the NFVO in the VNFD. When resources are to be released or modified, the VNFM provides references to the existing resources in the request ETSI GS NFV-IFA 007 [5].

Table 7.1.2.1.1-1 lists the information flow exchanged between NFVO and VNFM ETSI GS NFV-IFA 007 [5].

Table 7.1.2.1.1-1: Grant VNF Lifecycle Operation operation

Message	Requirement	Direction
GrantVnfLifecycleOperationRequest	Mandatory	VNFM → NFVO
GrantVnfLifecycleOperationResponse	Mandatory	NFVO → VNFM

7.1.2.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 6.3.2.2-1.

When the granting request is requested for InstantiateVNF, the instantiationLevelId parameter provides the identifier of the instantiation level. The energyAdditionalParamForVnfInInstantiateVnf parameter provided in Table 7.1.2.1.2-1 shall be added, allowing VNFM to provide additional parameter(s) per VNF instance that is to be created by VNFM as part of the VNF instantiation and not for existing VNFs that are referenced for reuse. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

**Table 7.1.2.1.2-1: energyAdditionalParamForVnfInInstantiateVnf parameter in
Grant VNF Lifecycle Operation operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamFor VnfInInstantiateVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

When the granting request contains the targetScaleLevelInfo attribute, i.e. this attribute provides an alternative way to define the resources to be added for the VNF when the VNF supports target scale level instantiation, the energyAdditionalParamForVnfAspectInScaleVnfToLevel parameter provided in Table 7.1.2.1.2-2 shall be added, allowing VNFM to provide additional parameter(s) for each aspect per VNF instance that is to be scaled to a target size by VNFM. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

**Table 7.1.2.1.2-2: energyAdditionalParamForVnfAspectInScaleVnfToLevel parameter in
Grant VNF Lifecycle Operation operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfAs pectInScaleVnfToLevel	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

When resource(s) has (have) to be added, the addResource parameter provides the definitions of the resources to be added by the LCM operation which is related to this grant request. The ResourceDefinition information element, in ETSI GS NFV-IFA 007 [5], Table 8.3.2.2-1, provides information of an existing or proposed resource used by the VNF. It shall contain the virtual energy-aware state of the virtual Compute resource when the resourceTemplateId attribute contains the identifier of a VirtualComputeDesc. It shall contain the virtual energy-aware state of the Compute MCIO when the resourceTemplateId attribute contains the identifier of an OsContainerDesc.

When resource(s) has (have) to be temporarily instantiated, the tempResource parameter provides the definitions of the resources to be temporarily instantiated during the runtime of the LCM operation which is related to this grant request. The ResourceDefinition information element, in ETSI GS NFV-IFA 007 [5], Table 8.3.2.2-1, provides information of an existing or proposed resource used by the VNF. It shall contain the virtual energy-aware state of the virtual Compute resource when the resourceTemplateId attribute contains the identifier of a VirtualComputeDesc. It shall contain the virtual energy-aware state of the Compute MCIO when the resourceTemplateId attribute contains the identifier of an OsContainerDesc.

When resource(s) has (have) to be updated, the updateResource parameter provides the definitions of resources to be updated by the LCM operation which is related to this grant request. The ResourceDefinition information element, in ETSI GS NFV-IFA 007 [5], Table 8.3.2.2-1, provides information of an existing or proposed resource used by the VNF. It shall contain the virtual energy-aware state of the virtual Compute resource when the resourceTemplateId attribute contains the identifier of a VirtualComputeDesc. It shall contain the virtual energy-aware state of the Compute MCIO when the resourceTemplateId attribute contains the identifier of an OsContainerDesc.

7.1.2.1.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 6.3.2.3-1.

7.1.2.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 6.3.2.4.

7.1.2.2   Instantiate VNF operation

7.1.2.2.1   Description

This operation instantiates a particular DF of a VNF that has been in the NOT_INSTANTIATED instantiation state, based on the definition in the VNFD ETSI GS NFV-IFA 007 [5].

Table 7.1.2.2.1-1 lists the information flow exchanged between NFVO and VNFM ETSI GS NFV-IFA 007 [5].

Table 7.1.2.2.1-1: Instantiate VNF operation

Message	Requirement	Direction
InstantiateVnfRequest	Mandatory	NFVO → VNFM
InstantiateVnfResponse	Mandatory	VNFM → NFVO

7.1.2.2.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.3.2-1.

The energyAdditionalParamForVnfInInstantiateVnf parameter provided in Table 7.1.2.2.2-1 shall be added, allowing NFVO to provide additional parameter(s) per VNF instance that is to be created by VNFM as part of the VNF instantiation and not for existing VNFs that are referenced for reuse. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

**Table 7.1.2.2.2-1: energyAdditionalParamForVnf parameter in
Instantiate VNF operation information element**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfInInstantiateVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

NOTE: In ETSI GS NFV-IFA 007 [5], Table 6.3.2.2-1, the input parameters of the Grant VNF Lifecycle Operation operation contains the energyAdditionalParamForVnfInInstantiateVnf parameter when the identifier of the instantiation level of the DF to be instantiated is present.

7.1.2.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.3.3-1.

7.1.2.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.3.4.

7.1.2.3   Scale VNF operation

7.1.2.3.1   Description

This operation provides methods to request horizontal scaling a VNF ETSI GS NFV-IFA 007 [5]:

- scale out: adding additional VNFC instances to increase the VNF capacity;

- scale in: removing VNFC instances from the VNF in order to release unused capacity.

Table 7.1.2.3.1-1 lists the information flow exchanged between NFVO and VNFM ETSI GS NFV-IFA 007 [5].

Table 7.1.2.3.1-1: Scale VNF operation

Message	Requirement	Direction
ScaleVnfRequest	Mandatory	NFVO → VNFM
ScaleVnfResponse	Mandatory	VNFM → NFVO

7.1.2.3.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.4.2-1.

The energyAdditionalParamForVnfAspectInScaleVnf parameter provided in Table 7.1.2.3.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each aspect per VNF instance that is to be scaled by VNFM. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

**Table 7.1.2.3.2-1: energyAdditionalParamForVnf attribute in
Scale VNF operation information element**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfAspectInScaleVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

7.1.2.3.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.4.3-1.

7.1.2.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.4.4.

7.1.2.4   Scale VNF to Level operation

7.1.2.4.1   Description

This operation scales an instantiated VNF of a particular DF to a target size. The target size is either expressed as an instantiation level of that DF as defined in the VNFD, or given as a list of scale levels, one per scaling aspect of that DF. Instantiation levels and scaling aspects are declared in the VNFD ETSI GS NFV-IFA 007 [5].

Table 7.1.2.4.1-1 lists the information flow exchanged between NFVO and VNFM ETSI GS NFV-IFA 007 [5].

Table 7.1.2.4.1-1: Scale VNF to Level operation

Message	Requirement	Direction
ScaleVnfToLevelRequest	Mandatory	NFVO → VNFM
ScaleVnfToLevelResponse	Mandatory	VNFM → NFVO

7.1.2.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.5.2-1.

When the instantiationLevelId parameter is present in the input parameters, the energyAdditionalParamForVnfLevelInScaleVnfToLevel parameter provided in Table 7.1.2.4.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each instantiation level per VNF instance that is to be scaled to a target size by VNFM. It shall identify the required EAS of the target instantiation level of the current Deployment Flavour, to which the VNF instance is requested to be scaled.

When the scaleInfo parameter is present in the input parameters, the energyAdditionalParamForVnfAspectInScaleVnfToLevel parameter provided in Table 7.1.2.4.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each aspect per VNF instance that is to be scaled to a target size by VNFM. It shall identify the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

**Table 7.1.2.4.2-1: energyAdditionalParamForVnf parameter in
Scale VNF to Level operation information element**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfLevelIn ScaleVnfToLevel	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour, to which the VNF instance is requested to be scaled.
energyAdditionalParamForVnfAspectInScaleVnfToLevel	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

NOTE: In ETSI GS NFV-IFA 007 [5], Table 6.3.2.2-1, the input parameters of the Grant VNF Lifecycle Operation operation contains the energyAdditionalParamForVnfAspectInScaleVnfToLevel parameter when the targetScaleLevelInfo parameter is present.

7.1.2.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.5.3-1.

7.1.2.4.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.5.4.

7.1.2.5 Change VNF Flavour operation

7.1.2.5.1 Description

This operation changes the DF of a VNF instance. It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF. This operation may be service-disruptive, see ETSI GS NFV-IFA 007 [5].

Table 7.1.2.5.1-1 lists the information flow exchanged between NFVO and VNFM, see ETSI GS NFV-IFA 007 [5].

Table 7.1.2.5.1-1: Change VNF Flavour operation

Message	Requirement	Direction
ChangeVnfFlavourRequest	Mandatory	NFVO → VNFM
ChangeVnfFlavourResponse	Mandatory	VNFM → NFVO

7.1.2.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.6.2-1.

The energyAdditionalParamForVnfLevelInChangeVnfFlavour parameter provided in Table 7.1.2.4.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each instantiation level per VNF instance which its Deployment Flavour is to be changed by VNFM. It shall identify the required EAS of the target instantiation level of the target Deployment Flavour to which the VNF instance is requested to be changed.

The energyAdditionalParamForVnfAspectInChangeVnfFlavour parameter provided in Table 7.1.2.5.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each aspect per VNF instance which its Deployment Flavour is to be changed by VNFM. It shall identify the required EAS of an aspect composing the VNF instance deployed according to a given Deployment Flavour in a given instantiation level.

**Table 7.1.2.5.2-1: energyAdditionalParamForVnf attribute in
Change VNF Flavour operation information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfLevelInChangeVnfFlavour	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour, to which the VNF instance is requested to be scaled
energyAdditionalParamForVnfAspectInChangeVnfFlavour	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given Deployment Flavour in a given instantiation level.

7.1.2.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.6.3-1.

7.1.2.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.6.4.

7.1.2.6   Query VNF operation

7.1.2.6.1   Description

This operation provides information about VNF instances. The applicable VNF instances can be chosen based on filtering criteria, and the information can be restricted to selected attributes ETSI GS NFV-IFA 007 [5].

Table 7.1.2.6.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.1.2.6.1-1: Query VNF operation

Message	Requirement	Direction
QueryVnfRequest	Mandatory	NFVO → VNFM
QueryVnfResponse	Mandatory	VNFM → NFVO

7.1.2.6.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.9.2-1.

7.1.2.6.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.9.3-1.

The attributes of the InstantiatedVnfInfo information element, in ETSI GS NFV-IFA 007 [5], Table 8.5.3.2-1, provide run-time information specific to an instantiated VNF instance. The identifier of the run-time virtual energy-aware state of the Deployment Flavour of the instantiated VNF instance, noted vnfDfVirtualEnergyAwareStateId, and provided in Table 7.1.2.6.3-1, shall be added.

**Table 7.1.2.6.3-1: vnfDfVirtualEnergyAwareStateId attribute in
InstantiatedVnfInfo information element**

Attribute	Qualifier	Cardinality	Content	Description
vnfDfVirtualEnergyAwareStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the Deployment Flavour of the instantiated VNF instance.

The ScaleInfo information element shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 8.5.8.2-1. The identifier of the run-time virtual energy-aware state of the scale level of the scaling aspect of the instantiated VNF instance, noted scalingAspectVirtualEnergyAwareStateId, and provided in Table 7.1.2.6.3-2, shall be added.

Table 7.1.2.6.3-2: scalingAspectVirtualEnergyAwareStateId attribute in ScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
scalingAspectVirtualEnergyAwareStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the scale level of the scaling aspect of the instantiated VNF instance.

The ResourceHandle information element, in ETSI GS NFV-IFA 007 [5], Table 8.5.7.2-1, of the VnfcResourceInfo information element, in ETSI GS NFV-IFA 007 [5], Table 8.5.4.2-1, provides information on virtualised compute used by a VNFC in a VNF instance. Depending on the form of the virtualisation container of the VNFC:

- For a VNFC based on VM, a reference to the corresponding VirtualCompute is provided.

- For a VNFC based on OS container(s), a reference to the Compute MCIO is provided. Hence, exposure of information by the VNFM to the NFVO is at the MCIO level.

The ResourceHandle information element shall contain the identifier of the run-time energy-aware state of the instantiated VNFC instance, noted virtualComputeDescVirtualEnergyAwareStateId, when the instantiated VNFC instance is realized by a virtual compute, noted mcioDescVirtualEnergyAwareStateId when the instantiated VNFC instance is realized by a set of OS Containers, and provided in Table 7.1.2.6.3-3.

Table 7.1.2.6.3-3: energyAwareStateId attribute in ResourceHandle information element

Attribute	Qualifier	Cardinality	Content	Description
virtualComputeDescVirtualEnergyAwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a virtual compute.
mcioDescVirtualEnergyAwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a set of OS Containers.

7.1.2.6.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.9.4.

7.1.2.7 Operate VNF operation

7.1.2.7.1 Description

This operation enables requesting to change the state of a VNF instance or VNFC(s) instance(s), including starting and stopping the instance(s) ETSI GS NFV-IFA 007 [5].

Table 7.1.2.7.1-1 lists the information flow exchanged between NFVO and VNFM ETSI GS NFV-IFA 007 [5].

Table 7.1.2.7.1-1: Operate VNF operation

Message	Requirement	Direction
OperateVnfRequest	Mandatory	NFVO → VNFM
OperateVnfResponse	Mandatory	VNFM → NFVO

7.1.2.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.11.2-1.

The energyAdditionalParamForVnfLevelInOperateVNF parameter provided in Table 7.1.2.7.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each instantiation level per VNF instance that is to be operated by VNFM. It shall identify the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be operated.

The energyAdditionalParamForVnfAspectInOperateVNF parameter provided in Table 7.1.2.7.2-1 shall be added, allowing NFVO to provide additional parameter(s) for each aspect per VNF instance that is to be operated by VNFM. It shall identify the required EAS of an aspect composing the VNF instance deployed according to a given Deployment Flavour in a given instantiation level.

**Table 7.1.2.7.2-1: energyAdditionalParamForVnf attribute in
Operate VNF operation information element**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnf LevelInOperateVNF	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be operated.
energyAdditionalParamForVnf AspectInChangeVnfFlavour	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given Deployment Flavour in a given instantiation level.

7.1.2.7.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.2.11.3-1.

7.1.2.7.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.2.11.4.

7.1.2.8   Notify (VnfLcmOperationOccurrenceNotification) operation

7.1.2.8.1   Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the producer (VNFM) that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the consumer (NFVO) shall perform an explicit Subscribe operation beforehand ETSI GS NFV-IFA 007 [5].

This notification is produced when there is a change in the VNF lifecycle caused by a VNF LifeCycle Management operation occurrence ETSI GS NFV-IFA 007 [5].

Table 7.1.2.8.1-1 lists the information flow exchanged between the VNFM and the NFVO.

Table 7.1.2.8.1-1: Notify (VnfLcmOperationOccurrenceNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notification is sent by this operation: VnfLcmOperationOccurrenceNotification.

Table 8.6.2.3-1 in ETSI GS NFV-IFA 007 [5] lists the attributes of the VnfLcmOperationOccurrenceNotification notification.

The energyAdditionalParamForAffectedVnfc attribute provided in Table 7.1.2.8.1-2 shall be added to the AffectedVnfc information element, provided in ETSI GS NFV-IFA 007 [5], Table 8.6.3.2-1, containing information about VNFC instances that were affected during the execution of the LifeCycle Management operation when this notification represents the result of a LifeCycle Management operation occurrence.

**Table 7.1.2.8.1-2: energyAdditionalParamForAffectedVnfc attribute in
AffectedVnfc information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForAffectedVnfc	Mandatory	0 .. N	Identifier(s) (reference(s) to Energy-Aware State(s))	Identifier(s) the virtual Energy-Aware State(s) of the VNFC instance that was affected during the execution of the LifeCycle Management operation.

7.1.3   Or-Vi reference point

7.1.3.1   Allocate Virtualised Compute Resource operation

7.1.3.1.1   Description

This operation allows requesting the allocation of virtualised compute resources as indicated by the consumer functional block ETSI GS NFV-IFA 005 [6].

Table 7.1.3.1.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.1.1-1: Allocate Virtualised Compute Resource operation

Message	Requirement	Direction
AllocateComputeRequest	Mandatory	NFVO → VIM
AllocateComputeResponse	Mandatory	VIM → NFVO

7.1.3.1.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.2.2-1. The computeFlavourId parameter identifies the Compute Flavour that provides information about the particular memory, CPU and disk resources for the virtualised compute resource to allocate.

The energyAdditionalParamForVirtualComputeFlavour attribute in Table 7.1.3.1.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.1.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.1.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.2.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.3.1.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.3.1.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.3.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.1.2.4.

7.1.3.2   Update Virtualised Compute Resource operation

7.1.3.2.1   Description

This operation allows updating the configuration and/or parameters of an instantiated virtualised compute resource. This can include, for instance, updating metadata, adding extra virtual network interfaces to a compute resource, or attaching a virtual network interface to a specific network port ETSI GS NFV-IFA 005 [6].

Table 7.1.3.2.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.2.1-1: Update Virtualised Compute Resource operation

Message	Requirement	Direction
UpdateComputeRequest	Mandatory	NFVO → VIM
UpdateComputeResponse	Mandatory	VIM → NFVO

7.1.3.2.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.4.2-1.

The energyAdditionalParamForUpdateVirtualisedCompute parameter provided in Table 7.1.3.2.2-1 shall be added to the Update Virtualised Compute Resource operation input parameters provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.4.2-1.

Table 7.1.3.2.2-1: energyAdditionalParamForUpdateVirtualisedCompute parameter in Update Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForUpdateVirtualisedCo mpute	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute.
NOTE: Cardinality can be "0" as it is recommended that only one type of update is made in a single operation request.				

7.1.3.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.4.3-1.

The energyAdditionalParamForVirtualCompute parameter provided in Table 7.1.3.2.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.3.2.3-1: energyAdditionalParamForVirtualCompute parameter in VirtualCompute information element

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.3.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.1.4.4.

7.1.3.3 Operate Virtualised Compute Resource operation

7.1.3.3.1 Description

This operation allows executing specific operation command on instantiated virtualised compute resources ETSI GS NFV-IFA 005 [6].

Table 7.1.3.3.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.3.1-1: Operate Virtualised Compute Resource operation

Message	Requirement	Direction
OperateComputeRequest	Mandatory	NFVO → VIM
OperateComputeResponse	Mandatory	VIM → NFVO

7.1.3.3.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.6.2-1 in ETSI GS NFV-IFA 005 [6].

The energyAdditionalParamForOperateVirtualisedCompute parameter provided in Table 7.1.3.3.2-1 shall be added to the Operate Virtualised Compute Resource operation input parameters provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.6.2-1.

Table 7.1.3.3.2-1: energyAdditionalParamForOperateVirtualisedCompute parameter in Operate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForOperateVirtualisedC ompute	Mandatory	1 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute.

7.1.3.3.3 Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.6.3-1 in ETSI GS NFV-IFA 005 [6].

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.3.3.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.3.3.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.3.3.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.1.6.4.

7.1.3.4 Scale Virtualised Compute Resource operation

7.1.3.4.1 Description

This operation allows scaling a virtualised compute resource by adding or removing capacity in terms of virtual CPUs and virtual memory ETSI GS NFV-IFA 005 [6].

Table 7.1.3.4.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.4.1-1: Scale Virtualised Compute Resource operation

Message	Requirement	Direction
ScaleComputeRequest	Mandatory	NFVO → VIM
ScaleComputeResponse	Mandatory	VIM → NFVO

7.1.3.4.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.7.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.4.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.4.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.7.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.3.4.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.3.4.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.3.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.1.7.4.

7.1.3.5   Migrate Virtualised Compute Resource operation

7.1.3.5.1   Description

This operation allows moving a virtualised compute resource between locations. For instance, the operation performs the migration of a computing resource from one physical machine (host) to another physical machine ETSI GS NFV-IFA 005 [6].

Table 7.1.3.5.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.5.1-1: Migrate Virtualised Compute Resource operation

Message	Requirement	Direction
MigrateComputeRequest	Mandatory	NFVO → VIM
MigrateComputeResponse	Mandatory	VIM → NFVO

7.1.3.5.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.8.2-1.

7.1.3.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.8.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.3.5.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

**Table 7.1.3.5.3-1: energyAdditionalParamForVirtualCompute attribute in
VirtualCompute information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.3.5.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.1.8.4.

7.1.3.6 Notify (VirtualisedResourceChangeNotification) operation

7.1.3.6.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription ETSI GS NFV-IFA 005 [6].

Table 7.1.3.6.1-1 lists the information flow exchanged between the VIM and the NFVO.

Table 7.1.3.6.1-1: Notify (VirtualisedResourceChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation: VirtualisedResourceChangeNotification.

Table 8.4.9.3-1 in ETSI GS NFV-IFA 005 [6] lists the attributes of the VirtualisedResourceChangeNotification. This notification is produced when the virtualised resource will be impacted due to changes in underlying resources produced by maintenance and operation of the NFVI, including:

- Maintenance of NFVI components, e.g. physical maintenance/repair, hypervisor software updates, etc.

- Evacuation of physical hosts.

- Addition and removal of physical resources.

- Operation and management of NFVI resources, e.g. to support energy efficiency or resource usage optimization.

The content of the changedResourceData attribute, that provides details of the changes of the resource, differs based on the different values of the changeType attribute. Possible values of changeType can be related to maintenance and operation of the NFVI, including e.g. normal, maintenance, evacuation, optimization, etc.

Depending on the changeType attribute value, the content of the changedResourceData attribute shall contain VirtualEnergyAwareStates.

7.1.3.7   Notify (InformationChangeNotification) operation

7.1.3.7.1   Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription ETSI GS NFV-IFA 005 [6].

Table 7.1.3.7.1-1 lists the information flow exchanged between the VIM and the NFVO.

Table 7.1.3.7.1-1: Notify (InformationChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation: InformationChangeNotification.

Table 8.3.2.3-1 in ETSI GS NFV-IFA 005 [6] lists the attributes of the InformationChangeNotification notification.

The changedResourceData attribute, that provides details of the changes of consumable virtualised resource information, shall contain the energyAdditionalParamForVirtualComputeResourceInformation parameter, when the value of the resourceTypeId attribute is the identifier of a VirtualComputeResourceInformation and the value of the changeType attribute is "ADDITION" or "UPDATE".

The energyAdditionalParamForVirtualComputeResourceInformation attribute provided in Table 7.1.3.7.1-2 shall be added to the VirtualComputeResourceInformation information element provided in ETSI GS NFV-IFA 005 [6], Table 8.3.3.2.2-1. The VirtualCompute information element defines the characteristics of consumable virtualised compute resources.

Table 7.1.3.7.1-2: energyAdditionalParamForVirtualComputeResourceInformation attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeReso urceInformation	Mandatory	1 .. N	VirtualEnergyAwareStates	Defines the virtual Energy-Aware States of the consumable virtualised compute resource.

7.1.3.8   Query Virtualised Compute Resource Information operation

7.1.3.8.1   Description

This operation supports retrieval of information for the various types of virtualised compute resources managed by the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.8.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.8.1-1: Query Virtualised Compute Resource Information operation

Message	Requirement	Direction
QueryVirtualComputeResourceInfoRequest	Mandatory	NFVO → VIM
QueryVirtualComputeResourceInfoResponse	Mandatory	VIM → NFVO

7.1.3.8.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.3.4.2-1.

7.1.3.8.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.3.4.3-1.

The energyAdditionalParamForVirtualComputeResourceInformation attribute provided in Table 7.1.3.8.3-1 shall be added to the VirtualComputeResourceInformation information element provided in ETSI GS NFV-IFA 005 [6], Table 8.3.3.2.2-1. The VirtualCompute information element defines the characteristics of consumable virtualised compute resources.

Table 7.1.3.8.3-1: energyAdditionalParamForVirtualComputeResourceInformation attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeReso urceInformation	Mandatory	1 .. N	VirtualEnergyAwareStates	Defines the virtual Energy-Aware States of the consumable virtualised compute resource.

7.1.3.8.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.3.4.4.

7.1.3.9   Query Compute Capacity operation

7.1.3.9.1   Description

This operation supports retrieval of capacity information for the various types of consumable virtualised compute resources available in the Virtualised Compute Resources Information Management Interface ETSI GS NFV-IFA 005 [6].

Table 7.1.3.9.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.9.1-1: Query Compute Capacity operation

Message	Requirement	Direction
QueryComputeCapacityRequest	Mandatory	NFVO → VIM
QueryComputeCapacityResponse	Mandatory	VIM → NFVO

7.1.3.9.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6] in Table 7.3.4.2.2-1. In the request, the computeResourceTypeId parameter or the resourceCriteria parameter shall be used. These parameters are mutually exclusive.

7.1.3.9.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.4.2.3-1. The four attributes of the CapacityInformation information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.7.3.2-1, i.e. availableCapacity, reservedCapacity, totalCapacity, allocatedCapacity, shall be applied to the VirtualEnergyAwareStates.

7.1.3.9.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.4.2.4.

7.1.3.10   Notify (CapacityChangeNotification) operation

7.1.3.10.1   Description

This notification informs the receiver of changes in the capacity of NFVI resources managed by the VIM. The notification is mandatory. This notification is published when the available, allocated, reserved or total capacity of NFVI resources managed by the VIM is changed due to ETSI GS NFV-IFA 005 [6]:

- Allocation/termination/updating of NFVI resources affecting the available and/or allocated/used capacity.

- Creation/termination/updating of reservations affecting the available and/or reserved capacity;

- Addition/removal/upgrading of physical infrastructure affecting the available and total capacity.

- Faults and repair of physical infrastructure affecting the available and total capacity.

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription ETSI GS NFV-IFA 005 [6].

Table 7.1.3.10.1-1 lists the information flow exchanged between the VIM and the NFVO.

Table 7.1.3.10.1-1: Notify (CapacityChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation: CapacityChangeNotification.

The CapacityChangeNotification shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.7.4.3-1. The four attributes of the CapacityInformation information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.7.3.2-1, i.e. availableCapacity, reservedCapacity, totalCapacity, allocatedCapacity, shall be applied to the VirtualEnergyAwareStates.

7.1.3.11   Query Compute Resource Zone operation

7.1.3.11.1   Description

This operation enables the NFVO to query information about a Resource Zone, e.g. listing the properties of the Resource Zone, and other metadata ETSI GS NFV-IFA 005 [6].

Table 7.1.3.11.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.11.1-1: Query Compute Resource Zone operation

Message	Requirement	Direction
QueryComputeResourceZoneRequest	Mandatory	NFVO → VIM
QueryComputeResourceZoneResponse	Mandatory	VIM → NFVO

7.1.3.11.2   Input Parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.4.5.2-1.

7.1.3.11.3   Output Parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.4.5.3-1. The zoneInfo parameter contains filtered information that has been retrieved about the Resource Zone.

The ResourceZone information element shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.10.2.2-1. The zoneProperty parameter, containing the set of properties that define the capabilities associated to the Resource Zone. Examples of capabilities may include: support of certain compute resource types (e.g. low performance, acceleration capabilities, association to certain NFVI-Point of Presence (PoP) physical segregation (e.g. different power or network sub-systems, availability of redundancy power sub-systems). The EnergyAwareStates shall be included among these capabilities.

7.1.3.11.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.4.5.4.

7.1.3.12   Create Compute Flavour operation

7.1.3.12.1   Description

This operation allows requesting the creation of a flavour as indicated by the consumer functional block ETSI GS NFV-IFA 005 [6].

Table 7.1.3.12.1-1 lists the information flow exchanged between NFVO and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.12.1-1: Create Compute Flavour operation

Message	Requirement	Direction
CreateComputeFlavourRequest	Mandatory	NFVO → VIM
CreateComputeFlavourResponse	Mandatory	VIM → NFVO

7.1.3.12.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.5.2.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.12.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.12.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.12.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.5.2.3-1.

7.1.3.12.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.5.2.4.

7.1.3.13   Query Compute Flavour operation

7.1.3.13.1   Description

This operation allows querying information about created Compute Flavours ETSI GS NFV-IFA 005 [6].

Table 7.1.3.13.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.13.1-1: Query Compute Flavour operation

Message	Requirement	Direction
QueryComputeFlavourRequest	Mandatory	NFVO → VIM
QueryComputeFlavourResponse	Mandatory	VIM → NFVO

7.1.3.13.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.5.3.2-1.

7.1.3.13.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.5.3.3-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.13.3-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.13.3-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.13.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.3.5.3.4.

7.1.3.14   Create Compute Resource Reservation operation

7.1.3.14.1   Description

This operation allows requesting the reservation of virtualised compute resources as indicated by the consumer functional block ETSI GS NFV-IFA 005 [6].

Table 7.1.3.14.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.14.1-1: Create Compute Resource Reservation operation

Message	Requirement	Direction
CreateComputeResourceReservationRequest	Mandatory	NFVO → VIM
CreateComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.1.3.14.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.2.2-1.

The ComputePoolReservation information element containing the amount of compute resources to be reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.2.2-1.

The VirtualComputeAttributesReservationData information element Information, specifying additional attributes of the compute resource to be reserved, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.4.2-1. The energyAdditionalParamForVirtualComputeAttributesReservationData attribute provided in Table 7.1.3.14.2-1 shall be added.

Table 7.1.3.14.2-1: energyAdditionalParamForVirtualComputeAttributesReservationData attribute in ComputePoolReservation information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeAttrib utesReservationData	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

The VirtualisationContainerReservation information element encapsulates information about the virtualisation containers to be reserved, following a specific compute flavour, and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.8.5.2.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.14.2-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.14.2-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamFo rVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.14.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.2.3-1.

The ReservedVirtualCompute information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.8.2.2-1.

The ReservedComputePool information element containing the amount of compute resources that have been reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.3.2-1.

The ReservedVirtualComputeAttributes information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.5.2-1, shall contain the energyAdditionalParamForReservedVirtualComputeAttributes attribute, provided in Table 7.1.3.14.3-1.

Table 7.1.3.14.3-1: energyAdditionalParamForReservedVirtualComputeAttributes attribute in ReservedVirtualComputeAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForReservedVirtualCom puteAttributes	Mandatory	0 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the reserved virtualised compute.

The ReservedVirtualisationContainer information element containing, in the flavourId parameter, the identifier of the given compute flavour used to reserve the virtualisation container, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.5.3.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.14.3-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.14.3-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.14.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.8.1.2.4.

7.1.3.15   Query Compute Resource Reservation operation

7.1.3.15.1   Description

This operation allows querying information about reserved compute resources that the consumer has access to ETSI GS NFV-IFA 005 [6].

Table 7.1.3.15.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.15.1-1: Query Compute Resource Reservation operation

Message	Requirement	Direction
QueryComputeResourceReservationRequest	Mandatory	NFVO → VIM
QueryComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.1.3.15.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.3.2-1.

7.1.3.15.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.3.3-1.

The ReservedVirtualCompute information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.8.2.2-1.

The ReservedComputePool information element containing the amount of compute resources that have been reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.3.2-1.

The ReservedVirtualComputeAttributes information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.5.2-1, shall contain the energyAdditionalParamForReservedVirtualComputeAttributes attribute, provided in Table 7.1.3.15.3-1.

Table 7.1.3.15.3-1: energyAdditionalParamForReservedVirtualComputeAttributes attribute in ReservedVirtualComputeAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForReservedVirtualComputeAttributes	Mandatory	0 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the reserved virtualised compute.

The ReservedVirtualisationContainer information element containing, in the flavourId parameter, the identifier of the given compute flavour used to reserve the virtualisation container, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.5.3.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.15.3-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.15.3-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.15.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.8.1.3.4.

7.1.3.16   Update Compute Resource Reservation operation

7.1.3.16.1   Description

This operation allows updating compute resource reservations (e.g. increase or decrease the amount of reserved resources) ETSI GS NFV-IFA 005 [6].

Table 7.1.3.16.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.16.1-1: Update Compute Resource Reservation operation

Message	Requirement	Direction
UpdateComputeResourceReservationRequest	Mandatory	NFVO → VIM
UpdateComputeResourceReservationResponse	Mandatory	VIM → NFVO

7.1.3.16.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.4.2-1.

The ComputePoolReservation information element containing the amount of compute resources to be reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.2.2-1.

The VirtualComputeAttributesReservationData information element Information, specifying additional attributes of the compute resource to be reserved, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.4.2-1. The energyAdditionalParamForVirtualComputeAttributesReservationData attribute provided in Table 7.1.3.16.2-1 shall be added.

Table 7.1.3.16.2-1: energyAdditionalParamForVirtualComputeAttributesReservationData attribute in VirtualComputeAttributesReservationData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeAttrib utesReservationData	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

The VirtualisationContainerReservation information element encapsulates information about the virtualisation containers to be reserved, following a specific compute flavour, and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.8.5.2.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.16.2-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.16.2-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.16.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.8.1.4.3-1.

The ReservedVirtualCompute information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.8.2.2-1.

The ReservedComputePool information element containing the amount of compute resources that have been reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.3.2-1.

The ReservedVirtualComputeAttributes information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.8.3.5.2-1, shall contain the energyAdditionalParamForReservedVirtualComputeAttributes attribute, provided in Table 7.1.3.16.3-1.

Table 7.1.3.16.3-1: energyAdditionalParamForReservedVirtualComputeAttributes attribute in ReservedVirtualComputeAttributes information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForReservedVirtualCom puteAttributes	Mandatory	0 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the reserved virtualised compute.

The ReservedVirtualisationContainer information element containing, in the flavourId parameter, the identifier of the given compute flavour used to reserve the virtualisation container, is provided in ETSI GS NFV-IFA 005 [6], Table 8.8.5.3.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.3.16.3-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.3.16.3-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.3.16.4 Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.8.1.4.4.

7.1.3.17 Create Compute Resource Quota operation

7.1.3.17.1 Description

This operation allows requesting the quota of virtualised compute resources as indicated by the consumer functional block ETSI GS NFV-IFA 005 [6].

Table 7.1.3.17.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.17.1-1: Create Compute Resource Quota operation

Message	Requirement	Direction
CreateComputeResourceQuotaRequest	Mandatory	NFVO → VIM
CreateComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.1.3.17.2 Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.2.2-1.

The VirtualComputeQuotaData information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.11.2.2.2-1, containing the amount of compute resources to be restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuotaData attribute provided in Table 7.1.3.17.2-1.

Table 7.1.3.17.2-1: energyAdditionalParamForVirtualComputeQuotaData attribute in VirtualComputeQuotaData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeQuot aData	Mandatory	0 .. 1	VirtualEnergyAwareStat eData	Required Virtual Energy-Aware State descriptor of the virtualised compute to be restricted by the quota. The cardinality can be 0 if no particular EAS is requested for the quota.

7.1.3.17.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.2.3-1.

The VirtualComputeQuota information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.11.2.3.2-1, containing the amount of compute resources that have been restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuota attribute provided in Table 7.1.3.17.3-1.

Table 7.1.3.17.3-1: energyAdditionalParamForVirtualComputeQuota attribute in VirtualComputeQuota information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamFo rVirtualComputeQuota	Mandatory	0 .. 1	VirtualEnergyAwareState	Virtual Energy-Aware State descriptor of the virtualised compute that has been restricted by the quota. The cardinality can be 0 if no particular EAS has been requested to be restricted by the quota.

7.1.3.17.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.9.1.2.4.

7.1.3.18   Query Compute Resource Quota operation

7.1.3.18.1   Description

This operation allows querying quota information about compute resources that the consumer has access to ETSI GS NFV-IFA 005 [6].

Table 7.1.3.18.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.18.1-1: Query Compute Resource Quota operation

Message	Requirement	Direction
QueryComputeResourceQuotaRequest	Mandatory	NFVO → VIM
QueryComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.1.3.18.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.3.2-1.

7.1.3.18.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.3.3-1.

The VirtualComputeQuota information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.11.2.3.2-1, containing the amount of compute resources that have been restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuota attribute provided in Table 7.1.3.18.3-1.

Table 7.1.3.18.3-1: energyAdditionalParamForVirtualComputeQuota attribute in VirtualComputeQuota information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeQuot a	Mandatory	0 .. 1	VirtualEnergyAwareState	Virtual Energy-Aware State descriptor of the virtualised compute that has been restricted by the quota. The cardinality can be 0 if no particular EAS has been requested to be restricted by the quota.

7.1.3.18.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.9.1.3.4.

7.1.3.19   Update Compute Resource Quota operation

7.1.3.19.1   Description

This operation allows updating compute resource quotas, e.g. increase or decrease the amount of quota resources ETSI GS NFV-IFA 005 [6].

Table 7.1.3.19.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.19.1-1: Update Compute Resource Quota operation

Message	Requirement	Direction
UpdateComputeResourceQuotaRequest	Mandatory	NFVO → VIM
UpdateComputeResourceQuotaResponse	Mandatory	VIM → NFVO

7.1.3.19.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.4.2-1.

The VirtualComputeQuotaData information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.11.2.2.2-1, containing the amount of compute resources to be restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuotaData attribute provided hin Table 7.1.3.19.2-1.

Table 7.1.3.19.2-1: energyAdditionalParamForVirtualComputeQuotaData attribute in VirtualComputeQuotaData information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeQuot aData	Mandatory	0 .. 1	VirtualEnergyAwareStat eData	Required Virtual Energy-Aware State descriptor of the virtualised compute to be restricted by the quota. The cardinality can be 0 if no particular EAS is requested for the quota.

7.1.3.19.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.9.1.4.3-1.

The VirtualComputeQuota information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.11.2.3.2-1, containing the amount of compute resources that have been restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuota attribute provided in Table 7.1.3.19.3-1.

Table 7.1.3.19.3-1: energyAdditionalParamForVirtualComputeQuota attribute in
VirtualComputeQuota information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeQuot a	Mandatory	0 .. 1	VirtualEnergyAwareStat e	Virtual Energy-Aware State descriptor of the virtualised compute that has been restricted by the quota. The cardinality can be 0 if no particular EAS has been requested to be restricted by the quota.

7.1.3.19.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.9.1.4.4.

7.1.3.20   Create Compute Host Reservation operation

7.1.3.20.1   Description

This operation allows requesting the reservation of compute hosts as indicated by the consumer functional block ETSI GS NFV-IFA 005 [6].

Table 7.1.3.20.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.20.1-1: Create Compute Host Reservation operation

Message	Requirement	Direction
CreateComputeHostReservationRequest	Mandatory	NFVO → VIM
CreateComputeHostReservationResponse	Mandatory	VIM → NFVO

7.1.3.20.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.2.2-1. The computeHostProperties parameter, containing the set of properties that specify the capabilities associated to the compute hosts (e.g. hypervisor capabilities) to be reserved, shall contain energy-aware states to be reserved.

7.1.3.20.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.2.3-1.

The ReservedComputeHosts information element encapsulates information about the reserved compute hosts and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.13.2.2-1.

The computeHostProperties attribute, containing the set of properties that define the capabilities associated to the reserved compute hosts (e.g. hypervisor capabilities), shall contain the reserved energy-aware states.

7.1.3.20.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.10.2.4.

7.1.3.21   Query Compute Host Reservation operation

7.1.3.21.1   Description

This operation allows querying information about reserved compute hosts ETSI GS NFV-IFA 005 [6].

Table 7.1.3.21.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.21.1-1: Query Compute Host Reservation operation

Message	Requirement	Direction
QueryComputeHostReservationRequest	Mandatory	NFVO → VIM
QueryComputeHostReservationResponse	Mandatory	VIM → NFVO

7.1.3.21.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.3.2-1.

7.1.3.21.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.3.3-1.

The ReservedComputeHosts information element encapsulates information about the reserved compute hosts and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.13.2.2-1.

The computeHostProperties attribute, containing the set of properties that define the capabilities associated to the reserved compute hosts (e.g. hypervisor capabilities), shall contain the reserved energy-aware states.

7.1.3.21.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.10.3.4.

7.1.3.22   Update Compute Host Reservation operation

7.1.3.22.1   Description

This operation allows updating compute host reservations (e.g. increase the minimum amount of reserved compute hosts) ETSI GS NFV-IFA 005 [6].

Table 7.1.3.22.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.22.1-1: Update Compute Host Reservation operation

Message	Requirement	Direction
UpdateComputeHostReservationRequest	Mandatory	NFVO → VIM
UpdateComputeHostReservationResponse	Mandatory	VIM → NFVO

7.1.3.22.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.4.2-1. The computeHostProperties parameter, containing the set of properties that specify the capabilities associated to the compute hosts (e.g. hypervisor capabilities) to be reserved, shall contain energy-aware states to be reserved.

7.1.3.22.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.10.4.3-1.

The ReservedComputeHosts information element encapsulates information about the updated reserved compute hosts and shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.13.2.2-1.

The computeHostProperties attribute, containing the set of properties that define the capabilities associated to the reserved compute hosts (e.g. hypervisor capabilities), shall contain the updated reserved energy-aware states.

7.1.3.22.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.10.4.4.

7.1.3.23   Query Compute Host Capacity operation

7.1.3.23.1   Description

This operation supports retrieval of compute host capacity information ETSI GS NFV-IFA 005 [6].

Table 7.1.3.23.1-1 lists the information flow exchanged between the NFVO and the VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.3.23.1-1: Query Compute Host Capacity operation

Message	Requirement	Direction
QueryComputeHostCapacityRequest	Mandatory	NFVO → VIM
QueryComputeHostCapacityResponse	Mandatory	VIM → NFVO

7.1.3.23.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.11.1.2.2-1.

7.1.3.23.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.11.1.2.3-1.

The capacityResponse parameter, containing information about the capacity matching the query, shall contain capacity information, i.e. total, available, reserved, used, about energy-aware states.

7.1.3.23.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.11.2.4.

7.1.3.24   Notify (Host CapacityChangeNotification) operation

7.1.3.24.1   Description

This notification informs the receiver of changes in the capacity of NFVI resources managed by the VIM. The notification is mandatory. This notification is published when the available, allocated, reserved or total capacity of NFVI resources managed by the VIM is changed due to ETSI GS NFV-IFA 005 [6]:

- Allocation/termination/updating of NFVI resources affecting the available and/or allocated/used capacity.

- Creation/termination/updating of reservations affecting the available and/or reserved capacity.

- Addition/removal/upgrading of physical infrastructure affecting the available and total capacity.

- Faults and repair of physical infrastructure affecting the available and total capacity.

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (NFVO). In order to receive notifications, the NFVO shall have a subscription ETSI GS NFV-IFA 005 [6].

Table 7.1.3.24.1-1 lists the information flow exchanged between the VIM and the NFVO.

Table 7.1.3.24.1-1: Notify (Host CapacityChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notification is sent by this operation: CapacityChangeNotification.

The CapacityChangeNotification shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 8.7.4.3-1. The four attributes of the CapacityInformation information element, provided in ETSI GS NFV-IFA 005 [6], Table 8.7.3.2-1, i.e. availableCapacity, reservedCapacity, totalCapacity, allocatedCapacity, shall be applied to the compute host EnergyAwareStates.

7.1.4   Vi-Vnfm reference point

7.1.4.1   Allocate Virtualised Compute Resource operation

7.1.4.1.1   Description

This operation allows requesting the allocation of virtualised compute resources as indicated by the consumer functional block ETSI GS NFV-IFA 006 [7].

Table 7.1.4.1.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.1.1-1: Allocate Virtualised Compute Resource operation

Message	Requirement	Direction
AllocateComputeRequest	Mandatory	VNFM → VIM
AllocateComputeResponse	Mandatory	VIM → VNFM

7.1.4.1.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.2.2-1. The computeFlavourId parameter identifies the Compute Flavour that provides information about the particular memory, CPU and disk resources for the virtualised compute resource to allocate.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.4.1.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.4.1.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.4.1.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.2.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.1.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.4.1.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.2.4.

7.1.4.2   Query Virtualised Compute Resource operation

7.1.4.2.1   Description

This operation allows querying information about instantiated virtualised compute resources ETSI GS NFV-IFA 006 [7].

Table 7.1.4.2.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.2.1-1: Query Virtualised Compute Resource operation

Message	Requirement	Direction
QueryComputeRequest	Mandatory	VNFM → VIM
QueryComputeResponse	Mandatory	VIM → VNFM

7.1.4.2.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.3.2-1.

7.1.4.2.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.3.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.2.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.4.2.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.3.4.

7.1.4.3   Update Virtualised Compute Resource operation

7.1.4.3.1   Description

This operation allows updating the configuration and/or parameters of an instantiated virtualised compute resource. This can include, for instance, updating metadata, adding extra virtual network interfaces to a compute resource, or attaching a virtual network interface to a specific network port ETSI GS NFV-IFA 006 [7].

Table 7.1.4.3.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.3.1-1: Update Virtualised Compute Resource operation

Message	Requirement	Direction
UpdateComputeRequest	Mandatory	VNFM → VIM
UpdateComputeResponse	Mandatory	VIM → VNFM

7.1.4.3.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.4.2-1. Source operation input parameters provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.4.2-1.

**Table 7.1.4.3.2-1: energyAdditionalParamForUpdateVirtualisedCompute parameter in
Update Virtualised Compute Resource operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForUpdateVirtualisedCompute	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute.
NOTE: Cardinality can be "0" as it is recommended that only one type of update is made in a single operation request.				

7.1.4.3.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.4.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.3.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

**Table 7.1.4.3.3-1: energyAdditionalParamForVirtualCompute attribute in
VirtualCompute information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStates	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.4.4.

7.1.4.4   Operate Virtualised Compute Resource operation

7.1.4.4.1   Description

This operation allows executing specific operation command on instantiated virtualised compute resources ETSI GS NFV-IFA 006 [7].

Table 7.1.4.4.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.4.1-1: Operate Virtualised Compute Resource operation

Message	Requirement	Direction
OperateComputeRequest	Mandatory	VNFM → VIM
OperateComputeResponse	Mandatory	VIM → VNFM

7.1.4.4.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in Table 7.3.1.6.2-1 in ETSI GS NFV-IFA 006 [7].

The energyAdditionalParamForOperateVirtualisedCompute parameter provided in Table 7.1.4.4.2-1 shall be added to the Operate Virtualised Compute Resource operation input parameters provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.6.2-1.

Table 7.1.4.4.2-1: energyAdditionalParamForOperateVirtualisedCompute parameter in Operate Virtualised Compute Resource operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForOperateVirtualisedC ompute	Mandatory	1 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute.

7.1.4.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in Table 7.3.1.6.3-1 in ETSI GS NFV-IFA 006 [7].

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.4.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.4.4.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.6.4.

7.1.4.5   Scale Virtualised Compute Resource operation

7.1.4.5.1   Description

This operation allows scaling a virtualised compute resource by adding or removing capacity in terms of virtual CPUs and virtual memory ETSI GS NFV-IFA 006 [7].

Table 7.1.4.5.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 005 [6].

Table 7.1.4.5.1-1: Scale Virtualised Compute Resource operation

Message	Requirement	Direction
ScaleComputeRequest	Mandatory	VNFM → VIM
ScaleComputeResponse	Mandatory	VIM → VNFM

7.1.4.5.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.7.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.4.5.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.4.5.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.4.5.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.7.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.5.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.4.5.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.7.4.

7.1.4.6   Migrate Virtualised Compute Resource operation

7.1.4.6.1   Description

This operation allows moving a virtualised compute resource between locations. For instance, the operation performs the migration of a computing resource from one physical machine (host) to another physical machine ETSI GS NFV-IFA 006 [7].

Table 7.1.4.6.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.6.1-1: Migrate Virtualised Compute Resource operation

Message	Requirement	Direction
MigrateComputeRequest	Mandatory	VNFM → VIM
MigrateComputeResponse	Mandatory	VIM → VNFM

7.1.4.6.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.1.8.2-1.

7.1.4.6.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.3.1.8.3-1.

The energyAdditionalParamForVirtualCompute attribute provided in Table 7.1.4.6.3-1 shall be added to the VirtualCompute information element provided in ETSI GS NFV-IFA 005 [6], Table 8.4.3.2.2-1. The VirtualCompute information element encapsulates data of an instantiated virtualised compute resource.

Table 7.1.4.6.3-1: energyAdditionalParamForVirtualCompute attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualCompute	Mandatory	1 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the instantiated virtualised compute.

7.1.4.6.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.1.8.4.

7.1.4.7   Notify (VirtualisedResourceChangeNotification) operation

7.1.4.7.1   Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (VNFM). In order to receive notifications, the VNFM shall have a subscription ETSI GS NFV-IFA 006 [7].

Table 7.1.4.7.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.1.4.7.1-1: Notify (VirtualisedResourceChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

The following notification is sent by this operation: VirtualisedResourceChangeNotification.

Table 8.4.9.3-1 in ETSI GS NFV-IFA 006 [7] lists the attributes of the VirtualisedResourceChangeNotification. This notification is produced when the virtualised resource will be impacted due to changes in underlying resources produced by maintenance and operation of the NFVI, including:

- Maintenance of NFVI components, e.g. physical maintenance/repair, hypervisor software updates, etc.

- Evacuation of physical hosts.

- Addition and removal of physical resources.

- Operation and management of NFVI resources, e.g. to support energy efficiency or resource usage optimization.

The content of the changedResourceData attribute, that provides details of the changes of the resource, differs based on the different values of the changeType attribute. Possible values of changeType can be related to maintenance and operation of the NFVI, including e.g. normal, maintenance, evacuation, optimization, etc.

Depending on the changeType attribute value, the content of the changedResourceData attribute shall contain VirtualEnergyAwareStates.

7.1.4.8 Notify (InformationChangeNotification) operation

7.1.4.8.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be invoked as an operation by the consumer (VNFM). In order to receive notifications, the VNFM shall have a subscription ETSI GS NFV-IFA 006 [7].

Table 7.1.4.8.1-1 lists the information flow exchanged between the VIM and the VNFM.

Table 7.1.4.8.1-1: Notify (InformationChangeNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

The following notification is sent by this operation: InformationChangeNotification.

Table 8.3.2.3-1 in ETSI GS NFV-IFA 006 [7] lists the attributes of the InformationChangeNotification notification.

The changedResourceData attribute, that provides details of the changes of consumable virtualised resource information, shall contain the energyAdditionalParamForVirtualComputeResourceInformation parameter, when the value of the resourceTypeId attribute is the identifier of a VirtualComputeResourceInformation and the value of the changeType attribute is "ADDITION" or "UPDATE".

The energyAdditionalParamForVirtualComputeResourceInformation attribute provided in Table 7.1.4.8.1-2 shall be added to the VirtualComputeResourceInformation information element provided in ETSI GS NFV-IFA 006 [7], Table 8.3.3.2.2-1. The VirtualCompute information element defines the characteristics of consumable virtualised compute resources.

Table 7.1.4.8.1-2: energyAdditionalParamForVirtualComputeResourceInformation attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeReso urceInformation	Mandatory	1 .. N	VirtualEnergyAwareStat es	Defines the virtual Energy-Aware States of the consumable virtualised compute resource.

7.1.4.9 Query Virtualised Compute Resource Information operation

7.1.4.9.1 Description

This operation supports retrieval of information for the various types of virtualised compute resources managed by the VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.9.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.9.1-1: Query Virtualised Compute Resource Information operation

Message	Requirement	Direction
QueryVirtualComputeResourceInfoRequest	Mandatory	VNFM → VIM
QueryVirtualComputeResourceInfoResponse	Mandatory	VIM → VNFM

7.1.4.9.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.3.4.2-1.

7.1.4.9.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.3.4.3-1.

The energyAdditionalParamForVirtualComputeResourceInformation attribute provided in Table 7.1.4.9.3-1 shall be added to the VirtualComputeResourceInformation information element provided in ETSI GS NFV-IFA 006 [7], Table 8.3.3.2.2-1. The VirtualCompute information element defines the characteristics of consumable virtualised compute resources.

Table 7.1.4.9.3-1: energyAdditionalParamForVirtualComputeResourceInformation attribute in VirtualCompute information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeReso urceInformation	Mandatory	1 .. N	VirtualEnergyAwareStat es	Defines the virtual Energy-Aware States of the consumable virtualised compute resource.

7.1.4.9.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.3.4.4.

7.1.4.10   Create Compute Flavour operation

7.1.4.10.1   Description

This operation allows requesting the creation of a flavour as indicated by the consumer functional block ETSI GS NFV-IFA 006 [7].

Table 7.1.4.10.1-1 lists the information flow exchanged between VNFM and VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.10.1-1: Create Compute Flavour operation

Message	Requirement	Direction
CreateComputeFlavourRequest	Mandatory	VNFM → VIM
CreateComputeFlavourResponse	Mandatory	VIM → VNFM

7.1.4.10.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.4.2.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.4.10.2-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.4.10.2-1: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeFlavour	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.4.10.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.4.2.3-1.

7.1.4.10.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.4.2.4.

7.1.4.11   Query Compute Flavour operation

7.1.4.11.1   Description

This operation allows querying information about created Compute Flavours ETSI GS NFV-IFA 006 [7].

Table 7.1.4.11.1-1 lists the information flow exchanged between the VNFM and the VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.11.1-1: Query Compute Flavour operation

Message	Requirement	Direction
QueryComputeFlavourRequest	Mandatory	NFVO → VIM
QueryComputeFlavourResponse	Mandatory	VIM → NFVO

7.1.4.11.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.4.3.2-1.

7.1.4.11.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.3.4.3.3-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.4.11.3-1 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

**Table 7.1.4.11.3-1: energyAdditionalParamForVirtualComputeFlavour attribute in
VirtualComputeFlavour information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.4.11.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.3.4.3.4.

7.1.4.12   Query Compute Resource Reservation operation

7.1.4.12.1   Description

This operation allows querying information about reserved compute resources that the consumer has access to ETSI GS NFV-IFA 006 [7].

Table 7.1.4.12.1-1 lists the information flow exchanged between the VNFM and the VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.12.1-1: Query Compute Resource Reservation operation

Message	Requirement	Direction
QueryComputeResourceReservationRequest	Mandatory	VNFM → VIM
QueryComputeResourceReservationResponse	Mandatory	VIM → VNFM

7.1.4.12.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.8.1.2.2-1.

7.1.4.12.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.8.1.2.3-1.

The ReservedVirtualCompute information element encapsulates information about a reservation for virtualised compute resources. It includes information about virtual compute resource pool and virtualisation container reservations and shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 8.7.2.2-1.

The ReservedComputePool information element containing the amount of compute resources that have been reserved, e.g. {"cpu_cores": 90, "vm_instances": 10, "ram": 10 000}, is provided in ETSI GS NFV-IFA 006 [7], Table 8.7.3.2.2-1.

The ReservedVirtualComputeAttributes information element, provided in ETSI GS NFV-IFA 006 [7], Table 8.7.3.3.2-1, shall contain the energyAdditionalParamForReservedVirtualComputeAttributes attribute, provided in Table 7.1.4.12.3-1.

**Table 7.1.4.12.3-1: energyAdditionalParamForReservedVirtualComputeAttributes attribute in
ReservedVirtualComputeAttributes information element**

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForReservedVirtualCom puteAttributes	Mandatory	0 .. N	VirtualEnergyAwareStat es	Virtual Energy-Aware States descriptor of the reserved virtualised compute.

The ReservedVirtualisationContainer information element containing, in the flavourId parameter, the identifier of the given compute flavour used to reserve the virtualisation container, is provided in ETSI GS NFV-IFA 006 [7], Table 8.7.5.2.2-1.

The energyAdditionalParamForVirtualComputeFlavour attribute provided in Table 7.1.4.12.3-2 shall be added to the VirtualComputeFlavour information element provided in ETSI GS NFV-IFA 006 [7], Table 8.4.2.2.2-1. The VirtualComputeFlavour information element encapsulates information for compute flavours. A compute flavour includes information about number of virtual CPUs, size of virtual memory, size of virtual storage, and virtual network interfaces.

NOTE: The virtualised compute resource EAS is associated to a VNFC instance.

Table 7.1.4.12.3-2: energyAdditionalParamForVirtualComputeFlavour attribute in VirtualComputeFlavour information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVirtualComputeFlavo ur	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.4.12.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.8.1.2.4.

7.1.4.13   Query Compute Resource Quota operation

7.1.4.13.1   Description

This operation allows querying quota information about compute resources that the consumer has access to ETSI GS NFV-IFA 006 [7].

Table 7.1.4.13.1-1 lists the information flow exchanged between the VNFM and the VIM ETSI GS NFV-IFA 006 [7].

Table 7.1.4.13.1-1: Query Compute Resource Quota operation

Message	Requirement	Direction
QueryComputeResourceQuotaRequest	Mandatory	VNFM → VIM
QueryComputeResourceQuotaResponse	Mandatory	VIM → VNFM

7.1.4.13.2   Input parameters

The parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.9.1.2.2-1.

7.1.4.13.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.9.1.2.3-1.

The VirtualComputeQuota information element, provided in ETSI GS NFV-IFA 006 [7], Table 8.8.2.2.2-1, containing the amount of compute resources that have been restricted by the quota, e.g. the number of instances, shall contain the energyAdditionalParamForVirtualComputeQuota attribute provided in Table 7.1.4.13.3-1.

Table 7.1.4.13.3-1: energyAdditionalParamForVirtualComputeQuota attribute in VirtualComputeQuota information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVirtualComputeQuota	Mandatory	0 .. 1	VirtualEnergyAwareState	Virtual Energy-Aware State descriptor of the virtualised compute that has been restricted by the quota. The cardinality can be 0 if no particular EAS has been requested to be restricted by the quota.

7.1.4.13.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.9.1.2.4.

7.1.5   Ve-Vnfm reference point

7.1.5.1   VNF exposed interfaces

7.1.5.1.1   Set Configuration

7.1.5.1.1.1   Description

This operation enables a VNFM to set the configuration parameters of a VNF instance and its VNFC instance(s) or individual VNFC instances ETSI GS NFV-IFA 008 [8].

Table 7.1.5.1.1.1-1 lists the information flow exchanged between the VNFM and the VNF ETSI GS NFV-IFA 008 [8].

Table 7.1.5.1.1.1-1: ModifyConfiguration operation

Message	Requirement	Direction
SetConfigurationRequest	Mandatory	VNFM → VNF
SetConfigurationResponse	Mandatory	VNF → VNFM

7.1.5.1.1.2   Input parameters

The input parameters sent when invoking the operation are provided in ETSI GS NFV-IFA 008 [8], Table 6.2.3.2-1.

The VnfConfiguration information element, provided in ETSI GS NFV-IFA 008 [8], Table 9.2.2.2-1, contains configuration data for the VNF instance. The energyAdditionalParamForVnfConfiguration attribute, provided in Table 7.1.5.1.1.2-1, shall be added to the VnfConfiguration information element.

Table 7.1.5.1.1.2-1: energyAdditionalParamForVnfConfiguration attribute in VnfConfiguration information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfConfiguration	Mandatory	0 .. N	VirtualEnergyAwareStatesData	Required Virtual Energy-Aware States descriptor of the VNF. The cardinality can be 0 if no particular EAS is requested.

The VnfcConfiguration information element, provided in ETSI GS NFV-IFA 008 [8], Table 9.2.3.2-1, contains configuration data for the VNFC instance. The energyAdditionalParamForVnfcConfiguration attribute, provided in Table 7.1.5.1.1.2-2, shall be added to the VnfcConfiguration information element.

Table 7.1.5.1.1.2-2: energyAdditionalParamForVnfcConfiguration attribute in
VnfcConfiguration information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVnfcConfiguration	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Required Virtual Energy-Aware States descriptor of the virtualised compute. The cardinality can be 0 if no particular EAS is requested.

7.1.5.1.1.3   Output parameters

The output parameters sent when responding to the operation is provided in ETSI GS NFV-IFA 008 [8], Table 6.2.3.3-1.

The VnfConfiguration information element, provided in ETSI GS NFV-IFA 008 [8], Table 9.2.2.2-1, contains configuration data for the VNF instance. The energyAdditionalParamForVnfConfiguration attribute, provided in Table 7.1.5.1.1.3-1, shall be added to the VnfConfiguration information element.

Table 7.1.5.1.1.3-1: energyAdditionalParamForVnfConfiguration attribute in
VnfConfiguration information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVnfConfiguration	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Correspond to the vnfConfigurationData in the input information elements of the SetConfiguration operation if it has.

The VnfcConfiguration information element, provided in ETSI GS NFV-IFA 008 [8], Table 9.2.3.2-1, contains configuration data for the VNFC instance. The energyAdditionalParamForVnfcConfiguration attribute, provided in Table 7.1.5.1.1.3-2, shall be added to the VnfcConfiguration information element.

Table 7.1.5.1.1.3-2: energyAdditionalParamForVnfcConfiguration attribute in VnfcConfiguration
information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForVnfcConfiguration	Mandatory	0 .. N	VirtualEnergyAwareStat esData	Correspond to the vnfcConfigurationData in the input information elements of the SetConfiguration operation if it has.

7.1.5.1.1.4   Operation Results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 6.2.3.3.

7.1.5.2   VNFM exposed interfaces

7.1.5.2.1   Instantiate VNF operation

7.1.5.2.1.1   Description

This operation instantiates a particular DF of a VNF that has been in the NOT_INSTANTIATED instantiation state, based on the definition in the VNFD ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.1.1-1 lists the information flow exchanged between the Element Manager and the VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.1.1-1: Instantiate VNF operation

Message	Requirement	Direction
InstantiateVnfRequest	Mandatory	EM → VNFM
InstantiateVnfResponse	Mandatory	VNFM → EM

7.1.5.2.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.3.2-1.

The energyAdditionalParamForVnfInInstantiateVnf parameter provided in Table 7.1.5.2.1.2-1 shall be added, allowing EM to provide additional parameter(s) per VNF instance that is to be created by VNFM as part of the VNF instantiation and not for existing VNFs that are referenced for reuse. It shall identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

**Table 7.1.5.2.1.2-1: energyAdditionalParamForVnf attribute in
Instantiate VNF operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnf InInstantiateVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

7.1.5.2.1.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.3.3-1.

7.1.5.2.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.3.4.

7.1.5.2.2   Scale VNF operation

7.1.5.2.2.1   Description

This operation enables a VNF instance or EM to request a VNFM to perform a scaling procedure ETSI GS NFV-IFA 008 [8]:

- scale out: adding additional VNFC instances to increase the VNF capacity;

- scale in: removing VNFC instances from the VNF in order to release unused capacity.

Table 7.1.5.2.2.1-1 lists the information flow exchanged between EM and VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.2.1-1: Scale VNF operation

Message	Requirement	Direction
ScaleVnfRequest	Mandatory	EM → VNFM VNF → VNFM (see note)
ScaleVnfResponse	Mandatory	VNFM → EM VNFM → VNF (see note)
NOTE: In case of VNF without EM, the scaling request is invoked by management function within the VNF. The management function may implement the consumer part of the VNF LCM interface on the Ve-Vnfm-em reference point.		

7.1.5.2.2.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 008 [8], Table 7.2.4.2-1.

The energyAdditionalParamForVnfAspectInScaleVnf parameter provided in Table 7.1.5.2.2.2-1 shall be added,
allowing EM to provide additional parameter(s) for each aspect per VNF instance that is to be scaled by VNFM. It shall
identify a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf
used to deploy the VNF instance whose identifier is vnfInstanceId.

Table 7.1.5.2.2.2-1: energyAdditionalParamForVnf attribute in Scale VNF operation input parameter

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnf AspectInScaleVnf	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of a required virtual energy-aware state chosen among the Virtual Energy-Aware States supported by the VnfDf used to deploy the VNF instance whose identifier is vnfInstanceId.

7.1.5.2.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8],
Table 7.2.4.3-1.

7.1.5.2.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.4.4.

7.1.5.2.3   Scale VNF to Level operation

7.1.5.2.3.1   Description

This operation scales an instantiated VNF of a particular DF to a target size. The target size is either expressed as an
instantiation level of that DF as defined in the VNFD, or given as a list of scale levels, one per scaling aspect of that DF.
Instantiation levels and scaling aspects are declared in the VNFD. Typically, the result of this operation is adding and/or
removing NFVI resources to/from the VNF ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.3.1-1 lists the information flow exchanged between VNF/EM and VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.3.1-1: Scale VNF To Level operation

Message	Requirement	Direction
ScaleVnfToLevelRequest	Mandatory	EM → VNFM VNF → VNFM (see note)
ScaleVnfToLevelResponse	Mandatory	VNFM → EM VNFM → VNF (see note)
NOTE: In case of VNF without EM, the scaling request is invoked by management function within the VNF. The management function may implement the consumer part of the VNF LCM interface on the Ve-Vnfm-em reference point.		

7.1.5.2.3.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 008 [8], Table 7.2.5.2-1.

The energyAdditionalParamForVnfLevelInScaleVnfToLevel parameter provided in Table 7.1.5.2.3.2-1 shall be added,
allowing EM to provide additional parameter(s) for each instantiation level per VNF instance that is to be scaled to a
target size by VNFM. It shall identify the required EAS of the target instantiation level of the current Deployment
Flavour to which the VNF instance is requested to be scaled.

The energyAdditionalParamForVnfAspectInScaleVnfToLevel parameter provided in Table 7.1.5.2.3.2-1 shall be added, allowing EM to provide additional parameter(s) for each aspect per VNF instance that is to be scaled to a target size by VNFM. It shall identify the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

Table 7.1.5.2.3.2-1: energyAdditionalParamForVnf attribute in
Scale VNF to Level operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfLevel In ScaleVnfToLevel	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be scaled.
energyAdditionalParamForVnfAspe ctInScaleVnfToLevel	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

7.1.5.2.3.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.5.3-1.

7.1.5.2.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.5.4.

7.1.5.2.4   Change VNF Flavour operation

7.1.5.2.4.1   Description

This operation changes the DF of a VNF instance. It depends on the VNF capabilities, and is declared in the VNFD, whether this operation is supported for a particular VNF. This operation may be service-disruptive ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.4.1-1 lists the information flow exchanged between EM and VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.4.1-1: Change VNF Flavour operation

Message	Requirement	Direction
ChangeVnfFlavourRequest	Mandatory	EM → VNFM
ChangeVnfFlavourResponse	Mandatory	VNFM → EM

7.1.5.2.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.6.2-1.

The energyAdditionalParamForVnfLevelInChangeVnfFlavour parameter provided in Table 7.1.5.2.4.2-1 shall be added, allowing EM to provide additional parameter(s) for each instantiation level per VNF instance which its Deployment Flavour is to be changed by VNFM. It shall identify the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be scaled.

The energyAdditionalParamForVnfAspectInChangeVnfFlavour parameter provided in Table 7.1.5.2.4.2-1 shall be added, allowing EM to provide additional parameter(s) for each aspect per VNF instance which its Deployment Flavour is to be changed by VNFM. It shall identify the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

**Table 7.1.5.2.4.2-1: energyAdditionalParamForVnf attribute in
Change VNF Flavour operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfLevelInChangeVnfFlavour	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be scaled.
energyAdditionalParamForVnfAspectInChangeVnfFlavour	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

7.1.5.2.4.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.6.3-1.

7.1.5.2.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.6.4.

7.1.5.2.5   Query VNF operation

7.1.5.2.5.1   Description

This operation provides information about VNF instances. The applicable VNF instances can be chosen based on filtering criteria, and the information can be restricted to selected attributes.

Table 7.1.5.2.5.1-1 lists the information flow exchanged between EM and VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.5.1-1: Query VNF operation

Message	Requirement	Direction
QueryVnfRequest	Mandatory	EM → VNFM VNF → VNFM
QueryVnfResponse	Mandatory	VNFM → EM VNFM → VNF

7.1.5.2.5.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.9.2-1.

7.1.5.2.5.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.2.9.3-1.

The attributes of the InstantiatedVnfInfo information element, in ETSI GS NFV-IFA 008 [8], Table 9.4.3.2-1, provide run-time information specific to an instantiated VNF instance. The identifier of the run-time virtual energy-aware state of the Deployment Flavour of the instantiated VNF instance, noted vnfDfVirtualEnergyAwareStateId, and provided in Table 7.1.5.2.5.3-1, shall be added.

Table 7.1.5.2.5.3-1: vnfDfVirtualEnergyAwareStateId attribute in InstantiatedVnfInfo information element

Attribute	Qualifier	Cardinality	Content	Description
vnfDfVirtualEnergyAwareStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the Deployment Flavour of the instantiated VNF instance.

The ScaleInfo information element shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 9.4.8.2-1. The identifier of the run-time virtual energy-aware state of the scale level of the scaling aspect of the instantiated VNF instance, noted scalingAspectVirtualEnergyAwareStateId, and provided in Table 7.1.5.2.5.3-2, shall be added.

Table 7.1.5.2.5.3-2: scalingAspectVirtualEnergyAwareStateId attribute in ScaleInfo information element

Attribute	Qualifier	Cardinality	Content	Description
scalingAspectVirtualEnergyAwareStateId	Mandatory	0 .. 1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the scale level of the scaling aspect of the instantiated VNF instance.

The ResourceHandle information element, in ETSI GS NFV-IFA 008 [8], Table 9.4.7.2-1, of the VnfcResourceInfo information element, in ETSI GS NFV-IFA 008 [8], Table 9.4.4.2-1, provides information on virtualised compute used by a VNFC in a VNF instance. Depending on the form of the virtualisation container of the VNFC:

- For a VNFC based on VM, a reference to the corresponding VirtualCompute is provided.

- For a VNFC based on OS container(s), a reference to the Compute MCIO is provided. Hence, exposure of information by the VNFM to the NFVO is at the MCIO level.

The ResourceHandle information element shall contain the identifier of the run-time energy-aware state of the instantiated VNFC instance, noted virtualComputeDescVirtualEnergyAwareStateId, when the instantiated VNFC instance is realized by a virtual compute, noted mcioDescVirtualEnergyAwareStateId when the instantiated VNFC instance is realized by a set of OS Containers, and provided in Table 7.1.5.2.5.3-3.

Table 7.1.5.2.5.3-3: energyAwareStateId attribute in ResourceHandle information element

Attribute	Qualifier	Cardinality	Content	Description
virtualComputeDescVirtualEnergyAwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a virtual compute.
mcioDescVirtualEnergyAwareStateId	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the run-time Energy-Aware State of the instantiated VNFC instance when realized by a set of OS Containers.

7.1.5.2.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.9.4.

7.1.5.2.6   Operate VNF operation

7.1.5.2.6.1   Description

This operation enables requesting to change the state of a VNF instance or VNFC(s) instance(s), including starting and stopping the instance(s) ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.6.1-1 lists the information flow exchanged between EM and VNFM ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.6.1-1: Operate VNF operation

Message	Requirement	Direction
OperateVnfRequest	Mandatory	EM → VNFM
OperateVnfResponse	Mandatory	VNFM → EM

7.1.5.2.6.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 008 [8], Table 7.2.11.2-1.

The energyAdditionalParamForVnfLevelInOperateVNF parameter provided in Table 7.1.5.2.6.2-1 shall be added,
allowing EM to provide additional parameter(s) for each instantiation level per VNF instance that is to be operated by
VNFM. It shall identify the required EAS of the target instantiation level of the current Deployment Flavour to which
the VNF instance is requested to be operated.

The energyAdditionalParamForVnfAspectInOperateVNF parameter provided in Table 7.1.5.2.6.2-1 shall be added,
allowing EM to provide additional parameter(s) for each aspect per VNF instance that is to be operated by VNFM. It
shall identify the required EAS of an aspect composing the VNF instance deployed according to a given VNF
Deployment Flavour in a given instantiation level.

**Table 7.1.5.2.6.2-1: energyAdditionalParamForVnf attribute in
Operate VNF operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
energyAdditionalParamForVnfLevelInOperateVNF	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of the target instantiation level of the current Deployment Flavour to which the VNF instance is requested to be operated.
energyAdditionalParamForVnfAspectInOperateVNF	Mandatory	0..1	Identifier (reference to a virtual energy aware state)	Identifier of the required EAS of an aspect composing the VNF instance deployed according to a given VNF Deployment Flavour in a given instantiation level.

7.1.5.2.6.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8],
Table 7.2.11.3-1.

7.1.5.2.6.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.2.11.4.

7.1.5.2.7   Notify (VnfLcmOperationOccurrenceNotification) operation

7.1.5.2.7.1   Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the producer (VNFM) that
cannot be invoked as an operation by the consumer (EM or VNF). In order to receive notifications, the consumer (EM
or VNF) shall perform an explicit Subscribe operation beforehand ETSI GS NFV-IFA 008 [8].

This notification is produced when there is a change in the VNF lifecycle caused by a VNF LifeCycle Management
operation occurrence ETSI GS NFV-IFA 008 [8].

Table 7.1.5.2.7.1-1 lists the information flow exchanged between the VNFM and the EM or VNF.

Table 7.1.5.2.7.1-1: Notify (VnfLcmOperationOccurrenceNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → EM VNFM → VNF

The following notification is sent by this operation: VnfLcmOperationOccurrenceNotification.

Table 9.5.2.3-1 in ETSI GS NFV-IFA 008 [8] lists the attributes of the VnfLcmOperationOccurrenceNotification notification.

The energyAdditionalParamForAffectedVnfc attribute provided in Table 7.1.5.2.7.1-2 shall be added to the AffectedVnfc information element, provided in ETSI GS NFV-IFA 008 [8], Table 9.5.3.2-1, containing information about VNFC instances that were affected during the execution of the LifeCycle Management operation when this notification represents the result of a LifeCycle Management operation occurrence.

Table 7.1.5.2.7.1-2: energyAdditionalParamForAffectedVnfc attribute in AffectedVnfc information element

Attribute	Qualifier	Cardinality	Content	Description
energyAdditionalParam ForAffectedVnfc	Mandatory	0 .. N	Identifier(s) (reference(s) to Energy-Aware State(s))	Identifier(s) the virtual Energy-Aware State(s) of the VNFC instance that was affected during the execution of the LifeCycle Management operation.

7.2   Monitoring operations

7.2.0   Generality

GAL Monitoring commands set permits to monitor the energy parameters and values of an individual resource or a group of resources.

7.2.1   Os-Ma-Nfvo reference point

7.2.1.0   Generality

This interface allows providing of performance information related to Network Services. Collection and reporting of performance information is controlled by a Performance Management (PM) job that groups details of performance collection and reporting information. Performance information on a given NS results from either collected performance information of the virtualised resources impacting the connectivity of this NS instance or VNF performance information, resulting from virtualised resource performance information, issued by the VNFM for the VNFs that is part of this NS instance ETSI GS NFV-IFA 013 [4].

7.2.1.1   Create PM Job operation

7.2.1.1.1   Description

This operation creates a PM job, enabling OSS/BSS to specify an NS or set of NSs, that NFVO is managing, for which it wants to receive performance information. This will allow the requesting OSS/BSS to specify its performance information requirements with NFVO. OSS/BSS needs to issue a Subscribe request for PerformanceInformationAvailable notifications in order to know when new collected performance information is available ETSI GS NFV-IFA 013 [4].

Table 7.2.1.1.1-1 lists the information flow exchanged between OSS/BSS and NFVO.

Table 7.2.1.1.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	OSS/BSS → NFVO
CreatePmJobResponse	Mandatory	NFVO → OSS/BSS

7.2.1.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.2.2-1.

The valid values of the performanceMetric parameter are specified as "Measurement Name" values of the performance measurements applicable to the Os-Ma-nfvo reference point.

Measurement Name: NsDfVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a Network Service instance.

Measurement Name: NsScalingAspectVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each Network Service Scaling Aspect of the Deployment Flavour of a Network Service instance.

Measurement Name: NsLevelVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfToLevelMappingVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfProfileVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF Profile" entity involved in a "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

7.2.1.1.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.2.3-1.

7.2.1.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.5.2.4.

7.2.1.2   Notify (ThresholdCrossedNotification) operation

7.2.1.2.1   Description

This operation distributes notifications to OSS/BSS. It is a one-way operation issued by NFVO that cannot be invoked as an operation by OSS/BSS ETSI GS NFV-IFA 013 [4].

Table 7.2.1.2.1-1 lists the information flow exchanged between NFVO and OSS/BSS.

Table 7.2.1.2.1-1: Notify (ThresholdCrossedNotification) operation

Message	Requirement	Direction
Notify	Mandatory	NFVO → OSS/BSS

The following notifications are sent by this operation:

- PerformanceInformationAvailableNotification.

- ThresholdCrossedNotification.

Table 8.4.9.3-1 in ETSI GS NFV-IFA 013 [4] lists the ThresholdCrossedNotification attributes. The performanceMetric attribute provides the related "Measurement Name" value of the performance measurements applicable to the Os-Ma-nfvo reference point.

Measurement Name: NsDfVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a Network Service instance.

Measurement Name: NsScalingAspectVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each Network Service Scaling Aspect of the Deployment Flavour of a Network Service instance.

Measurement Name: NsLevelVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfToLevelMappingVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfProfileVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF Profile" entity involved in a "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

7.2.1.3   Query PM Job operation

7.2.1.3.1   Description

This operation will enable the OSS/BSS to solicit from the NFVO the details of one or more PM job(s). This operation does not return performance reports ETSI GS NFV-IFA 013 [4].

Table 7.2.1.3.1-1 lists the information flow exchanged between NFVO and OSS/BSS.

Table 7.2.1.3.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	OSS/BSS → NFVO
QueryPmJobResponse	Mandatory	NFVO → OSS/BSS

7.2.1.3.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.6.2-1.

7.2.1.3.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.6.3-1.

The performanceMetric attribute of the PmJob information element, contained in ETSI GS NFV-IFA 013 [4], Table 8.4.3.2-1, provides the related "Measurement Name" value of the performance measurements applicable to the Os-Ma-nfvo reference point.

Measurement Name: NsDfVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a Network Service instance.

Measurement Name: NsScalingAspectVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each Network Service Scaling Aspect of the Deployment Flavour of a Network Service instance.

Measurement Name: NsLevelVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfToLevelMappingVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfProfileVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF Profile" entity involved in a "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

7.2.1.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.5.6.4.

7.2.1.4   Create Threshold operation

7.2.1.4.1   Description

This operation will allow the OSS/BSS to create a threshold and specify threshold levels on specified performance metric (for NS related measured object(s)) for which notifications will be generated when crossed. Creating a threshold does not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed metric for the selected entities ETSI GS NFV-IFA 013 [4].

Table 7.2.1.4.1-1 lists the information flow exchanged between NFVO and OSS/BSS.

Table 7.2.1.4.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	OSS/BSS → NFVO
CreateThresholdResponse	Mandatory	NFVO → OSS/BSS

7.2.1.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.7.2-1.

The performanceMetric parameter, defining the performance metric on which the threshold will be defined, provides the related "Measurement Name" value of the performance measurements applicable to the Os-Ma-nfvo reference point.

Measurement Name: NsDfVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a Network Service instance.

Measurement Name: NsScalingAspectVirtualEnergyAwareState. The performance measurements applicable to the Os Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each Network Service Scaling Aspect of the Deployment Flavour of a Network Service instance.

Measurement Name: NsLevelVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfToLevelMappingVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfProfileVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF Profile" entity involved in a "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

The thresholdDetails parameter shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.1.4.3 Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.7.3-1.

7.2.1.4.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.5.7.4.

7.2.1.5 Query Threshold operation

7.2.1.5.1 Description

This operation will allow the OSS/BSS to query the details of an existing threshold ETSI GS NFV-IFA 013 [4].

Table 7.2.1.5.1-1 lists the information flow exchanged between NFVO and OSS/BSS.

Table 7.2.1.5.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	OSS/BSS → NFVO
QueryThresholdResponse	Mandatory	NFVO → OSS/BSS

7.2.1.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.9.2-1.

7.2.1.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 013 [4], Table 7.5.9.3-1. The Threshold information element, defined in ETSI GS NFV-IFA 013 [4], Table 8.4.4.2-1, lists the threshold details matching the input filter.

The performanceMetric attribute, defining the performance metric associated with the threshold, provides the related "Measurement Name" value of the performance measurements applicable to the Os-Ma-nfvo reference point.

Measurement Name: NsDfVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a Network Service instance.

Measurement Name: NsScalingAspectVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each Network Service Scaling Aspect of the Deployment Flavour of a Network Service instance.

Measurement Name: NsLevelVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfToLevelMappingVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

Measurement Name: VnfProfileVirtualEnergyAwareState. The performance measurements applicable to the Os-Ma-nfvo reference point, defined in clause 7.3 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "VNF Profile" entity involved in a "VNF To Level Mapping" entity involved in the Network Service Level of the Deployment Flavour of a Network Service instance.

The thresholdDetails attribute shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.1.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 013 [4], clause 7.5.9.4.

7.2.2   Or-Vnfm reference point

7.2.2.0   Generality

This interface allows providing performance management related to VNFs. Performance information on a given VNF results from performance information of the virtualised resources that is collected from VIM and mapped to this VNF instance. Collection and reporting of performance information is controlled by a PM job that groups details of performance collection and reporting information ETSI GS NFV-IFA 007 [5].

7.2.2.1   Create PM Job operation

7.2.2.1.1   Description

This operation will create a PM job enabling NFVO to specify a VNF or set of VNFs, that VNFM is managing, for which it wants to receive performance information. This will allow NFVO to specify its performance information requirements with VNFM ETSI GS NFV-IFA 007 [5].

Table 7.2.2.1.1-1 lists the information flow exchanged between NFVO and VNFM.

Table 7.2.2.1.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	NFVO → VNFM
CreatePmJobResponse	Mandatory	VNFM → NFVO

7.2.2.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA007 [5], Table 7.4.2.2-1.

The valid values of the performanceMetric parameter are specified as "Measurement Name" values of the performance measurements applicable to the Or-Vnfm reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.2.1.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.2.3-1.

7.2.2.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.4.2.4.

7.2.2.2   Notify (ThresholdCrossedNotification) operation

7.2.2.2.1   Description

This operation distributes notifications to NFVO. It is a one-way operation issued by VNFM that cannot be invoked as an operation by NFVO ETSI GS NFV-IFA 007 [5].

Table 7.2.2.2.1-1 lists the information flow exchanged between VNFM and NFVO.

Table 7.2.2.2.1-1: Notify (ThresholdCrossedNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → NFVO

The following notifications are sent by this operation:

- PerformanceInformationAvailableNotification.

- ThresholdCrossedNotification.

Table 8.7.9.3-1 in ETSI GS NFV-IFA 007 [5] lists the attributes of the ThresholdCrossedNotification. The valid values of the performanceMetric attribute are specified as "Measurement Name" values of the performance measurements applicable to the Or-Vnfm reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.2.3 Query PM Job operation

7.2.2.3.1 Description

This operation will enable the NFVO to solicit from the VNFM the details of one or more PM job(s). This operation is not returning performance reports ETSI GS NFV-IFA 007 [5].

Table 7.2.2.3.1-1 lists the information flow exchanged between NFVO and OSS/BSS.

Table 7.2.2.3.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	NFVO → VNFM
QueryPmJobResponse	Mandatory	VNFM → NFVO

7.2.2.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.6.2-1.

7.2.2.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.6.3-1.

The performanceMetric attribute of the PmJob information element, contained in ETSI GS NFV-IFA 007 [5], Table 8.7.3.2-1, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vnfm reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.2.3.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.4.6.4.

7.2.2.4   Create Threshold operation

7.2.2.4.1   Description

This operation will allow the NFVO to create a threshold to specify threshold levels on specified performance metric and VNF related measured object(s) for which notifications will be generated when crossed. Creating a threshold does not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed metric for the selected entities ETSI GS NFV-IFA 007 [5].

Table 7.2.2.4.1-1 lists the information flow exchanged between NFVO and VNFM.

Table 7.2.2.4.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	NFVO → VNFM
CreateThresholdResponse	Mandatory	VNFM → NFVO

7.2.2.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.7.2-1.

The performanceMetric parameter, defining the performance metric on which the threshold will be defined, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vnfm reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

The thresholdDetails parameter shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.2.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.7.3-1.

7.2.2.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.4.7.4.

7.2.2.5   Query Threshold operation

7.2.2.5.1   Description

This operation will allow the NFVO to query the details of an existing threshold ETSI GS NFV-IFA 007 [5].

Table 7.2.2.5.1-1 lists the information flow exchanged between NFVO and VNFM.

Table 7.2.2.5.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	NFVO → VNFM
QueryThresholdResponse	Mandatory	VNFM → NFVO

7.2.2.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.9.2-1.

7.2.2.5.3 Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 007 [5], Table 7.4.9.3-1. The Threshold information element, defined in ETSI GS NFV-IFA 007 [5], Table 8.7.4.2-1, lists the threshold details matching the input filter.

The performanceMetric attribute, defining the performance metric associated with the threshold, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vnfm reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

The thresholdDetails attribute shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.2.5.4 Operation results

The operation results are defined in ETSI GS NFV-IFA 007 [5], clause 7.4.9.4.

7.2.3 Or-Vi reference point

7.2.3.0 Generality

This interface allows providing performance management information related to virtualised resources including (but not limited to) resource consumption level, e.g. virtual CPU (vCPU) power consumption, VM memory usage oversubscription, VM disk latency, etc. It should be noted that only types of resources that have been catalogued and offered through abstractions to consumer functional blocks are in scope ETSI GS NFV-IFA 005 [6].

7.2.3.1   Create PM Job operation

7.2.3.1.1   Description

This operation will create a PM job, enabling NFVO to specify a resource or set of resources, that VIM is managing, for which it wants to receive performance information. This will allow the requesting NFVO to specify its performance information requirements with VIM ETSI GS NFV-IFA 005 [6].

Table 7.2.3.1.1-1 lists the information flow exchanged between NFVO and VIM.

Table 7.2.3.1.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	NFVO → VIM
CreatePmJobResponse	Mandatory	VIM → NFVO

7.2.3.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.2.2-1.

The valid values of the performanceMetric parameter are specified as "Measurement Name" values of the performance measurements applicable to the Or-Vi reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

7.2.3.1.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.2.3-1.

7.2.3.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.7.2.4.

7.2.3.2   Query PM Job operation

7.2.3.2.1   Description

This operation will enable the NFVO to solicit from the VIM the details of one or more PM job(s). This operation is not returning performance reports ETSI GS NFV-IFA 005 [6].

Table 7.2.3.2.1-1 lists the information flow exchanged between NFVO and VIM.

Table 7.2.3.2.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	NFVO → VIM
QueryPmJobResponse	Mandatory	VIM → NFVO

7.2.3.2.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.3.2-1.

7.2.3.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.3.3-1.

The performanceMetric attribute of the PmJob information element, contained in ETSI GS NFV-IFA 005 [6], Table 8.5.3.2-1, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vi reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

7.2.3.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.7.3.4.

7.2.3.3   Notify (ThresholdCrossedNotification) operation

7.2.3.3.1   Description

This operation distributes notifications to NFVO. It is a one-way operation issued by VIM that cannot be invoked as an operation by NFVO ETSI GS NFV-IFA 005 [6].

Table 7.2.3.3.1-1 lists the information flow exchanged between VIM and NFVO.

Table 7.2.3.3.1-1: Notify (ThresholdCrossedNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → NFVO

The following notifications are sent by this operation:

- PerformanceInformationAvailableNotification.

- ThresholdCrossedNotification.

Table 8.5.9.3-1 in ETSI GS NFV-IFA 005 [6] lists the attributes of the ThresholdCrossedNotification. The valid values of the performanceMetric attribute are specified as "Measurement Name" values of the performance measurements applicable to the Or-Vi reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

7.2.3.4   Create Threshold operation

7.2.3.4.1   Description

This operation will allow the NFVO to create a threshold to specify threshold levels on specified performance metric and VNF related measured object(s) for which notifications will be generated when crossed. Creating a threshold does not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed metric for the selected entities ETSI GS NFV-IFA 005 [6].

Table 7.2.3.4.1-1 lists the information flow exchanged between NFVO and VIM.

Table 7.2.3.4.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	NFVO → VIM
CreateThresholdResponse	Mandatory	VIM → NFVO

7.2.3.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.7.2-1.

The performanceMetric parameter, defining the performance metric on which the threshold will be defined, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vi reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

The thresholdDetails parameter shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.3.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.7.3-1.

7.2.3.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.7.7.4.

7.2.3.5   Query Threshold operation

7.2.3.5.1   Description

This operation will allow the NFVO to query the details of an existing threshold ETSI GS NFV-IFA 005 [6].

Table 7.2.3.5.1-1 lists the information flow exchanged between NFVO and VIM.

Table 7.2.3.5.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	NFVO → VIM
QueryThresholdResponse	Mandatory	VIM → NFVO

7.2.3.5.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.8.2-1.

7.2.3.5.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 005 [6], Table 7.7.8.3-1. The Threshold information element, defined in ETSI GS NFV-IFA 005 [6], Table 8.5.4.2-1, lists the threshold details matching the input filter.

The performanceMetric attribute, defining the performance metric associated with the threshold, provides the related "Measurement Name" value of the performance measurements applicable to the Or-Vi reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

The thresholdDetails attribute shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.3.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 005 [6], clause 7.7.8.4.

7.2.4   Vi-Vnfm reference point

7.2.4.0   Generality

This interface allows providing performance management information related to virtualised resources including (but not limited to) resource consumption level, e.g. vCPU power consumption, VM memory usage oversubscription, VM disk latency, etc. It should be noted that only types of resources that have been catalogued and offered through abstractions to consumer functional blocks are in scope ETSI GS NFV-IFA 006 [7].

7.2.4.1   Create PM Job operation

7.2.4.1.1   Description

This operation will create a PM job, enabling VNFM to specify a resource or set of resources, that VIM is managing, for which it wants to receive performance information. This will allow the requesting VNFM to specify its performance information requirements with VIM ETSI GS NFV-IFA 006 [7].

Table 7.2.4.1.1-1 lists the information flow exchanged between VNFM and VIM.

Table 7.2.4.1.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	VNFM → VIM
CreatePmJobResponse	Mandatory	VIM → VNFM

7.2.4.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.7.2.2-1.

The valid values of the performanceMetric parameter are specified as "Measurement Name" values of the performance measurements applicable to the Vi-Vnfm reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

7.2.4.1.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7], Table 7.7.2.3-1.

7.2.4.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.7.2.4.

7.2.4.2   Query PM Job operation

7.2.4.2.1   Description

This operation will enable the VNFM to solicit from the VIM the details of one or more PM job(s). This operation is not returning performance reports ETSI GS NFV-IFA 006 [7].

Table 7.2.4.2.1-1 lists the information flow exchanged between VNFM and VIM.

Table 7.2.4.2.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	VNFM → VIM
QueryPmJobResponse	Mandatory	VIM → VNFM

7.2.4.2.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 006 [7], Table 7.7.3.2-1.

7.2.4.2.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7],
Table 7.7.3.3-1.

The performanceMetric attribute of the PmJob information element, contained in ETSI GS NFV-IFA 006 [7],
Table 8.5.3.2-1, provides the related "Measurement Name" value of the performance measurements applicable to the
Vi-Vnfm reference point.

7.2.4.2.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.7.3.4.

7.2.4.3   Notify (ThresholdCrossedNotification) operation

7.2.4.3.1   Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the VIM that cannot be
invoked as an operation by the consumer (VNFM) ETSI GS NFV-IFA 006 [7].

Table 7.2.4.3.1-1 lists the information flow exchanged between VIM and VNFM.

Table 7.2.4.3.1-1: Notify (ThresholdCrossedNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VIM → VNFM

The following notifications are sent by this operation:

- PerformanceInformationAvailableNotification;

- ThresholdCrossedNotification.

Table 8.5.9.3-1 in ETSI GS NFV-IFA 006 [7] lists the attributes of the ThresholdCrossedNotification. The valid values
of the performanceMetric attribute are specified as "Measurement Name" values of the performance measurements
applicable to the Vi-Vnfm reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the
Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the
Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

7.2.4.4   Create Threshold operation

7.2.4.4.1   Description

This operation will allow the VNFM to create a threshold to specify threshold levels on specified performance metric
and VNF related measured object(s) for which notifications will be generated when crossed. Creating a threshold does
not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed
metric for the selected entities ETSI GS NFV-IFA 006 [7].

Table 7.2.4.4.1-1 lists the information flow exchanged between VNFM and VIM.

Table 7.2.4.4.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	VNFM → VIM
CreateThresholdResponse	Mandatory	VIM → VNFM

7.2.4.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 006 [7], Table 7.7.7.2-1.

The performanceMetric parameter, defining the performance metric on which the threshold will be defined, provides
the related "Measurement Name" value of the performance measurements applicable to the Vi-Vnfm reference point.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the
Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the
Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

The thresholdDetails parameter shall provide the details of the threshold (value to be crossed, direction in which it is
crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this
clause.

7.2.4.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7],
Table 7.7.7.3-1.

7.2.4.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.7.7.4.

7.2.4.5   Query Threshold operation

7.2.4.5.1   Description

This operation will allow the VNFM to query the details of an existing threshold ETSI GS NFV-IFA 006 [7].

Table 7.2.4.5.1-1 lists the information flow exchanged between VNFM and VIM.

Table 7.2.4.5.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	VNFM → VIM
QueryThresholdResponse	Mandatory	VIM → VNFM

7.2.4.5.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI
GS NFV-IFA 006 [7], Table 7.7.8.2-1.

7.2.4.5.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 006 [7],
Table 7.7.8.3-1. The Threshold information element, defined in ETSI GS NFV-IFA 006 [7], Table 8.5.4.2-1, lists the
threshold details matching the input filter.

Measurement Name: VirtualComputeDescVirtualEnergyAwareState. The performance measurements applicable to the Or-Vi reference point, defined in clause 7.1 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the VNFC when a virtual compute resource realizes the Vdu of this VNFC.

The thresholdDetails attribute shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.4.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 006 [7], clause 7.7.8.4.

7.2.5   Ve-Vnfm reference point

7.2.5.0   Generality

This interface allows providing performance management related to VNFs. Performance information on a given VNF/VNFC results from performance information of the virtualised resources that is collected from the VIM and mapped to this VNF/VNFC instance. Collection and reporting of performance information is controlled by a PM job that groups details of performance collection and reporting information ETSI GS NFV-IFA 008 [8].

7.2.5.1   Create PM Job operation

7.2.5.1.1   Description

This operation will create a PM job enabling VNF/EM to specify a VNF/VNFC or set of VNFs/VNFCs, that VNFM is managing, for which it wants to receive performance information. This will allow VNF/EM to specify its performance information requirements with VNFM ETSI GS NFV-IFA 008 [8].

Table 7.2.5.1.1-1 lists the information flow exchanged between VNF/EM and VNFM.

Table 7.2.5.1.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	VNF → VNFM EM → VNFM
CreatePmJobResponse	Mandatory	VNFM → VNF VNFM → EM

7.2.5.1.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV_IFA 008 [8], Table 7.4.2.2-1.

The valid values of the performanceMetric parameter are specified as "Measurement Name" values of the performance measurements applicable to the Ve-Vnfm-em reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.5.1.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.2.3-1.

7.2.5.1.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.4.2.4.

7.2.5.2   Notify (ThresholdCrossedNotification) operation

7.2.5.2.1   Description

This operation distributes notifications to VNF/EM. It is a one-way operation issued by VNFM that cannot be invoked as an operation by VNF/EM ETSI GS NFV-IFA 008 [8].

Table 7.2.5.2.1-1 lists the information flow exchanged between VNFM and VNF/EM.

Table 7.2.5.2.1-1: Notify (ThresholdCrossedNotification) operation

Message	Requirement	Direction
Notify	Mandatory	VNFM → VNF
		VNFM → EM

The following notifications are sent by this operation:

- PerformanceInformationAvailableNotification.

- ThresholdCrossedNotification.

Table 9.7.9.3-1 in ETSI GS NFV-IFA 008 [8] lists the attributes of the ThresholdCrossedNotification. The valid values of the performanceMetric attribute are specified as "Measurement Name" values of the performance measurements applicable to the Ve-Vnfm-em reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.5.3   Query PM Job operation

7.2.5.3.1   Description

This operation will enable the VNF/EM to solicit from the VNFM the details of one or more PM job(s). This operation is not returning performance reports ETSI GS NFV-IFA 008 [8].

Table 7.2.5.3.1-1 lists the information flow exchanged between VNF/EM and VNFM.

Table 7.2.5.3.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	VNF → VNFM EM → VNFM
QueryPmJobResponse	Mandatory	VNFM → VNF VNFM → EM

7.2.5.3.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.6.2-1.

7.2.5.3.3   Output parameters

The output parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.6.3-1.

The performanceMetric attribute of the PmJob information element, contained in ETSI GS NFV-IFA 008 [8], Table 9.7.3.2-1, provides the related "Measurement Name" value of the performance measurements applicable to the Ve-Vnfm-em reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

7.2.5.3.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.4.6.4.

7.2.5.4   Create Threshold operation

7.2.5.4.1   Description

This operation will allow the VNF/EM to create a threshold to specify threshold levels on specified performance metric and VNF/VNFC related measured object(s) for which notifications will be generated when crossed. Creating a threshold does not trigger collection of metrics. In order for the threshold to be active, there needs to be a PM job collecting the needed metric for the selected entities ETSI GS NFV-IFA 008 [8].

Table 7.2.5.4.1-1 lists the information flow exchanged between VNF/EM and VNFM.

Table 7.2.5.4.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	VNF → VNFM EM → VNFM
CreateThresholdResponse	Mandatory	VNFM → VNF VNFM → EM

7.2.5.4.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.7.2-1.

The performanceMetric parameter, defining the performance metric on which the threshold will be defined, provides the related "Measurement Name" value of the performance measurements applicable to the Ve-Vnfm-em reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

The thresholdDetails parameter shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.5.4.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.7.3-1.

7.2.5.4.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.4.7.4.

7.2.5.5   Query Threshold operation

7.2.5.5.1   Description

This operation will allow the VNF/EM to query the details of an existing threshold ETSI GS NFV-IFA 008 [8].

Table 7.2.5.5.1-1 lists the information flow exchanged between VNF/EM and VNFM.

Table 7.2.5.5.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	VNF → VNFM EM → VNFM
QueryThresholdResponse	Mandatory	VNFM → VNF VNFM → EM

7.2.5.5.2   Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.9.2-1.

7.2.5.5.3   Output parameters

The parameters returned by the operation shall follow the indications provided in ETSI GS NFV-IFA 008 [8], Table 7.4.9.3-1. The Threshold information element, defined in ETSI GS NFV-IFA 008 [8], Table 9.7.4.2-1, lists the threshold details matching the input filter.

The performanceMetric attribute, defining the performance metric associated with the threshold, provides the related "Measurement Name" value of the performance measurements applicable to the Ve-Vnfm-em reference point.

Measurement Name: VnfDfVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Deployment Flavour of a VNF instance.

Measurement Name: InstantiationLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: VduLevelVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each "Vdu Level" entity involved in the Instantiation Level of the Deployment Flavour of a VNF instance.

Measurement Name: AspectDetailsVirtualEnergyAwareState. The performance measurements applicable to the Or-Vnfm reference point, defined in clause 7.2 of ETSI GS NFV-IFA 027 [9], shall contain power measurements for the Virtual Energy-Aware States of each scaling step of each aspect involved in the Deployment Flavour of a VNF instance when the VNF supports scaling.

The thresholdDetails attribute shall provide the details of the threshold (value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.) associated with each of the Measurement Name listed in this clause.

7.2.5.5.4   Operation results

The operation results are defined in ETSI GS NFV-IFA 008 [8], clause 7.4.9.4.

Annex A (informative):
Actual virtual energy-aware states

A.1   Virtual compute resource actual virtual energy-aware states

A.1.1   Definition

The virtual compute resource actual virtual energy-aware states depend on the compute domain on which the virtual compute resource is deployed. They are obtained as the decision result of the management and orchestration functions.

The xth actual virtual energy-aware state of the virtual compute resource realizing the kth instance of the VNFC deployed on a given compute domain, VNFC~c $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$, is defined according to the following formula:

$$(EAS_x)^{VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} = \left\{ (P_s)^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}, (S_{s'})^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)} \right\}$$

With:

$0 \leq s \leq L$ and $0 \leq s' \leq L'$

- $(S_0)^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(0)^{th}$ standby state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the virtual compute is active;

- $(S_{s'})^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(s')^{th}$ standby state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier;

- $(S_{L'})^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the lowest standby state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the virtual compute is completely off;

- $(P_0)^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(0)^{th}$ power state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the virtual compute power is maximum;

- $(P_s)^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(s)^{th}$ power state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the virtual compute power is lower than the virtual compute power of the $(0)^{th}$ power state;

- $(P_L)^{cd\left(VNFC{\sim}c\#k \text{ Ì } VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the lowest power state of the virtual compute associated with $VNFC{\sim}c\#k$ Ì $VNF{\sim}b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the virtual compute power is minimum.

The real number x identifying an actual virtual energy-aware state of a VNFC instance is mapped with (s, s') according to the following rules:

- negative values of x regard the standby configurations ($s = 0, 0 < s' \leq L'$). The sorting is based on the power gain in ascending order;

- $x = 0$ corresponds to the pair with the highest power configuration among the ones allowed by the energy-aware entity ($s = 0, s' = 0$);

- the first L positive values of x regard the power scaling configurations ($0 < s \leq L, s' = 0$). The sorting is based on the power gain in ascending order;

- the next positive values of x refer to the other possible configurations ($0 < s \leq L, 0 < s' \leq L'$).

Table A.1.1-1 summarizes the different virtual energy-aware state configuration identifiers values.

Table A.1.1-1: virtual energy-aware state configuration identifiers

virtual energy-aware state configuration identifier	virtual energy-aware state configuration name	(s, s') values
$x < 0$	Standby	$s = 0 \ and \ 0 < s' \leq L'$
$x = 0$	Max performance and power consumption	$s = 0 \ and \ s' = 0$
$x > 0$	Power scaling	$0 < s \leq L \ and \ s' = 0$
$x > 0$	Power scaling and standby	$0 < s \leq L \ and \ 0 < s' \leq L'$

A.1.2   Attributes

The xth actual virtual energy-aware state attributes of the virtual compute resource realizing the kth instance of the VNFC deployed on a given compute domain using the Vdu, VNFC~c $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$, is defined according to the following formula:

- $power\left((EAS_x)^{VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: virtual compute resource power representing the actual state of the VNFC when deployed on a specific compute domain;

- $performance\left((EAS_x)^{VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: virtual compute resource performance representing the actual state of the VNFC when deployed on a specific compute domain;

- $delay\left((EAS_x)^{VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: transition delay between the xth virtual energy-aware state and another virtual energy-aware state.

A.2   MCIO resource actual virtual energy-aware states

A.2.1   Definition

The MCIO resource actual virtual energy-aware states depend on the compute domain on which the MCIO resource is deployed. They are obtained as the decision result of the management and orchestration functions.

The xth actual virtual energy-aware state of the MCIO resource realizing the kth instance of the VNFC deployed on a given compute domain, VNFC~c $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$, is defined according to the following formula:

$$(EAS_x)^{VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} = \left\{ (P_s)^{cd\left(VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}, (S_{s'})^{cd\left(VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)} \right\}$$

With:

$0 \leq s \leq L \ and \ 0 \leq s' \leq L'$

- $(S_0)^{cd\left(VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(0)^{th}$ standby state of the MCIO associated with $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the MCIO is active;

- $(S_{s'})^{cd\left(VNFC\sim c\#k \ \grave{I} \ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(s')^{th}$ standby state of the MCIO associated with $VNFC\sim c\#k$ Ì $VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier;

- $(S_{L'})^{cd\left(VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the lowest standby state of the MCIO associated with $VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the MCIO is completely off;

- $(P_0)^{cd\left(VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(0)^{th}$ power state of the MCIO associated with $VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the MCIO power is maximum;

- $(P_s)^{cd\left(VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the $(s)^{th}$ power state of the MCIO associated with $VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the MCIO power is lower than the MCIO power of the $(0)^{th}$ power state;

- $(P_L)^{cd\left(VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}\right)}$ identifies the lowest power state of the MCIO associated with $VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$ and deployed with a given compute domain identifier. In this state the MCIO power is minimum.

The real number x identifying an actual virtual energy-aware state of a VNFC instance is mapped with (s, s') according to the following rules:

- negative values of x regard the standby configurations ($s = 0, 0 < s' \le L'$). The sorting is based on the power gain in ascending order;

- $x = 0$ corresponds to the pair with the highest power configuration among the ones allowed by the energy-aware entity ($s = 0, s' = 0$);

- the first L positive values of x regard the power scaling configurations ($0 < s \le L, s' = 0$). The sorting is based on the power gain in ascending order;

- the next positive values of x refer to the other possible configurations ($0 < s \le L, 0 < s' \le L'$). The present document does not define all the possible configurations.

Table A.2.1-1 summarizes the different virtual energy-aware state configuration identifiers values.

Table A.2.1-1: virtual energy-aware state configuration identifiers

virtual energy-aware state configuration identifier	virtual energy-aware state configuration name	(s, s') values
$x < 0$	Standby	$s = 0 \; and \; 0 < s' \le L'$
$x = 0$	Max performance and power consumption	$s = 0 \; and \; s' = 0$
$x > 0$	Power scaling	$0 < s \le L \; and \; s' = 0$
$x > 0$	Power scaling and standby	$0 < s \le L \; and \; 0 < s' \le L'$

A.2.2 Attributes

The xth actual virtual energy-aware state attributes of the MCIO resource realizing the kth instance of the VNFC deployed on a given compute domain using the Vdu, VNFC~c $VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}$, is defined according to the following formula:

- $power\left((EAS_x)^{VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: MCIO resource power representing the actual state of the VNFC when deployed on a specific compute domain;

- $performance\left((EAS_x)^{VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: MCIO resource performance representing the actual state of the VNFC when deployed on a specific compute domain;

- $delay\left((EAS_x)^{VNFC\sim c\#k \; \grave{\textrm{I}} \; VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: transition delay between the xth virtual energy-aware state and another virtual energy-aware state.

A.3   VNF actual virtual energy-aware states

A.3.1   Definition

The actual virtual energy-aware states are associated to the VNF instance deployed according to a given VNF Deployment Flavour, in a given instantiation level, see ETSI GS NFV-IFA 011 [2].

The yth actual virtual energy-aware state of the jth instance of VNF~b deployed according to a given VNF Deployment Flavour, noted DF-X, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is defined according to the following formula:

$$
\left(EAS_y\right)^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}
$$

$$
= \left\{
\begin{array}{l}
\left(\begin{array}{c} (EAS_\alpha)^{VNFC\sim c0\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} \\ \vdots \\ (EAS_\beta)^{VNFC\sim c0\#k_1\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} \end{array} \right), \dots, \left(\begin{array}{c} (EAS_\gamma)^{VNFC\sim cm\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} \\ \vdots \\ (EAS_\delta)^{VNFC\sim cm\#k_2\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}} \end{array} \right), \\[3em]
\left(\begin{array}{c} (EAS_\varepsilon)^{VNFC\sim cn\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \\ \vdots \\ (EAS_\epsilon)^{VNFC\sim cn\#k_3\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \end{array} \right), \dots, \left(\begin{array}{c} (EAS_\theta)^{VNFC\sim co\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \\ \vdots \\ (EAS_\vartheta)^{VNFC\sim co\#k_4\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \end{array} \right), \\[3em]
\left(\begin{array}{c} (EAS_\mu)^{VNFC\sim cp\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \\ \vdots \\ (EAS_\pi)^{VNFC\sim cp\#k_5\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \end{array} \right), \dots, \left(\begin{array}{c} (EAS_\rho)^{VNFC\sim cq\#0\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \\ \vdots \\ (EAS_\sigma)^{VNFC\sim cq\#k_6\ \grave{\text{I}}\ VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \end{array} \right)
\end{array}
\right\}
$$

The real number y identifying identifying an actual virtual energy-aware state of the VNF instance is mapped with $(\alpha, \beta, \gamma, \dots)$ according to rules that are out of the scope of the present document.

A.3.2   Attributes

The yth actual virtual energy-aware state attributes of the jth instance of VNF~b deployed according to a given VNF Deployment Flavour, noted DF-X, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is defined as follows:

- $power\left(\left(EAS_y\right)^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: actual virtual power related value of the jth instance of VNF~b deployed according to a given VNF Deployment Flavour in a given instantiation level;

- $performance\left(\left(EAS_y\right)^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: actual virtual performance related value of the jth instance of VNF~b deployed according to a given VNF Deployment Flavour in a given instantiation level;

- $delay\left(\left(EAS_y\right)^{VNF\sim b\#j_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: transition delay between this virtual energy-aware state and another virtual energy-aware state.

A.4   NS actual virtual energy-aware states

A.4.1   Definition

The actual virtual energy-aware states are associated to an instance of a given NS deployed according to a given NS Deployment Flavour in a given instantiation level, see ETSI GS NFV-IFA 014 [3].

The zth actual virtual energy-aware state of the ith instance of NS~a deployed according to a given NS Deployment Flavour, noted $DF\text{-}X$, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is defined according to the following formula:

$$(EAS_z)^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}$$

$$= \left\{ \begin{pmatrix} (EAS_\alpha)^{VNF\sim b0\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}} \\ \vdots \\ (EAS_\beta)^{VNF\sim b0\#j_{1_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}} \end{pmatrix}, \dots, \begin{pmatrix} (EAS_\gamma)^{VNF\sim bm\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}} \\ \vdots \\ (EAS_\delta)^{VNF\sim bm\#j_{2_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}} \end{pmatrix}, \right.$$

$$\begin{pmatrix} (EAS_\epsilon)^{VNF\sim bn\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \\ \vdots \\ (EAS_\epsilon)^{VNF\sim bn\#j_{3_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \end{pmatrix}, \dots, \begin{pmatrix} (EAS_\theta)^{VNF\sim bo\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \\ \vdots \\ (EAS_\vartheta)^{VNF\sim bo\#j_{4_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Y1\#l_{Y1}}} \end{pmatrix},$$

$$\dots,$$

$$\left. \begin{pmatrix} (EAS_\mu)^{VNF\sim bp\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \\ \vdots \\ (EAS_\pi)^{VNF\sim bp\#j_{5_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \end{pmatrix}, \dots, \begin{pmatrix} (EAS_\rho)^{VNF\sim bq\#0_{DF\text{-}X\#l_{DF\text{-}X}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \\ \vdots \\ (EAS_\sigma)^{VNF\sim bq\#j_{6_{DF\text{-}X\#l_{DF\text{-}X}}}\grave{\text{I}}\,NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}\text{-}ASP\text{-}Ym\#l_{Ym}}} \end{pmatrix} \right\}$$

The real number z identifying identifying an actual virtual energy-aware state of the NS instance is mapped with $(\alpha, \beta, \gamma, \dots)$ according to rules that are out of the scope of the present document.

A.4.2 Attributes

The zth actual virtual energy-aware state attributes of the ith instance of NS~a deployed according to a given NS Deployment Flavour, noted DF-X, in a given instantiation level, noted $DF\text{-}X\#l_{DF\text{-}X}$, is defined as follows:

- $power\left((EAS_z)^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: actual virtual power related value of the ith instance of NS~a deployed according to a given NS Deployment Flavour in a given instantiation level;

- $performance\left((EAS_x)^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: actual virtual performance related value of the ith instance of NS~a deployed according to a given NS Deployment Flavour in a given instantiation level;

- $delay\left((EAS_x)^{NS\sim a\#i_{DF\text{-}X\#l_{DF\text{-}X}}}\right)$: transition delay between this virtual energy-aware state and another virtual energy-aware state.

History

Document history		
V1.1.1	February 2020	Publication
V1.2.0	January 2024	Membership Approval Procedure MV 20240308: 2024-01-08 to 2024-03-08