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Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Requirements and interfaces specification for management of NFV-MANO

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Foreword

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

Modal verbs terminology

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

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1 Scope

The present document specifies the interface requirements, the interfaces and the necessary information elements enabling the fault, configuration and information, performance, state and log management of NFV-MANO functional entities.

In addition, the present document also describes the framework to support the management of NFV-MANO functional entities.

The different aspects specified in the present document have been analysed firstly in ETSI GR NFV-IFA 021 [i.1].

2 References

2.1 Normative references

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

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

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

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

[1] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Functional requirements specification".

[2] Recommendation ITU-T X.733: "Information technology - Open Systems Interconnection - Systems Management: Alarm reporting function".

[3] ETSI GS NFV-SEC 012 (V3.1.1): "Network Functions Virtualisation (NFV) Release 3; Security; System architecture specification for execution of sensitive NFV components".

2.2 Informative references

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

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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 GR NFV-IFA 021 (V3.1.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on management of NFV-MANO and automated deployment of EM and other OSS functions".

[i.2] ETSI GS NFV-MAN 001 (V1.1.1): "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.3] ETSI GS NFV-IFA 005 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".

[i.4] ETSI GS NFV-IFA 006 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[i.5] ETSI GS NFV-IFA 007 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[i.6] ETSI GS NFV-IFA 008 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[i.7] ETSI GS NFV-IFA 013 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification".

[i.8] ETSI GS NFV-IFA 011 (V3.6.1): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; VNF Descriptor and Packaging Specification".

[i.9] ISO/IEC 9646-7: "Information technology -- Open Systems Interconnection -- Conformance testing methodology and framework -- Part 7: Implementation Conformance Statements".

[i.10] Recommendation ITU-T X.731: "Information technology - Open Systems Interconnection - Systems Management: State management function".

[i.11] Linux® man pages: "vmstat - Report virtual memory statistics".

NOTE 1: Available at: http://man7.org/linux/man-pages/man8/vmstat.8.html.

NOTE 2: Linux® is the registered trademark of Linus Torvalds in the U.S. and other countries.

[i.12] ETSI GR NFV 003 (V1.6.1): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.13] Void.

[i.14] ETSI GS NFV-SEC 006 (V1.1.1): "Network Functions Virtualisation (NFV); Security Guide; Report on Security Aspects and Regulatory Concerns".

[i.15] ETSI GS NFV-SEC 014 (V3.1.1): "Network Functions Virtualisation (NFV) Release 3; NFV Security; Security Specification for MANO Components and Reference Points".

[i.16] ETSI GS NFV-IFA 030: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Multiple Administrative Domain Aspect Interfaces Specification".

[i.17] ETSI GS NFV-IFA 032: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Interface and Information Model Specification for Multi-Site Connectivity Services".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR NFV 003 [i.12] and the following apply:

NOTE: A term defined in the present document takes precedence over the definition of the same term, if any, in ETSI GR NFV 003 [i.12].

NFV-MANO functional entity application: set of NFV-MANO services

NFV-MANO functional entity component: internal component of an NFV-MANO functional entity

NFV-MANO management service: one or more management capabilities offered by an NFV-MANO functional block for the support of its operations, administration and maintenance

NFV-MANO service interface: interface, associated to an NFV-MANO service, over which operations can be invoked and/or notifications issued

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.12] and the following apply:

FM	Fault Management
HTTP	Hypertext Transfer Protocol
MANO	Management and Orchestration
MSCS	Multi-Site Connectivity Service
MSNC	Multi-Site Network Connection
OM	Object Mapping
OSS	Operations Support Systems
PM	Performance Management
PNFD	PNF Descriptor
RAM	Random Access Memory
SC	Status Counter
TF	Transparent Forwarding
VL	Virtual Link
VR	Virtualised Resource

4 Overview and framework of management of NFV-MANO

4.1 Introduction

Network Functions Virtualisation (NFV) introduces a new set of management and orchestration functions in addition to existing Element Management (EM) and Operations Support Systems (OSS) functions. This new set of management and orchestration functions is referred as Network Functions Virtualisation Management and Orchestration (NFV-MANO), and is used to manage and orchestrate:

- The relationship between the Virtualised Network Functions (VNFs) and the NFV Infrastructure (NFVI).
- The interconnection of VNFs and/or other Physical Network Functions (PNFs) and/or nested Network Service(s) (NS) to realize a NS.

The NFV-MANO architectural framework in ETSI GS NFV-MAN 001 [i.2] identifies and describes the following functional blocks:

- NFV Orchestrator (NFVO);
- VNF Manager (VNFM); and
- Virtualised Infrastructure Manager (VIM).

The NFVO has two main responsibilities:

- the orchestration of NFVI resources across multiple VIM instances, fulfilling the Resource Orchestration functions; and

- the lifecycle management of NS, fulfilling the Network Service Orchestration functions.

The VNFM is mainly responsible for the lifecycle management of VNF instances.

The VIM is responsible for controlling and managing NFVI compute, storage and network resources. The VIM manages the association of the virtualised resources to the physical compute, storage and networking resources.

In addition, ETSI GS NFV-IFA 010 [1] introduces the WAN Infrastructure Manager (WIM) who manages the connectivity for multi-site services. The WIM is responsible for managing network resources across multiple NFVI-PoPs (sites) and used to establish connectivity between different NFVI-PoPs, or between a PNF and an NFVI-PoP. The NFV Architectural Framework supports the integration of WIM deployed as part of the NFV-MANO framework and external to the NFV-MANO framework (e.g. under control of other OSS/BSS).

Functional requirements for the NFVO, VNFM and VIM are specified in ETSI GS NFV-IFA 010 [1].

NFV-MANO functional entities shall be able to be managed for the purpose of configuring, monitoring and retrieving relevant information for the network operator as specified in clause 5.3 and clause 10 of ETSI GS NFV-IFA 010 [1].

4.2 Framework

4.2.1 Overview

The framework for the management of NFV-MANO is based on the definition and exposure of a set of management interfaces by the NFV-MANO functional entities as specified in subsequent clauses of the present document. The set of interfaces can be consumed in two ways:

- by an external entity beyond NFV-MANO; and/or
- by an NFV-MANO functional entity.

4.2.2 External entity consuming interfaces for management of an NFV-MANO functional entity

The exposure and consumption of interfaces by an external entity beyond NFV-MANO is illustrated in figure 4.2.2-1. The NFV-MANO functional entity exposes a set of management interfaces to an external entity through an interface Producer.

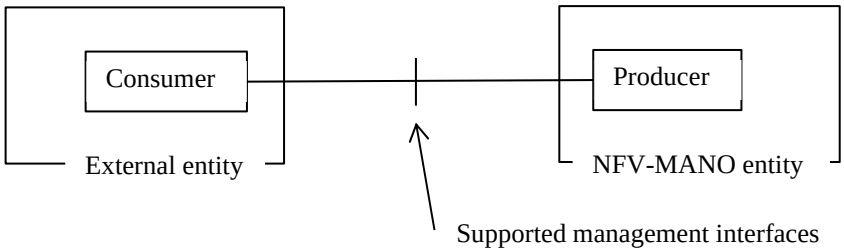

Figure 4.2.2-1: Framework of external entity consuming interfaces for management of an NFV-MANO functional entity

The Producer implements and supports a set of management interfaces that can be consumed by a Consumer within an external entity.

4.2.3 NFV-MANO functional entity consuming interfaces for management of another NFV-MANO functional entity

The exposure and consumption of interfaces by another NFV-MANO functional entity is illustrated in figure 4.2.3-1. The NFV-MANO functional entity exposes a set of management interfaces to another NFV-MANO functional entity through an interface Producer.

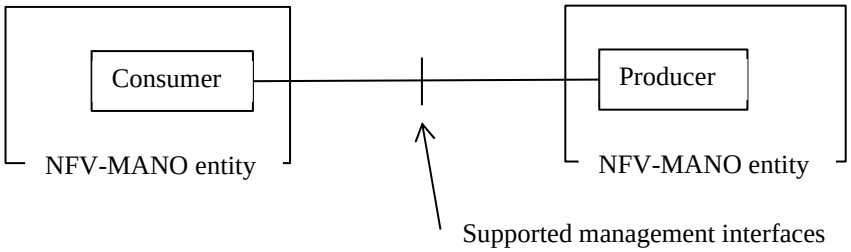

Figure 4.2.3-1: Framework of NFV-MANO functional entity consuming interfaces for management of another NFV-MANO functional entity

The Producer implements and supports a set of management interfaces that can be consumed by a Consumer within another NFV-MANO functional entity.

When enabling the consumption of interfaces by a peering NFV-MANO functional entity, the network operator shall be able to control what interfaces and individual consumable operations are needed to be consumed by the peering NFV-MANO functional entity in order to avoid unnecessary exposure of information or overloading the actual NFV-MANO functional entities beyond the limits of what needs to be managed.

4.3 NFV-MANO functional entity and NFV-MANO services

The NFV-MANO architectural framework in ETSI GS NFV-MAN 001 [i.2] identifies the following NFV-MANO functional entities:

- NFV Orchestrator (NFVO);
- VNF Manager (VNFM); and
- Virtualised Infrastructure Manager (VIM).

In addition, ETSI GS NFV-IFA 010 [1] defines the case of the WIM as part of the NFV-MANO framework. An NFV-MANO functional entity provides NFV-MANO services. An NFV-MANO service is one or more capabilities offered by the NFV-MANO functional entity which can be invoked using a defined interface, hereafter referred as NFV-MANO service interface.

EXAMPLE 1: The VNFM offers a type of NFV-MANO service for VNF lifecycle management.

EXAMPLE 2: The NFVO offers a type of NFV-MANO service for Network Service lifecycle management.

The NFV-MANO services offered by an NFV-MANO functional entity are grouped as the NFV-MANO functional entity application. The NFV-MANO functional entity can be decomposed into a set of NFV-MANO functional entity components to address functional and non-functional requirements such as scalability, resiliency, versioning, etc. An NFV-MANO functional entity component can support a sub-set of instances of NFV-MANO service.

The relationship of a type of NFV-MANO service and a type of NFV-MANO service interface is 1:1. More than one instance of an NFV-MANO service and/or NFV-MANO service interface is possible to cater for the possibility of providing more than one API endpoint or to expose different versions of a type of NFV-MANO service interface.

Figure 4.3-1 illustrates an example of the relationship between the different concepts introduced in the present clause. The NFV-MANO functional entity has an NFV-MANO functional entity application which groups the set of specific instances of NFV-MANO services. In this example, the types of NFV-MANO services are: "NFV-MANO service A", "NFV-MANO service B", "NFV-MANO service C" and "NFV-MANO service D". Each one of the NFV-MANO service types is associated to one and only one type of NFV-MANO service interface. In addition, the NFV-MANO functional entity is composed of one or multiple NFV-MANO functional entity components. An instance of an NFV-MANO service can depend on one or multiple NFV-MANO functional entity components (this is illustrated by overlapping the boxes of NFV-MANO functional entity components with the boxes of NFV-MANO services).

EXAMPLE 3: Figure 4.3-1 is also used to illustrate an example of services produced by a VNFM.

In this example, the VNFM offers four types of NFV-MANO services through a total of five NFV-MANO services interface instances:

- "NFV-MANO service type A" is for VNF performance management, which is provided and accessible via the interface type #1 - the "VNF performance management interface", which has one instance;
- "NFV-MANO service type B" is for VNF fault management, which is provided and accessible via the interface type #2 - the "VNF fault management interface", which has one instance;
- "NFV-MANO service type C" is for VNF Indicator(s), which is provided and accessible via the interface type #3 - the "VNF Indicator interface", which has one instance; and
- "NFV-MANO service type D" is for VNF lifecycle management, which is provided and accessible via the interface type #4 - the "VNF Lifecycle Management interface", which has two instances providing different API endpoints. These API endpoints can provide different paths indicating the support of different versions of a same type of NFV-MANO service interface.

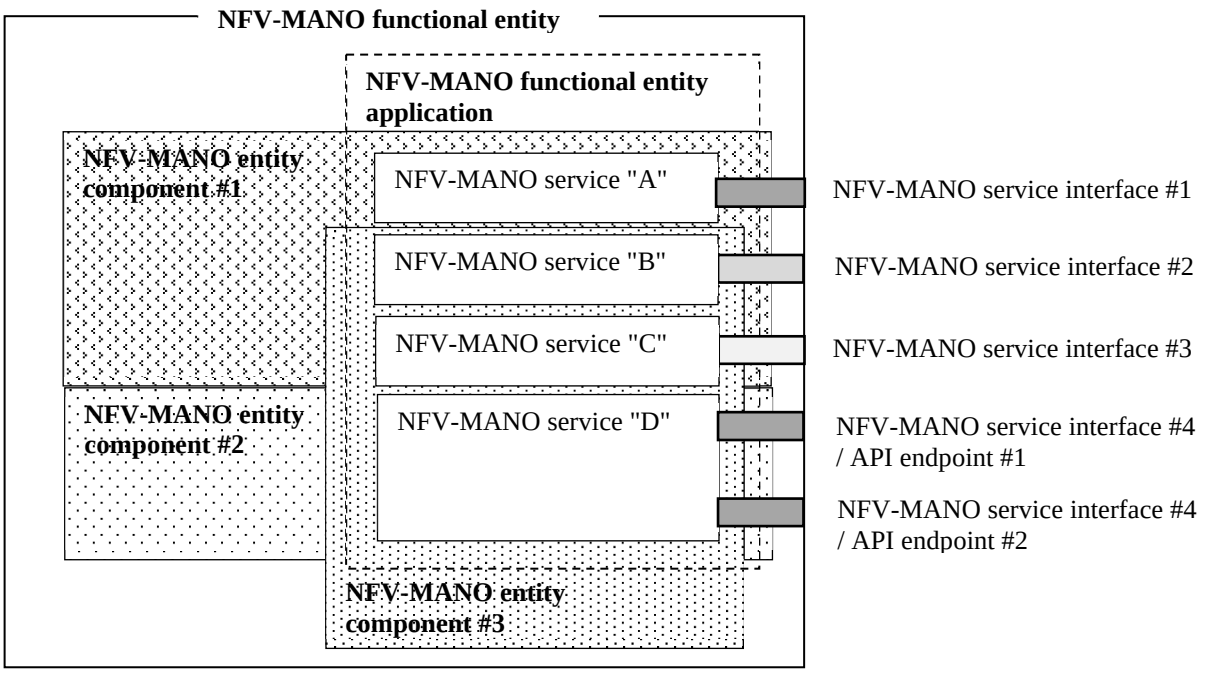

Figure 4.3-1: Example of relationship between NFV-MANO functional entity, NFV-MANO functional entity application, NFV-MANO service and NFV-MANO service interface

5 Requirements

5.1 Introduction and conventions

5.1.1 Overview

Clause 5 in the present document specifies the set of interface requirements applicable to management of NFV-MANO.

In addition, clauses 6, 7 and 8 specify the information model of interfaces, information elements, metrics and performance measurements. The information model specification uses the conventions introduced in clause 5.1.2.

5.1.2 Conventions

The following notations, defined in ISO/IEC 9646-7 [i.9], are used for the qualifier column of interface information elements:

- M mandatory - the capability is required to be supported.
- O optional - the capability may be supported or not.
- CM conditional mandatory - the capability is required to be supported and is conditional on the support of some condition. This condition shall be specified in the Description column.
- CO conditional optional - the capability may be supported or not and is conditional on the support of some condition. This condition shall be specified in the Description column.

The following notation is used for parameters that represent identifiers, and for attributes that represent identifiers in information elements and notifications:

- If parameters are referring to an identifier of an actual object, their type is "Identifier".
- If an object (information element or notification) contains an attribute that identifies the object, the type of that attribute is "Identifier" and the description states that the attribute is the identifier of that particular notification or information element.

EXAMPLE 1: Identifier "fooId" of the "Foo information element" has type "Identifier" and description "Identifier of this Foo information element".

- If an object (information element or notification) contains an attribute that references another object or objects defined in an ETSI GS NFV, the type of the attribute is "Identifier", followed by the list of objects it references.

EXAMPLE 2: "Identifier (Reference to Foo)" or "Identifier (Reference to Foo1, Foo2 or Foo3)".

- If the type of a parameter or attribute has been marked as "Not specified" in the "Content" column, this means that its specification is part of the protocol design/data model design.

5.2 Interface requirements

5.2.1 Interface requirements for fault management of an NFV-MANO functional entity

Table 5.2.1-1 provides requirements related to the interface for fault management of an NFV-MANO functional entity (see clauses 5.3 and 10 in ETSI GS NFV-IFA 010 [1]). Thereby, the NFV-MANO functional interface producer is NFVO, VNFM, VIM or WIM.

Table 5.2.1-1: NFV-MANO fault management interface requirements

Identifier	Requirement
Nfvmanoif.Fm.001	The NFV-MANO fault management interface shall support notifications related to fault monitoring, and the corresponding subscription, query and terminate subscription operations for such notifications.
Nfvmanoif.Fm.002	The NFV-MANO fault management interface shall support querying the list of active alarms by a consumer.
Nfvmanoif.Fm.003	The NFV-MANO fault management interface shall support acknowledging alarms.

5.2.2 Interface requirements for performance management of an NFV-MANO functional entity

Table 5.2.2-1 provides requirements related to the interface for performance management of an NFV-MANO functional entity (see clauses 5.3 and 10 in ETSI GS NFV-IFA 010 [1]). Thereby, the NFV-MANO functional interface producer is NFVO, VNFM, VIM or WIM.

Table 5.2.2-1: NFV-MANO performance management interface requirements

Identifier	Requirement
Nfvmanoif.Pm.001	The NFV-MANO performance management interface shall support creation, deletion, and query of PM jobs for performance monitoring.
Nfvmanoif.Pm.002	The NFV-MANO performance management interface shall support creation, deletion, and query of thresholds for performance monitoring.
Nfvmanoif.Pm.003	The NFV-MANO performance management interface shall support notifications related to performance monitoring, and the corresponding subscription, query and terminate subscription operations for such notifications.

5.2.3 Interface requirements for configuration and information management of an NFV-MANO functional entity

Table 5.2.3-1 provides requirements related to the interface for configuration and information management of an NFV-MANO functional entity (see clauses 5.3 and 10 in ETSI GS NFV-IFA 010 [1]). Thereby, the NFV-MANO functional interface producer is NFVO, VNFM, VIM or WIM.

Table 5.2.3-1: NFV-MANO configuration and information management interface requirements

Identifier	Requirement
Nfvmanoif.Cim.001	The NFV-MANO configuration and information management interface shall support modification of configuration and information parameters.
Nfvmanoif.Cim.002	The NFV-MANO configuration and information management interface shall support querying of current configuration and information parameters.
Nfvmanoif.Cim.003	The NFV-MANO configuration and information management interface shall support notifications related to changes in configuration and information, and the corresponding subscription, query and terminate subscription operations for such notifications.
Nfvmanoif.Cim.00a	The NFV-MANO configuration and information management interface shall support changing the state of the NFV-MANO functional entity.
Nfvmanoif.Cim.00b	The NFV-MANO configuration and information management interface shall support starting and stopping of the NFV-MANO functional entity application and/or specific NFV-MANO service interfaces.
Nfvmanoif.Cim.00c	The NFV-MANO configuration and information management interface shall support notifications related to state changes of the NFV-MANO functional entity application and/or specific NFV-MANO service interfaces.

5.2.4 Void

5.2.5 Interface requirements for interface for log management of an NFV-MANO functional entity

Table 5.2.5-1 provides requirements related to the interface for log management of an NFV-MANO functional entity (see clauses 5.3 and 10 in ETSI GS NFV-IFA 010 [1]). Thereby, the NFV-MANO functional interface producer is NFVO, VNFM, VIM or WIM.

Table 5.2.5-1: NFV-MANO log management interface requirements

Identifier	Requirement
Nfvmanoif.Logm.001	The NFV-MANO log management interface shall support creating logging jobs according to a specified input information. See note.
Nfvmanoif.Logm.002	The NFV-MANO log management interface shall support stopping a specified logging job.
Nfvmanoif.Logm.003	The NFV-MANO log management interface shall support querying information about logging jobs.
Nfvmanoif.Logm.004	The NFV-MANO log management interface shall support notifications related to log management of the NFV-MANO functional entity, and the corresponding subscription, query and terminate subscription operations for such notifications.
NOTE: Input information includes the type and configuration of the logging job.	

6 Interfaces specification

6.1 Introduction

This clause defines the interfaces for enabling the management of an NFV-MANO functional entity. The interfaces can be exposed by an NFV-MANO functional entity towards a consumer which can be an external entity beyond NFV-MANO or a peering NFV-MANO functional entity.

NOTE: The set of interfaces specified in clause 6 are interfaces defined for the purpose of management of an NFV-MANO functional entity (referred also as NFV-MANO management interfaces) and are not the same interfaces as the ones defined in ETSI GS NFV-IFA 005 [i.3], ETSI GS NFV-IFA 006 [i.4], ETSI GS NFV-IFA 007 [i.5], ETSI GS NFV-IFA 008 [i.6], ETSI GS NFV-IFA 013 [i.7], ETSI GS NFV-IFA 030 [i.16] and ETSI GS NFV-IFA 032 [i.17] (referred as NFV-MANO service interfaces or simply NFV-MANO interfaces in the present document).

6.2 NFV-MANO configuration and information management interface

6.2.1 Description

This interface enables a consumer to configure the NFV-MANO functional entity. For example, the interface allows configuring the behaviour of the entity as well as its status according to the supported NFV-MANO functional entity's resource model. The interface also provides the capability to query configuration and information from the NFV-MANO functional entity. The interface also provides the mechanism to notify to subscribers when configuration and information data changes.

With regards to state management, this interface enables a consumer to change the state of an NFV-MANO functional entity application and its provided NFV-MANO service interface(s). Clause A.2 provides information about the state change operations (e.g. lock, unlock, start, stop, restart) and the state transitions that can be supported with the interface. The interface also provides the mechanism to notify to subscribers when the state of an NFV-MANO functional entity application or the provided service interface(s) changes.

According to the relationship of the NFV-MANO functional entity application and the provided NFV-MANO services interfaces, wherein the application encompasses the set of services offered by the NFV-MANO functional entity (refer to clause 4.3), the state of the NFV-MANO functional entity application determines and regulates the state of the NFV-MANO service interfaces. For instance, if the NFV-MANO functional entity application is SHUTDOWN_LOCKED (see also clause A.2.1), so are the NFV-MANO service interfaces. Only under a state where the NFV-MANO functional entity application is fully operational and is not administratively prohibited from use (i.e. STARTED_UNLOCKED), can the state of the individual NFV-MANO service interfaces be changed and be different than the state of the NFV-MANO functional entity application. In this case, an individual NFV-MANO service interface can be shutdown, restarted, locked, etc., while the NFV-MANO functional entity application remains operational and not administratively prohibited from use.

The state of an NFV-MANO service interface of an NFV-MANO functional entity shall not affect the ability of the NFV-MANO functional entity to respond to management operations specified in the present document.

The NFV-MANO configuration and information management interface provided by NFV-MANO functional entity support the following operations:

- Modify Config;
- Query Config Info;
- Change State;
- Subscribe;
- Terminate Subscription;

- Notify;
- Query Subscription Information.

Querying the state of the NFV-MANO functional entity application and/or its provided NFV-MANO service interface(s) is supported via the `QueryConfigInfo` operation of the NFV-MANO configuration and information management interface.

6.2.2 Modify Config operation

6.2.2.1 Operation description

This operation enables a consumer to modify the values of configuration parameters of a NFV-MANO functional entity.

Table 6.2.2.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.2.2.1-1: Modify Config operation

Message	Requirement	Direction
ModifyConfigRequest	Mandatory	Consumer → NFV-MANO functional entity
ModifyConfigResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.2.2-1.

Table 6.2.2.2-1: Modify Config operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
newValues	M	1..N	KeyValuePair	Contains the set of attributes to update. The key in the KeyValuePair indicates the name of an attribute that is writable and is to be updated. The value in the KeyValuePair indicates the new attribute value.

6.2.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.2.3-1.

Table 6.2.2.3-1: Modify Config operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
modifiedValues	M	0..N	KeyValuePair	Contains the set of attributes that have been modified. The key in the KeyValuePair indicates the name of the modified attribute and the value in the KeyValuePair indicates the attribute value.

6.2.2.4 Operation results

In case of success, the NFV-MANO functional entity configuration and information has been changed/updated according to the input parameters specified in the operation.

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer whether or not the operation was successful. In particular, error information shall indicate the reason why the value of the requested attribute has not been updated, e.g. changing the value of the attribute is not supported, input attribute name is not recognized, etc.

6.2.3 Query Config Info operation

6.2.3.1 Operation description

This operation enables a consumer to query the values of configuration, information, and state parameters of the NFV-MANO functional entity.

Table 6.2.3.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.2.3.1-1: Query Config Info operation

Message	Requirement	Direction
QueryConfigInfoRequest	Mandatory	Consumer → NFV-MANO functional entity
QueryConfigInfoResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.3.2-1.

Table 6.2.3.2-1: Query Config Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter to select the NFV-MANO services and NFV-MANO service interfaces. It can be a single identifier, multiple identifiers or a wildcard. The filter shall also support queries that apply to the NFV-MANO functional entity as a whole. Since a single ManoEntityInfo corresponds to a single NFV-MANO functional entity, the filter cannot be used to select among different ManoEntityInfo.
attributeSelector	M	0..N	String	Provides a list of attribute names. If present, only these attributes are returned for the NFV-MANO functional entity. If absent, the complete information is returned for object(s) matching the filter.

6.2.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.3.3-1.

Table 6.2.3.3-1: Query Config Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
manoEntityInfo	M	1	ManoEntityInfo	The information items about the NFV-MANO functional entity that are returned. The information items correspond to those specified in the ManoEntityInfo. If attributeSelector is present, only the attributes listed in attributeSelector are returned for the NFV-MANO functional entity.

6.2.3.4 Operation results

In case of success, configuration, information and/or state data related to the NFV-MANO functional entity is returned. In case of failure, appropriate error information is returned.

6.2.4 Subscribe operation

6.2.4.1 Operation description

This operation enables a consumer to subscribe with a filter for the notifications related to configuration, information, and state changes on the producer NFV-MANO functional entity.

NOTE: Specification of filtering mechanism is part of the protocol design.

Table 6.2.4.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.2.4.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	Consumer → NFV-MANO functional entity
SubscribeResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.4.2-1.

Table 6.2.4.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting notifications. The filter can be based on attribute(s) of the notification.

6.2.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.4.3-1.

Table 6.2.4.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

6.2.4.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the SubscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

6.2.5 Terminate Subscription operation

6.2.5.1 Operation description

This operation enables a consumer to terminate an existing notification subscription.

Table 6.2.5.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.2.5.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	Consumer → NFV-MANO functional entity
TerminateSubscriptionResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.5.2-1.

Table 6.2.5.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

6.2.5.3 Output parameters

None.

6.2.5.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the TerminateSubscriptionResponse message whether the termination of the notification subscription was successful or not.

6.2.6 Notify operation

6.2.6.1 Operation description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFV-MANO functional entity towards the consumer that cannot be invoked as an operation by the consumer.

In order to receive notifications, the consumer shall have a subscription.

Table 6.2.6.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.2.6.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFV-MANO functional entity → Consumer

The following notifications can be notified/sent by this operation:

- InformationChangedNotification. See clause 7.2.2.
- StateChangeNotification. See clause 7.4.2.

6.2.7 Query Subscription Info operation

6.2.7.1 Description

This operation enables a consumer to query information about subscriptions to notifications related to NFV-MANO configuration, information, and state management.

Table 6.2.7.1-1 lists the information flow exchanged between the consumer and the NFV-MANO functional entity.

Table 6.2.7.1-1: Query Subscription Info operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	Consumer → NFV-MANO functional entity
QuerySubscriptionInfoResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.7.2-1.

Table 6.2.7.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. See note.
NOTE: Specification details of the Filter are part of the protocol design.				

6.2.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.7.3-1.

Table 6.2.7.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query.

6.2.7.4 Operation results

After successful operation, the NFV-MANO functional entity has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to NFV-MANO configuration, information, and state management that the consumer has access to and that are matching the filter shall be returned.

6.2.8 Change State operation

6.2.8.1 Description

This operation enables a consumer to change the state on the producer NFV-MANO functional entity application and/or its provided NFV-MANO service interface.

Table 6.2.8.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.2.8.1-1: Change State operation

Message	Requirement	Direction
ChangeStateRequest	Mandatory	Consumer → NFV-MANO functional entity
ChangeStateResponse	Mandatory	NFV-MANO functional entity → Consumer

6.2.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.8.2-1.

Table 6.2.8.2-1: Change State operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
manoEntityInterfaceId	M	0..1	Identifier (Reference to ManoEntityInterface)	Specific NFV-MANO service interface for which the operation applies. The parameter shall only be provided when the operation is requested to be performed on a specific NFV-MANO service provided by the NFV-MANO functional entity. If the parameter is not present, the operation is requested to be performed for the NFV-MANO functional entity application.
changeOperation	M	1	Not specified	The operation associated to the requested state change into which the NFV-MANO functional entity application or NFV-MANO service transitions.

6.2.8.3 Output parameters

None.

6.2.8.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

If the operation performs successfully, the NFV-MANO functional entity application or provided NFV-MANO service interface will transition to the state indicated by input parameter `changeOperation`. Information about the state changes transitions and end operation result are provided to the consumer via the Notify operation (see clause 6.2.6).

Figure A.2.1.4-1 illustrates the state changes resulting from the operation.

6.3 NFV-MANO performance management interface

6.3.1 Description

This interface enables an NFV-MANO functional entity to provide to a consumer performance information (measurement results collection and notifications) related to the NFV-MANO functional entity.

Collection and reporting of performance information is controlled via PM jobs. A PM job groups details of performance collection and reporting information.

When new performance information is available, the consumer is notified using the notification PerformanceInformationAvailableNotification (see clause 7.3.2). The details of the performance measurements are provided using the PerformanceReport information element (see clause 7.3.6).

NOTE: Delivery mechanism for the performance reports is part of the protocol design.

The NFV-MANO performance management interface provided by NFV-MANO functional entity supports the following operations:

- Create PM Job;
- Delete PM Jobs;
- Query PM Job;
- Create Threshold;
- Delete Thresholds;
- Query Threshold;
- Subscribe;
- Terminate Subscription;
- Notify;
- Query Subscription Information.

6.3.2 Create PM Job operation

6.3.2.1 Description

This operation enables a consumer to create a PM job on the producer NFV-MANO functional entity for collecting performance data.

The consumer needs to be subscribed to receive PerformanceInformationAvailable notifications in order to know when collected performance information is available.

Table 6.3.2.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.2.1-1: Create PM Job operation

Message	Requirement	Direction
CreatePmJobRequest	Mandatory	Consumer → NFV-MANO functional entity
CreatePmJobResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.2.2-1.

Table 6.3.2.2-1: Create PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Identifiers of the measured object instances for which performance information is requested to be collected.
performanceMetric	M	0..N	String	Defines the type of performance metric(s) for the specified performance job. See note 1.
performanceMetricGroup	M	0..N	String	Group of performance metrics. A metric group is a pre-defined list of metrics, known to the producer that it can decompose to individual metrics. See note 1.
collectionPeriod	M	1	Not specified	Specifies the periodicity at which the NFV-MANO functional entity will collect performance information. See note 2.
reportingPeriod	M	1	Not specified	Specifies the periodicity at which the NFV-MANO functional entity will report to the consumer about performance information. See note 2.
reportingBoundary	O	0..1	Not specified	Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE 1: At least one of the two attributes (performanceMetric or performanceMetricGroup) shall be present. NOTE 2: At the end of each reportingPeriod, the NFV-MANO functional entity informs the consumer about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reportingPeriod is part of the protocol design, it is recommended that the reportingPeriod be equal to or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

6.3.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.2.3-1.

Table 6.3.2.3-1: Create PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobId	M	1	Identifier	Identifier of the created PM job.

6.3.2.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

The pmJobId is only returned when the operation has been successful.

6.3.3 Delete PM Jobs operation

6.3.3.1 Description

This operation enables a consumer to delete one or more PM job(s) on the producer NFV-MANO functional entity.

NOTE: It is up to the protocol design stage to determine whether this operation should or not need to be modeled as a "bulk" operation that allows to delete multiple PM Jobs in one request, or as a series of requests that delete one PM Job at a time.

Table 6.3.3.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.3.1-1: Delete PM Jobs operation

Message	Requirement	Direction
DeletePmJobsRequest	Mandatory	Consumer → NFV-MANO functional entity
DeletePmJobsResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.3.2-1.

Table 6.3.3.2-1: Delete PM Jobs operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobId	M	1..N	Identifier	Identifiers of the PM jobs to be deleted.

6.3.3.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.3.3-1.

Table 6.3.3.3-1: Delete PM Jobs operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedPmJobId	M	1..N	Identifier	Identifiers of the PM Jobs that have been deleted successfully.

6.3.3.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

6.3.4 Query PM Job operation

6.3.4.1 Description

This operation enables a consumer to query the details of one or more PM job(s) on the producer NFV-MANO functional entity.

Table 6.3.4.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.4.1-1: Query PM Job operation

Message	Requirement	Direction
QueryPmJobRequest	Mandatory	Consumer → NFV-MANO functional entity
QueryPmJobResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.4.2-1.

Table 6.3.4.2-1: Query PM Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the PM jobs on which the query applies. It can be a single identifier, multiple identifiers or a wildcard.

6.3.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.4.3-1.

Table 6.3.4.3-1: Query PM Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
pmJobDetails	M	0..N	PmJob	Details of PM jobs matching the input filter.

6.3.4.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

6.3.5 Create Threshold operation

6.3.5.1 Description

This operation enables a consumer to create a threshold and specify threshold levels on a specified performance metric on the producer NFV-MANO functional entity. 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 measurements.

Table 6.3.5.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.5.1-1: Create Threshold operation

Message	Requirement	Direction
CreateThresholdRequest	Mandatory	Consumer → NFV-MANO functional entity
CreateThresholdResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.5.2-1.

Table 6.3.5.2-1: Create Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Identifiers of the measured object instances for which the threshold will be defined.
performanceMetric	M	1	String	Defines the performance metric on which the threshold will be defined.
thresholdType	M	1	Enum	Defines the type of threshold. The list of possible values is part of the protocol design and might include: single/multi valued threshold, static/dynamic threshold, template based threshold, etc. VALUES: • SIMPLE: Single-valued static threshold • etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, direction in which it is crossed, details on the notification to be generated, etc.

6.3.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.5.3-1.

Table 6.3.5.3-1: Create Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of the created threshold.

6.3.5.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

The thresholdId is only returned when the operation has been successful.

6.3.6 Delete Thresholds operation

6.3.6.1 Description

This operation enables a consumer to delete one or more existing threshold(s) on the producer NFV-MANO functional entity.

NOTE: It is up to the protocol design stage to determine whether this operation should or not need to be modeled as a "bulk" operation that allows to delete multiple Thresholds in one request, or as a series of requests that delete one Threshold at a time.

Table 6.3.6.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.6.1-1: Delete Thresholds operation

Message	Requirement	Direction
DeleteThresholdsRequest	Mandatory	Consumer → NFV-MANO functional entity
DeleteThresholdsResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.6.2-1.

Table 6.3.6.2-1: Delete Thresholds operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdId	M	1..N	Identifier	Identifiers of the thresholds to be deleted.

6.3.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.6.3-1.

Table 6.3.6.3-1: Delete Thresholds operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
deletedThresholdId	M	1..N	Identifier	Identifiers of the thresholds that have been deleted successfully.

6.3.6.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

6.3.7 Query Threshold operation

6.3.7.1 Description

This operation enables a consumer to query the details of one or more existing thresholds on the producer NFV-MANO functional entity.

Table 6.3.7.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.7.1-1: Query Threshold operation

Message	Requirement	Direction
QueryThresholdRequest	Mandatory	Consumer → NFV-MANO functional entity
QueryThresholdResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.7.2-1.

Table 6.3.7.2-1: Query Threshold operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the thresholds on which the query applies. It can be a single identifier, multiple identifiers or a wildcard.

6.3.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.7.3-1.

Table 6.3.7.3-1: Query Threshold operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
thresholdDetails	M	0..N	Threshold	Details of thresholds matching the input filter.

6.3.7.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

6.3.8 Subscribe operation

6.3.8.1 Description

This operation enables a consumer to subscribe with a filter for the notifications related to performance monitoring on the producer NFV-MANO functional entity.

NOTE 1: Specification of filtering mechanism is part of the protocol design stage.

NOTE 2: It is part of the protocol design stage whether subscribing is represented as a separate "Subscribe" operation or whether subscription-related information is managed as part of managing PM jobs and Thresholds.

Table 6.3.8.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.8.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	Consumer → NFV-MANO functional entity
SubscribeResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.8.2-1.

Table 6.3.8.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter for selecting notifications. The filter can be on the selected monitored object, type of notification or attribute of the notification.

6.3.8.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.8.3-1.

Table 6.3.8.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription realized.

6.3.8.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the SubscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

6.3.9 Terminate Subscription operation

6.3.9.1 Description

This operation enables a consumer to terminate an existing notification subscription.

NOTE: It is part of the protocol design stage whether terminating a subscription is represented as a separate "Terminate Subscription" operation or whether subscription-related information is managed as part of managing PM jobs and Thresholds.

Table 6.3.9.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.9.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	Consumer → NFV-MANO functional entity
TerminateSubscriptionResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.9.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.9.2-1.

Table 6.3.9.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

6.3.9.3 Output parameters

None.

6.3.9.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the TerminateSubscriptionResponse message whether the termination of the notification subscription was successful or not.

6.3.10 Notify operation

6.3.10.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFV-MANO functional entity towards the consumer that cannot be invoked as an operation by the consumer.

In order to receive notifications, the consumer shall have a subscription.

Table 6.3.10.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.3.10.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFV-MANO functional entity → Consumer

The following notifications can be notified/sent by this operation:

- PerformanceInfomationAvailableNotification. See clause 7.3.2.
- ThresholdCrossedNotification. See clause 7.3.3.

6.3.11 Query Subscription Info operation

6.3.11.1 Description

This operation enables a consumer to query information about subscriptions to notifications related to NFV-MANO performance management.

NOTE: It is part of the protocol design stage whether querying information about subscriptions is represented as a separate "Query Subscription Info" operation or whether subscription-related information is managed as part of managing PM jobs and Thresholds.

Table 6.3.11.1-1 lists the information flow exchanged between the consumer and the NFV-MANO functional entity.

Table 6.3.11.1-1: Query Subscription Info operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	Consumer → NFV-MANO functional entity
QuerySubscriptionInfoResponse	Mandatory	NFV-MANO functional entity → Consumer

6.3.11.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.3.11.2-1.

Table 6.3.11.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. See note.
NOTE: Specification details of the Filter are part of the protocol design.				

6.3.11.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.3.11.3-1.

Table 6.3.11.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query.

6.3.11.4 Operation results

After successful operation, the NFV-MANO functional entity has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to NFV-MANO performance management that the consumer has access to and that are matching the filter shall be returned.

6.4 Void

6.5 NFV-MANO Fault Management interface

6.5.1 Description

This interface enables a consumer to monitor the faults in an NFV-MANO functional entity. The consumer will receive information through alarm notifications when a failure is detected. The granularity of failures include:

- Communication failures with other peering NFV-MANO functional entities.
- Failures affecting a specific interface produced by the NFV-MANO functional entity, e.g. VNF lifecycle management interface produced by a VNFM.
- Malfunctioning of the NFV-MANO functional entity due to failures on resources supporting the execution of the entity, e.g. CPU, memory, reported as event type relevant to resources (see Recommendation ITU-T X.733 [2]).

The NFV-MANO fault management interface provided by NFV-MANO functional entity supports the following operations:

- Subscribe;
- Terminate Subscription;
- Notify;
- Get Alarm List;
- Query Subscription Information;
- Acknowledge alarms.

6.5.2 Subscribe operation

6.5.2.1 Description

This operation enables a consumer to subscribe with a filter for the notifications related to alarms on the producer NFV-MANO functional entity.

NOTE: Specification of filtering mechanism is part of the protocol design.

Table 6.5.2.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.5.2.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	Consumer → NFV-MANO functional entity
SubscribeResponse	Mandatory	NFV-MANO functional entity → Consumer

6.5.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.2.2-1.

Table 6.5.2.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting monitored objects and related alarms. This can contain the monitored object information, fault type, severity and cause of the alarm.

6.5.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.2.3-1.

Table 6.5.2.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

6.5.2.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the SubscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

6.5.3 Terminate Subscription operation

6.5.3.1 Description

This operation enables a consumer to terminate a particular subscription.

Table 6.5.3.1-1 lists the information flow exchanged between the consumer and the NFV-MANO functional entity.

Table 6.5.3.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	Consumer → NFV-MANO functional entity
TerminateSubscriptionResponse	Mandatory	NFV-MANO functional entity → Consumer

6.5.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.3.2-1.

Table 6.5.3.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated.

6.5.3.3 Output parameters

None.

6.5.3.4 Operation results

After successful termination of a subscription, the identified subscription does not exist anymore, and the consumer will not receive notifications related that subscription any longer. The result of the operation shall indicate if the subscription termination has been successful or not with a standard success/error result.

6.5.4 Notify operation

6.5.4.1 Description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFV-MANO functional entity towards the consumer that cannot be invoked as an operation by the consumer.

In order to receive notifications, the consumer shall have a subscription.

Table 6.5.4.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.5.4.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFV-MANO functional entity → Consumer

The following notifications can be notified/sent by this operation:

- AlarmNotification. See clause 7.5.2.
- AlarmClearedNotification. See clause 7.5.3.
- AlarmListRebuiltNotification. See clause 7.5.5.

6.5.5 Get Alarm List operation

6.5.5.1 Description

This operation enables a consumer to query the active alarms from the producer NFV-MANO functional entity.

Table 6.5.5.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.5.5.1-1: Get Alarm List operation

Message	Requirement	Direction
GetAlarmListRequest	Mandatory	Consumer → NFV-MANO functional entity
GetAlarmListResponse	Mandatory	NFV-MANO functional entity → Consumer

6.5.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.5.2-1.

Table 6.5.5.2-1: Get Alarm List operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting alarms. This can contain the list of the monitored object Identifiers, fault type, severity and cause.

6.5.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.5.3-1.

Table 6.5.5.3-1: Get Alarm List operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
alarm	M	0..N	Alarm	Information about alarms including alarmId, affected NFV-MANO functional entity identifier, and FaultDetails. The cardinality can be "0" to indicate that no Alarm could be retrieved based on the input Filter information (e.g. no matching alarm).

6.5.5.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular request, only alarms matching the filter are delivered to the consumer.

6.5.6 Query Subscription Info operation

6.5.6.1 Description

This operation enables a consumer to query information about subscriptions to notifications related to NFV-MANO fault management.

Table 6.5.6.1-1 lists the information flow exchanged between the consumer and the NFV-MANO functional entity.

Table 6.5.6.1-1: Query Subscription Info operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	Consumer → NFV-MANO functional entity
QuerySubscriptionInfoResponse	Mandatory	NFV-MANO functional entity → Consumer

6.5.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.6.2-1.

Table 6.5.6.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. See note.
NOTE: Specification details of the Filter are part of the protocol design.				

6.5.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.6.3-1.

Table 6.5.6.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query.

6.5.6.4 Operation results

After successful operation, the NFV-MANO functional entity has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to NFV-MANO fault management that the consumer has access to and that are matching the filter shall be returned.

6.5.7 Acknowledge Alarms operation

6.5.7.1 Description

This operation enables a consumer to acknowledge alarms at the producer NFV-MANO functional entity.

Table 6.5.7.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.5.7.1-1: Acknowledge Alarms operation

Message	Requirement	Direction
AcknowledgeAlarmsRequest	Mandatory	Consumer → NFV-MANO functional entity
AcknowledgeAlarmsResponse	Mandatory	NFV-MANO functional entity → Consumer

6.5.7.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.5.7.2-1.

Table 6.5.7.2-1: Acknowledge Alarms operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
alarmId	M	1..N	Identifier (Reference to Alarm)	Identifier of an individual alarm to be acknowledged, or multiple identifiers of the alarms to be acknowledged. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to acknowledge multiple alarms in one request, or as a series of requests that acknowledge one alarm at a time.				

6.5.7.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.5.7.3-1.

Table 6.5.7.3-1: Acknowledge Alarms operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
acknowledgedAlarmId	M	1..N	Identifier (Reference to Alarm)	Identifier of an individual alarm that is acknowledged, or multiple identifiers of the alarms that are acknowledged. See note.
NOTE: It is up to the protocol design stage to determine whether this operation will be modelled as a "bulk" operation that allows to acknowledge multiple alarms in one request, or as a series of requests that acknowledge one alarm at a time.				

6.5.7.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

As a result of this operation, the `ackState` of the Alarm(s), for which the request has been successful, changes to "Acknowledged" (refer to clause 7.5.4).

6.6 NFV-MANO log management interface

6.6.1 Description

This interface enables a consumer to manage logging jobs on the NFV-MANO functional entity, and enables corresponding log reporting.

The interface enables managing different types of logs, including:

- Messaging logs: logs of messages exchanged on an interface between NFV-MANO functional entities, and between NFV-MANO functional entities and external entities. This includes logging of the input and output message parameters of interfaces exposed by the functional entities, e.g. input and output messages when an NFVO entity queries the InstantiateVnf operation of the VNF LCM interface (see clause 7.2.3 in ETSI GS NFV-IFA 007 [i.5]).
- Provider-specific logs: provider-specific logs of NFV-MANO functional entity. In this case, it is assumed that such logs may have security restrictions in place, e.g. be encrypted, so that only a certain organization can have access to the content in the log.

The NFV-MANO log management interface provided by NFV-MANO functional entity supports the following operations:

- Create Logging Job;
- Stop Logging Job;
- Query Logging Job;
- Subscribe;
- Terminate Subscription;
- Notify;
- Query Subscription Information.

NOTE: The CreateLoggingJob and StopLoggingJob operations can be used to create and terminate a specific logging job for messaging logs or provider-specific logs. The NFV-MANO functional entity can also collect common messaging logs automatically or pre-configured with normal operations and executions.

6.6.2 Create Logging Job operation

6.6.2.1 Operation description

This operation enables a consumer to create a logging job according to the specified parameters, so that the NFV-MANO functional entity starts the logging activity and generates the associated log.

Table 6.6.2.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.6.2.1-1: Create Logging Job operation

Message	Requirement	Direction
CreateLoggingJobRequest	Mandatory	Consumer → NFV-MANO functional entity
CreateLoggingJobResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.2.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.2.2-1.

Table 6.6.2.2-1: Create Logging Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
startTime	M	0..1	DateTime	Specifies the time for the logging job to be started. Cardinality can be "0", which means to start the logging job immediately.
endTime	M	0..1	DateTime	Specifies the time for the logging job to be terminated. Cardinality can be "0", which means that the logging job needs to be explicitly stopped.
logObjectSelector	M	1..N	Not specified	Selector to address the log object (e.g. an individual interface/ operation) in the NFV-MANO functional entity, or list of selectors to address multiple of those. The selector also allows to specify the type of logs to be collected, including: "message logging" and "provider-specific logging".
isEncrypted	M	1	Boolean	Specifies if the log report needs to be encrypted.
loggingConfig	M	0..N	KeyValuePair	Specifies the configuration of the logging job.
reportingCondition	M	0..1	Not specified	Defines the conditions and criteria about when, as part of the requested logging job, the log shall be compiled and the producer report about its availability. The criteria shall cover the capability to: i) report based on log size; ii) report based on time information (e.g. every 24 hours); iii) report based on events. Examples of events are: explicit stop of the logging job, a threshold reached in a certain performance monitoring, etc. The parameter shall be provided for non-stop logging jobs (refer to the endTime parameter). It may be absent otherwise.

6.6.2.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.6.2.3-1.

Table 6.6.2.3-1: Create Logging Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
loggingJobId	M	1	Identifier	Identifier of the logging job returned.

6.6.2.4 Operation results

In case of success, the logging job specified by the parameters has been created on the NFV-MANO functional entity.

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer whether or not the operation was successful. In particular, error information shall indicate the reason why the specified logging job has not been created.

6.6.3 Stop Logging operation

6.6.3.1 Operation description

This operation enables a consumer to stop logging activity of an existing logging job by terminating such a logging job on the NFV-MANO functional entity.

Table 6.6.3.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.6.3.1-1: Stop Logging operation

Message	Requirement	Direction
StopLoggingRequest	Mandatory	Consumer → NFV-MANO functional entity
StopLoggingResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.3.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.3.2-1.

Table 6.6.3.2-1: Stop Logging operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
loggingJobId	M	1	Identifier	Identifier of the logging job to be terminated.

6.6.3.3 Output parameters

None.

6.6.3.4 Operation results

In case of success, the logging job with the loggingJobId has been terminated on the NFV-MANO functional entity.

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer whether or not the operation was successful. In particular, error information shall indicate the reason why the specified logging job has not been terminated.

6.6.4 Query Logging Job operation

6.6.4.1 Operation description

This operation enables a consumer to query the details of one or more logging job(s) on the producer NFV-MANO functional entity with a specified filter.

Table 6.6.4.1-1 lists the information flow exchange between the NFV-MANO functional entity and the consumer.

Table 6.6.4.1-1: Query Logging Job operation

Message	Requirement	Direction
QueryLoggingJobRequest	Mandatory	Consumer → NFV-MANO functional entity
QueryLoggingJobResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.4.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.4.2-1.

Table 6.6.4.2-1: Query Logging Job operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter defining the logging jobs on which the query applies. It can be a single identifier, multiple identifiers or a wildcard.

6.6.4.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.6.4.3-1.

Table 6.6.4.3-1: Query Logging Job operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
loggingJobDetails	M	0..N	LoggingJob	Details of logging jobs matching the input filter.

6.6.4.4 Operation results

The result of the operation indicates if it has been successful or not with a standard success/error result.

6.6.5 Subscribe operation

6.6.5.1 Operation description

This operation enables a consumer to subscribe with a filter for the notifications related to log management on the producer NFV-MANO functional entity.

NOTE: Specification of filtering mechanism is part of the protocol design.

Table 6.6.5.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.6.5.1-1: Subscribe operation

Message	Requirement	Direction
SubscribeRequest	Mandatory	Consumer → NFV-MANO functional entity
SubscribeResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.5.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.5.2-1.

Table 6.6.5.2-1: Subscribe operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Input filter for selecting notifications. The filter can be based on attribute(s) of the notification.

6.6.5.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.6.5.3-1.

Table 6.6.5.3-1: Subscribe operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription returned.

6.6.5.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the SubscribeResponse message whether the subscription was successful or not.

For a particular subscription, only notifications matching the filter will be delivered to the consumer.

6.6.6 Terminate Subscription operation

6.6.6.1 Operation description

This operation enables a consumer to terminate an existing notification subscription.

Table 6.6.6.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.6.6.1-1: Terminate Subscription operation

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	Consumer → NFV-MANO functional entity
TerminateSubscriptionResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.6.2-1.

Table 6.6.6.2-1: Terminate Subscription operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
subscriptionId	M	1	Identifier	Identifier of the subscription to be terminated

6.6.6.3 Output parameters

None.

6.6.6.4 Operation results

As a result of this operation, the NFV-MANO functional entity shall indicate to the consumer in the TerminateSubscribeResponse message whether the termination of the notification subscription was successful or not.

6.6.7 Notify operation

6.6.7.1 Operation description

This operation distributes notifications to subscribers. It is a one-way operation issued by the NFV-MANO functional entity towards the consumer that cannot be invoked as an operation by the consumer.

In order to receive notifications, the consumer shall have a subscription.

Table 6.6.7.1-1 lists the information flow exchanged between the NFV-MANO functional entity and the consumer.

Table 6.6.7.1-1: Notify operation

Message	Requirement	Direction
Notify	Mandatory	NFV-MANO functional entity → Consumer

The following notifications can be notified/sent by this operation:

- LogReportAvailabilityNotification. See clause 7.6.2.

6.6.8 Query Subscription Info operation

6.6.8.1 Description

This operation enables a consumer to query information about subscriptions to notification related to NFV-MANO log management.

Table 6.6.8.1-1 lists the information flow exchanged between the consumer and the NFV-MANO functional entity.

Table 6.6.8.1-1: Query Subscription Info operation

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	Consumer → NFV-MANO functional entity
QuerySubscriptionInfoResponse	Mandatory	NFV-MANO functional entity → Consumer

6.6.8.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.6.8.2-1.

Table 6.6.8.2-1: Query Subscription Info operation input parameters

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filtering criteria to select one or a set of subscriptions. See note.
NOTE: Specification details of the Filter are part of the protocol design.				

6.6.8.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.6.8.3-1.

Table 6.6.8.3-1: Query Subscription Info operation output parameters

Parameter	Qualifier	Cardinality	Content	Description
queryResult	M	0..N	Not specified	Information about the subscription(s) matching the query.

6.6.8.4 Operation results

After successful operation, the NFV-MANO functional entity has queried the internal subscription objects. The result of the operation indicates if it has been successful or not with a standard success/error result. For a particular query, information about the subscriptions to notifications related to NFV-MANO log management that the consumer has access to and that are matching the filter shall be returned.

7 Information elements

7.1 Introduction

This clause defines, or references, definitions of information elements used in the interfaces defined in the present document.

The specification of the following information elements is part of the protocol design:

- Identifier;
- Integer;
- Filter;

- DateTime;
- String;
- Version;
- URL;
- KeyValuePair.

7.2 Information elements and notifications related to NFV-MANO configuration and information management

7.2.1 Introduction

This clause defines information elements and notifications related to NFV-MANO configuration and information management.

7.2.2 InformationChangedNotification

7.2.2.1 Description

This notification informs the receiver of the configuration and information data changes of the NFV-MANO functional entity, e.g. if the software has been upgraded, new features and/or capabilities have been added, certain configurable parameters have been updated, etc.

The support of this notification is mandatory.

7.2.2.2 Trigger condition

The configuration and information of the NFV-MANO functional entity has been changed.

7.2.2.3 Attributes

The InformationChangedNotification shall follow the indications provided in table 7.2.2.3-1.

Table 7.2.2.3-1: Attributes of the InformationChangedNotification

Attribute	Qualifier	Cardinality	Content	Description
informationChangedTime	M	1	DateTime	Timestamp indicating when the information was changed.
manoEntityChangedInfo	M	1..N	KeyValuePair	Data about the changed configuration and information of the NFV-MANO functional entity.

7.2.3 ManoEntityInfo information element

7.2.3.1 Description

The ManoEntityInfo information element encapsulates information about information, configuration, capabilities and state of an NFV-MANO functional entity.

7.2.3.2 Attributes

The ManoEntityInfo information element shall follow the indications provided in table 7.2.3.2-1.

Table 7.2.3.2-1: Attributes of ManoEntityInfo information element

Attribute	Qualifier	Cardinality	Content	Description
manoEntityId	M	1	Identifier	Identifier of this NFV-MANO functional entity.
manoEntityType	M	1	Enum	Type of NFV-MANO functional entity. VALUES: • NFVO • VNFM • VIM • WIM
manoEntityName	M	1	String	Human-readable name given to this specific NFV-MANO functional entity. The attribute shall be writable.
manoEntityDescription	M	1	String	Human-readable description of this specific NFV-MANO functional entity. The attribute shall be writable.
manoEntityProvider	M	1	String	Information about the provider of this entity. It typically includes the name of the provider.
manoEntitySoftwareVersion	M	1	Version	The version of the software of this specific NFV-MANO functional entity.
manoEntityComponent	M	1..N	ManoEntityComponent	The deployed NFV-MANO functional entity components which realize the NFV-MANO functional entity.
manoEntityInterface	M	1..N	ManoEntityInterface	Information about the supported interfaces.
manoConfigurableParam	M	1	ManoConfigurableParam	Information and current values of the configurable parameters. This attribute's content include the information about NFV-MANO functional entity peers and links. The attribute shall be writable.
manoApplicationState	M	1	Not specified	Information and current values of the NFV-MANO functional entity's application state. The state of the NFV-MANO functional entity application determines the state of different NFV-MANO services offered by the NFV-MANO functional entity (refer to clause 6.2.1).
manoMonitoringConfigParameter	M	1..N	Not specified	Information and current values of the NFV-MANO functional entity's fault monitoring configuration parameters. This attribute's content includes the information for the fault monitoring mechanism. The attribute shall be writable.
manoService	M	1..N	ManoServiceInfo	Information about the individual NFV-MANO service(s) provided by the NFV-MANO functional entity.
nfvoSpecificInfo	M	0..1	NfvoSpecificInfo	The information specific to a NFVO entity. See also clause 7.2.7. See notes 1 and 4.
vnfmSpecificInfo	M	0..1	VnfmSpecificInfo	The information specific to a VNFM entity. See also clause 7.2.8. See notes 2 and 4.
vimSpecificInfo	M	0..1	VimSpecificInfo	The information specific to a VIM entity. See also clause 7.2.9. See notes 3 and 4.

Attribute	Qualifier	Cardinality	Content	Description
wimSpecificInfo	M	0..1	WimSpecificInfo	The information specific to a WIM entity. See also clause 7.2.14. See notes 5 and 4.
NOTE 1: It shall be present when manoEntityType is "NFVO", and it shall be absent in any other case. NOTE 2: It shall be present when manoEntityType is "VNFM", and it shall be absent in any other case. NOTE 3: It shall be present when manoEntityType is "VIM", and it shall be absent in any other case. NOTE 4: The information about the NFV-MANO services offered by a specific type of NFV-MANO functional entity is specified by the manoService attribute. NOTE 5: It shall be present when manoEntityType is "WIM", and it shall be absent in any other case.				

7.2.4 ManoEntityInterface information element

7.2.4.1 Description

The ManoEntityInterface information element provides the list of attributes about the supported interfaces of an NFV-MANO functional entity.

7.2.4.2 Attributes

The ManoEntityInterface information element shall follow the indications provided in table 7.2.4.2-1.

Table 7.2.4.2-1: Attributes of ManoEntityInterface information element

Attribute	Qualifier	Cardinality	Content	Description
manoEntityInterfaceId	M	1	Identifier	Identifier of this NFV-MANO functional entity interface.
manoEntityInterfaceName	M	1	String	Human-readable name of the NFV-MANO functional entity interface. The attribute shall be writable.
manoEntityInterfaceType	M	1	Enum	Type of this NFV-MANO interface. For VIM, the following values are allowed. VALUES: • Sim • Vcrm • Vcrim • Vcrcam • Vcrcn • Vcfm • Vnrm • Vnrim • Vnrcam • Vnrcn • Nfpm • Vsrm • Vsrim • Vsrcam • Vsrcn • Vrpm • Vrfm • Vcrmm • Vnrmm • Vsrmm • Vrrcn • Vcrqm • Vnrqm • Vsrqm • Vrqcn • Chrm • Chcam • Pom

Attribute	Qualifier	Cardinality	Content	Description
				For VNFM, the following values are allowed. VALUES: • Vnflcm • Vnfpm • Vnffm • Vnfind • Pom For NFVO, the following values are allowed. VALUES: • Nsd • Vnfpkgm • Nslcm • Nspm • Nsfm • Vnflcog • Vrim • Vrm • Vrrm • Vrrcn • Vrcn • Vrpm • Vrfm • Vrqm • Vrqan • Pom • Vnfspm • Nfvici • Nslcog • Nsiun For WIM, the following values are allowed. VALUES: • Mscsm • Mscscapm • Mscsfm • Mscspm For the meaning of the abbreviations, refer to the description under the table.
standardVersion	M	1	Version	Version of the standard the interface is compliant to. See note 1.
providerSpecificApiVersion	M	1	Version	Provider-specific software API version.
apiEndpoint	M	1	Not specified	Exposed API endpoint. It provides the information relevant about the protocol, host and port, and path where the interface API can be accessed. The attribute shall be writable. See note 2.
supportedOperation	M	1..N	SupportedOperation	Information about supported operations of this interface.
maxConcurrentIntOpNumber	M	1	Integer	Maximum number of concurrent operations supported on this interface.
manoEntityInterfaceState	M	1	Not specified	State of the NFV-MANO service interface. The state of the NFV-MANO service interface is also determined by the state of the NFV-MANO functional entity application (refer to clause 6.2.1).

Attribute	Qualifier	Cardinality	Content	Description
securityInfo	M	0..1	Not specified	Security related information. The attribute's content shall support describing the authentication policies and protocols (e.g. URI of Oauth), the security protocols, and the cipher algorithms (values of cipher suites, i.e. combination of algorithms, e.g. TLS_DHE_RSA_WITH_DES_CBC_SHA) configured to be used to access the interface. The attribute shall be writable.
NOTE 1: The information to be provided in this attribute shall relate to the specification and version of the specification. For instance, "ETSI GS NFV-SOL 003 (V2.4.1)". NOTE 2: At the protocol and data model design phase, an example of apiEndpoint information is the structure of RESTful API URIs. In this case, the structure has the following prefix: {apiRoot}/{apiName}/{apiMajorVersion}.				

The list of abbreviations used in the manoEntityInterfaceType attribute are as follows:

- For VIM:
  - + Sim: Software Image Management interface.
  - + Virtualised Compute interfaces:
    - * Vcrm: Virtualised Compute Resources Management interface.
    - * Vcrim: Virtualised Compute Resources Information Management interface.
    - * Vcrcam: Virtualised Compute Resources Capacity Management interface.
    - * Vcrcn: Virtualised Compute Resources Change Notification interface.
    - * Vcfm: Virtualised Compute Flavour Management interface.
  - + Virtualised Network interfaces:
    - * Vnrm: Virtualised Network Resources Management interface.
    - * Vnrim: Virtualised Network Resources Information Management interface.
    - * Vnrcam: Virtualised Network Resources Capacity Management interface.
    - * Vnrcn: Virtualised Network Resources Change Notification interface.
    - * Nfpm: Network Forwarding Path Management interface.
  - + Virtualised Storage interfaces:
    - * Vsrm: Virtualised Storage Resources Management interface.
    - * Vsrim: Virtualised Storage Resources Information Management interface.
    - * Vsrcam: Virtualised Storage Resources Capacity Management interface.
    - * Vsrcn: Virtualised Storage Resources Change Notification interface.
  - + Vrpm: Virtualised Resources Performance Management interface.
  - + Vrfm: Virtualised Resources Fault Management interface.
  - + Virtualised Resource Reservation interfaces:
    - * Vcrmm: Virtualised Compute Resources Reservation Management interface.
    - * Vnrmm: Virtualised Network Resources Reservation Management interface.
    - * Vsrmm: Virtualised Storage Resources Reservation Management interface.
  - + Vrrcn: Virtualised Resources Reservation Change Notification interface.

    + Virtualised Resource Quota interfaces:
        * Vcrqm: Virtualised Compute Resources Quota Management interface.
        * Vnrqm: Virtualised Network Resources Quota Management interface.
        * Vsrqm: Virtualised Storage Resources Quota Management interface.
    + Vrqcn: Virtualised Resources Quota Change Notification interface.
    + Chrm: Compute Host Reservation Management interface.
    + Chcam: Compute Host Capacity Management interface.
    + Pom: Policy Management interface.
- For VNFM:
    + Vnflcm: VNF Lifecycle Management interface.
    + Vnfpm: VNF Performance Management interface.
    + Vnffm: VNF Fault Management interface.
    + Vnfind: VNF Indicator interface.
    + Pom: Policy Management interface.
- For NFVO:
    + Nsd: NSD Management interface.
    + Vnfpkgm: VNF Package Management interface.
    + Nslcm: NS Lifecycle Management interface.
    + Nspm: NS Performance Management interface.
    + Nsfm: NS Fault Management interface.
    + Vnflcog: VNF Lifecycle Operation Granting interface.
    + Vrim: Virtualised Resources Information Management interface.
    + Vrm: Virtualised Resources Management interface.
    + Vrrm: Virtualised Resources Reservation Management interface.
    + Vrrcn: Virtualised Resources Reservation Change Notification interface.
    + Vrcn: Virtualised Resource Change Notification interface.
    + Vrpm: Virtualised Resources Performance Management interface.
    + Vrfm: Virtualised Resources Fault Management interface.
    + Vrqm: Virtualised Resources Quota Management interface.
    + Vrqan: Virtualised Resources Quota Available Notification.
    + Pom: Policy Management interface.
    + Vnfspm: VNF Snapshot Package Management interface.
    + Nfvici: NFVI Capacity Information interface.
    + Specific interfaces across multi-admin domains (Or-Or):
        * Nslcog: NS Lifecycle Operation Granting interface.

    * Nsiun: NS Instance Usage Notification interface.

- For WIM:
    + Mscsm: MSCS Management interface.
    + Mscscapm: (MSCS) Capacity Management interface.
    + Mscsfm: (MSCS) Fault Management interface.
    + Mscspm: (MSCS) Performance Management interface.

7.2.5 SupportedOperation information element

7.2.5.1 Description

The SupportedOperation information element provides the list of attributes about the supported operations of a specific interface.

7.2.5.2 Attributes

The SupportedOperation information element shall follow the indications provided in table 7.2.5.2-1.

Table 7.2.5.2-1: Attributes of SupportedOperation information element

Attribute	Qualifier	Cardinality	Content	Description
operationName	M	1	String	Name of the operation supported on its interface.
maxConcurrentOpNumber	M	1	Integer	Maximum number of concurrent requests supported by the interface operation.

7.2.6 ManoConfigurableParam information element

7.2.6.1 Description

The ManoConfigurableParam information element provides the list of parameters that can be configured on the NFV-MANO functional entity.

7.2.6.2 Attributes

The ManoConfigurableParam information element shall follow the indications provided in table 7.2.6.2-1.

Table 7.2.6.2-1: Attributes of ManoConfigurableParam information element

Attribute	Qualifier	Cardinality	Content	Description
manoPeerConfig	M	0..N	ManoPeerConfig	Configuration parameters related to the NFV-MANO functional entity peers of the present NFV-MANO functional entity.
ntpServer	M	1	Not specified	Address of the NTP server to be used for the clock synchronization.

7.2.7 NfvoSpecificInfo information element

7.2.7.1 Description

The NfvoSpecificInfo information element provides the list of information attributes specific to a NFVO entity. The information element specifies information which can be relevant to more than one NFV-MANO service offered by an NFVO entity.

7.2.7.2 Attributes

The NfvoSpecificInfo information element shall follow the indications provided in table 7.2.7.2-1.

Table 7.2.7.2-1: Attributes of NfvoSpecificInfo information element

Attribute	Qualifier	Cardinality	Content	Description
maxOnboardedNsdNum	M	1	Integer	Maximum number of NSDs that can be on-boarded on the NFVO.
maxOnboardedVnfPkgNum	M	1	Integer	Maximum number of VNF Packages that can be on-boarded on the NFVO.
maxNsInstanceNum	M	1	Not specified	Maximum number of NS instances that the NFVO can manage. The attribute's content shall support relating the number with the reference criteria under which the value has been determined. The content may also specify different values for different reference criteria. See note.
supportedVnfdFormat	M	1..N	String	Supported VNFD data format.
supportedNsdFormat	M	1..N	String	Supported NSD data format.
NOTE: At runtime, the number of NS constituents can vary among the NS instances, and therefore it might not be feasible to have a single value to cover all possible combinations. The content specifies the reference criteria, such as the number and type of the NS constituents, applicable in determining the maxNsInstanceNum.				

7.2.8 VnfmSpecificInfo information element

7.2.8.1 Description

The VnfmSpecificInfo information element provides the list of information attributes specific to a VNFM entity. The information element specifies information which can be relevant to more than one NFV-MANO service offered by a VNFM entity.

7.2.8.2 Attributes

The VnfmSpecificInfo information element shall follow the indications provided in table 7.2.8.2-1.

Table 7.2.8.2-1: Attributes of VnfmSpecificInfo information element

Attribute	Qualifier	Cardinality	Content	Description
resourceMgmtModeSupport	M	1	Enum	The supported resource management modes of the VNFM. It can support direct mode, indirect mode or both. VALUES: • DIRECT • INDIRECT • BOTH
managedVnfInstanceInfo	M	1..N	String	The kinds of VNF instances that can be managed, e.g. to determine the compatibility of a VNF with certain VNFM according to the `vnfmInfo` attribute in the VNFD (see table 7.1.2.2-1 in ETSI GS NFV-IFA 011 [i.8]).
maxVnfInstanceNum	M	1	Not specified	Maximum number of VNF instances that the VNFM can manage. The attribute's content shall support relating the number with the reference criteria under which the attribute value has been determined. The content may also specify different values for different reference criteria. See note.
supportedVnfdFormat	M	1..N	String	Supported VNFD data format.
NOTE: At runtime, the number of VNF internal constituents can vary among the VNF instances, and therefore it might not be feasible to have a single value to cover all possible combinations. The content specifies the reference criteria, such as the number and type of the constituents in the VNF, applicable in determining the maxVnfInstanceNum.				

7.2.9 VimSpecificInfo information element

7.2.9.1 Description

The VimSpecificInfo information element provides the list of information attributes specific to a VIM entity. The information element specifies information which can be relevant to more than one NFV-MANO service offered by a VIM entity.

7.2.9.2 Attributes

The VimSpecificInfo information element shall follow the indications provided in table 7.2.9.2-1.

Table 7.2.9.2-1: Attributes of VimSpecificInfo information element

Attribute	Qualifier	Cardinality	Content	Description
maxVirtualResourceNum	M	1..N	Not specified	Maximum number of Virtualised Resources that the VIM can manage. The attribute's content shall support relating the number with the reference criteria under which the attribute value has been determined. The content shall define to which type of virtualised resource the value refers, such as virtual compute, virtual storage and virtual network. The cardinality caters for the specification of values for the different virtualised resource types. The content may also specify different values for different reference criteria. See note.
imageContainerFormat	M	1..N	Not specified	List of supported image container formats. Container format indicates whether a software image is in a file that also contains metadata about the actual software.
imageDiskFormat	M	1..N	Not specified	List of supported image disk formats. The disk format of a software image is the format of the underlying disk image.
imageSignatureVerification	M	1	Not specified	Information about the supported mechanisms, algorithms, and protocols for verifying the signature of software images.
imageDigestAlgorithm	M	1..N	Not specified	List of supported digest algorithms that can be used for digital signatures.
NOTE: At runtime, the size of the virtualised resources can vary, and therefore it might not be feasible to have a single value to cover all possible combinations. The content specifies the reference criteria, such as the virtualised resource size, applicable in determining the maxVirtualResourceNum.				

7.2.10 ManoServiceInfo information element

7.2.10.1 Description

The ManoServiceInfo information element encapsulates information about an NFV-MANO service provided by the NFV-MANO functional entity.

7.2.10.2 Attributes

The ManoServiceInfo information element shall follow the indications provided in table 7.2.10.2-1.

Table 7.2.10.2-1: Attributes of ManoServiceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
manoServiceId	M	1	Identifier	Identifier of this NFV-MANO service.
manoServiceName	M	1	String	Human-readable name of the NFV-MANO service. The attribute shall be writable.
manoServiceDescription	M	1	String	Human-readable description of the NFV-MANO service. The attribute shall be writable.
manoEntityInterfaceId	M	1..N	Identifier (Reference to ManoEntityInterface)	Reference to the NFV-MANO interface(s) associated to this service. If cardinality is greater than one, the type of ManoEntityInterface shall be the same. See note.
NOTE: A cardinality greater than one supports having different interface versions or apiEndpoints to be used for accessing the same instance of a NFV-MANO service.				

7.2.11 ManoPeerConfig information element

7.2.11.1 Description

The ManoPeerConfig information element provides the list of run-time parameters that can be configured related to a peer functional entity of the present NFV-MANO functional entity, which can be either a NFV-MANO functional entity or other external entities.

NOTE: The ManoPeerConfig information element holds run-time and current configuration values, and it is not used as a whole as an input parameter in the related configuration and information management operations. The ModifyConfig operation uses as input parameter a generic KeyValuePair, where the KeyValuePair indicates the name of an attribute to be updated.

7.2.11.2 Attributes

The ManoPeerConfig information element shall follow the indications provided in table 7.2.11.2-1.

Table 7.2.11.2-1: Attributes of ManoPeerConfig information element

Attribute	Qualifier	Cardinality	Content	Description
peerEntityType	M	1	Enum	Type of the peer functional entity. VALUES: • VIM • NFVO • VNFM • WIM • EM • OSS
peerEntityId	M	1	Identifier	Identifier of the peer functional entity. See note 1.
apiDiscoveryEndpoint	M	0..1	Not specified	Information for the discovery of API endpoints related to interfaces exposed/produced by the peer functional entity.
manoConsumerInterface	M	0..N	ManoConsumerInterfaceInfo	Information of the interface consumed by the NFV-MANO functional entity from the peer functional entity. See note 2.
statePeerEntity	M	1	Not specified	Current values of the state of the peer functional entity.
NOTE 1: The peerEntityId identifier can also be used in some NFV-MANO interface procedures. For instance, the value of the vimId of the VimConnectionInfo (refer to clause 8.12.5 of ETSI GS NFV-IFA 007 [i.5]) is the same as the value of the peerEntityId, when a specific VIM is peer with the NFVO and the VNFM.				

Attribute	Qualifier	Cardinality	Content	Description
NOTE 2: The NFV-MANO consumer interface information or part of it can be filled via: i) explicit modification configuration; and ii) through API discovery mechanisms based on the configuration of the apiDiscoveryEndpoint. See also clause B.2.1 in annex B.				

7.2.12 ManoConsumerInterfaceInfo information element

7.2.12.1 Description

The ManoConsumerInterfaceInfo information element holds information about an interface consumed by the NFV-MANO functional entity from another peer functional entity.

7.2.12.2 Attributes

The ManoConsumerInterfaceInfoinformation element shall follow the indications provided in table 7.2.12.2-1.

Table 7.2.12.2-1: Attributes of ManoConsumerInterfaceInfo information element

Attribute	Qualifier	Cardinality	Content	Description
manoConsumerInterfaceId	M	1	Identifier	Identifier of the consumed NFV-MANO interface.
manoConsumerInterfaceName	M	1	String	Human-readable name of the NFV-MANO interface.
manoConsumerInterfaceType	M	1	Enum	Type of the consumed NFV-MANO interface. When consuming from VIM, the following values are allowed. VALUES: • Sim • Vcrm • Vcrim • Vcrcam • Vcrcn • Vcfm • Vnrm • Vnrim • Vnrcam • Vnrcn • Nfpm • Vsrm • Vsrim • Vsrcam • Vsrcn • Vrpm • Vrfm • Vcrmm • Vnrmm • Vsrmm • Vrrcn • Vcrqm • Vnrqm • Vsrqm • Vrqcn • Chrm • Chcam • Pom When consuming from VNFM, the following values are allowed. VALUES: • Vnflcm

Attribute	Qualifier	Cardinality	Content	Description
				• Vnfpm • Vnffm • Vnfind • Pom When consuming from NFVO, the following values are allowed. VALUES: • Vnfpkgm • Vnflcog • Vrim • Vrm • Vrrm • Vrrcn • Vrcn • Vrpm • Vrfm • Vrqm • Vrqan • Vnfspm • Nslcog • Nsiun When consuming from WIM, the following values are allowed. VALUES: • Mscsm • Mscscapm • Mscsfm • Mscspm When consuming from EM, the following values are allowed. VALUES: • Vnfind • Lcmcoord When consuming from OSS, the following values are allowed. VALUES: • Lcmcoord For the use of the abbreviations, refer to the description in clause 7.2.4 and below the present table. See note 1.
standardVersion	M	1	Version	Version of the standard the interface is compliant to. See note 2.
providerSpecificApiVersion	M	1	Version	Provider-specific software API version.
apiEndpoint	M	1	Not specified	Consumable API endpoint. It provides the information relevant about the protocol, host and port, and path where the interface API can be accessed. See note 3.
securityInfo	M	0..1	Not specified	Security related information including credentials information if needed for consuming the API.
consumerOpTimeout	M	1	Integer	Timer (in msec) value of the consumer operation request until response is received. It is used to handle error cases such as unresponsive interface operations, e.g. due to network failure, errors on the producer, etc.
maxConcurrentConsumerOpNumber	M	0..1	Integer	Maximum number of concurrent operations supported on this interface from consumer point of view.

Attribute	Qualifier	Cardinality	Content	Description
NOTE 1: As specified in ETSI GS NFV-IFA 010 [1], ETSI GS NFV-IFA 007 [i.5], ETSI GS NFV-IFA 013 [i.7] and ETSI GS NFV-IFA 030 [i.16], no other NFV-MANO functional entity is a consumer of the Nfvici interface produced by the NFVO. Therefore, the list of consumed interfaces differs from the ones listed as a producer in clause 7.2.4. According to ETSI GS NFV-IFA 030 [i.16], Nsd, Nslcm, Nspm, Nsfm, Nslcog, Nsiun and Pom interfaces can be consumed (fully or partially) by another NFVO on the Or-Or reference point. NOTE 2: The information to be provided in this attribute shall relate to the specification and version of the specification. For instance, "ETSI GS NFV-SOL 003 (V2.4.1)". NOTE 3: At the protocol and data model design phase, an example of apiEndpoint information is the structure of RESTful API URIs. In this case, the structure has the following prefix: {apiRoot}/{apiName}/{apiMajorVersion}.				

In addition to the list of abbreviations provided in clause 7.2.4 the following abbreviations represent interfaces that can also be consumed and are applicable as values for the manoConsumerInterfaceType:

- Produced by EM:
  + VnfInd: Indicator interface.
  + Lcmcoord: LCM Coordination interface.
- Produced by OSS:
  + Lcmcoord: LCM Coordination interface.

7.2.13 ManoEntityComponent information element

7.2.13.1 Description

The ManoEntityComponent information element encapsulates information a deployed component realizing part of the NFV-MANO functional entity.

7.2.13.2 Attributes

The ManoEntityComponent information element shall follow the indications provided in table 7.2.13.2-1.

Table 7.2.13.2-1: Attributes of ManoEntityComponent information element

Attribute	Qualifier	Cardinality	Content	Description
manoEntityComponentId	M	1	Identifier	Identifier of this NFV-MANO functional entity component.
manoServiceId	M	0..N	Identifier (Reference to ManoServiceInfo)	The set of NFV-MANO services that depend on the NFV-MANO functional entity component.

7.2.14 WimSpecificInfo information element

7.2.14.1 Description

The WimSpecificInfo information element provides the list of information attributes specific to a WIM entity. The information element specifies information which can be relevant to more than one NFV-MANO service offered by a WIM entity.

7.2.14.2 Attributes

The WimSpecificInfo information element shall follow the indications provided in table 7.2.14.2-1.

Table 7.2.14.2-1: Attributes of WimSpecificInfo information element

Attribute	Qualifier	Cardinality	Content	Description
maxMscsNum	M	1..N	Not specified	Maximum number of MSCS that the WIM can manage. The attribute's content shall support relating the number with the reference criteria under which the attribute value has been determined. The cardinality caters for the specification of values for different MSCS characteristics. The content may also specify different values for different reference criteria. See note.
maxMsncNum	M	1..N	Not specified	Maximum number of MSNC that the WIM can manage. The attribute's content shall support relating the number with the reference criteria under which the attribute value has been determined. The cardinality caters for the specification of values for different MSNC characteristics. The content may also specify different values for different reference criteria. See note.
mscsLayerProtocolSupport	M	1..N	Not specified	List of protocols of particular layers used to realize an MSCS that are supported by the WIM.
msncLayerProtocolSupport	M	1..N	Not specified	List of protocols of particular layers used to realize an MSNC that are supported by the WIM.
NOTE: At runtime, the composition of an MSCS or MSNC can vary, and therefore it might not be feasible to have a single value to cover all possible combinations.				

7.3 Information elements and notifications related to NFV-MANO performance management

7.3.1 Introduction

This clause defines information elements and notifications related to NFV-MANO performance management.

7.3.2 PerformanceInformationAvailableNotification

7.3.2.1 Description

This notification informs the receiver that performance information is available. Delivery mechanism for the performance reports is not specified in the present document.

The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

The support of this notification is mandatory.

7.3.2.2 Trigger Conditions

The notification is produced when:

- New performance information is available.

7.3.2.3 Attributes

The attributes of the PerformanceInformationAvailableNotification shall follow the indications provided in table 7.3.2.3-1.

Table 7.3.2.3-1: Attributes of the PerformanceInformationAvailableNotification

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1..N	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Object instances for which performance information is available. The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

7.3.3 ThresholdCrossedNotification

7.3.3.1 Description

This notification informs the receiver that a threshold value has been crossed.

The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

The support of this notification is mandatory.

7.3.3.2 Trigger conditions

The notification is produced when:

- A Threshold has been crossed. Depending on threshold type, there might be a single or multiple crossing values.

7.3.3.3 Attributes

The attributes of the ThresholdCrossedNotification shall follow the indications provided in table 7.3.3.3-1.

Table 7.3.3.3-1: Attributes of the ThresholdCrossedNotification

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier (Reference to Threshold)	Threshold which has been crossed.
crossingDirection	M	1	Enum	An indication of whether the threshold was crossed in upward or downward direction. VALUES: • UP • DOWN
objectInstanceId	M	1	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Object instance for which the threshold has been crossed. The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).
performanceMetric	M	1	String	Performance metric associated with the threshold.
performanceValue	M	1	Value	Value of the metric that resulted in threshold crossing.

Attribute	Qualifier	Cardinality	Content	Description
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each kind of performance metrics is defined in clause 8.4.

7.3.4 PmJob information element

7.3.4.1 Description

This information element provides the details of the PM Job.

The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

7.3.4.2 Attributes

The attributes of the PmJob information element shall follow the indications provided in table 7.3.4.2-1.

Table 7.3.4.2-1: Attributes of the PmJob information element

Attribute	Qualifier	Cardinality	Content	Description
pmJobId	M	1	Identifier	Identifier of this PmJob information element.
objectInstanceId	M	1..N	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Identifiers of the measured object instances for which performance information is collected.
performanceMetric	M	0..N	String	This defines the type of performance metric(s) for the object instances. See note 1.
performanceMetricGroup	M	0..N	String	Group of performance metrics. A metric group is a pre-defined list of metrics, known to the producer that it can decompose to individual metrics. See note 1.
collectionPeriod	M	1	Not specified	Specifies the periodicity at which the producer will collect performance information. See note 2.
reportingPeriod	M	1	Not specified	Specifies the periodicity at which the producer will report to the consumer about performance information. See note 2.
reportingBoundary	O	0..1	Not specified	Identifies a boundary after which the reporting will stop. The boundary shall allow a single reporting as well as periodic reporting up to the boundary.
NOTE 1: At least one of the two (performanceMetric or performanceMetricGroup) shall be present. NOTE 2: At the end of each reportingPeriod, the producer will inform the consumer about availability of the performance data collected for each completed collection period during this reportingPeriod. While the exact definition of the types for collectionPeriod and reporting period is part of the protocol design, it is recommended that the reportingPeriod be equal or a multiple of the collectionPeriod. In the latter case, the performance data for the collection periods within one reporting period would be reported together.				

7.3.5 Threshold information element

7.3.5.1 Description

This information element provides the details of a threshold.

The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

7.3.5.2 Attributes

The attributes of the Threshold information element shall follow the indications provided in table 7.3.5.2-1.

Table 7.3.5.2-1: Attributes of the Threshold information element

Attribute	Qualifier	Cardinality	Content	Description
thresholdId	M	1	Identifier	Identifier of this Threshold information element.
objectInstanceId	M	1	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	Identifier of the measured object instance associated with the threshold.
performanceMetric	M	1	String	Defines the performance metric associated with the threshold.
thresholdType	M	1	Enum	Type of threshold. The list of possible values is part of the protocol design and might include: single/multi valued threshold, static/dynamic threshold, template based threshold, etc. VALUES: • SIMPLE: Single-valued static threshold • etc.
thresholdDetails	M	1	Not specified	Details of the threshold: value to be crossed, details on the notification to be generated.

7.3.6 PerformanceReport information element

7.3.6.1 Description

This information element defines the format of a performance report provided by the producer to the consumer on a specified object instance or a set of them.

The object instances for this information element will be NFV-MANO functional entities.

7.3.6.2 Attributes

The attributes of the PerformanceReport information element shall follow the indications provided in table 7.3.6.2-1.

Table 7.3.6.2-1: Attributes of the PerformanceReport information element

Attribute	Qualifier	Cardinality	Content	Description
performanceReport	M	1..N	PerformanceReportEntry	List of performance information entries.

7.3.7 PerformanceReportEntry information element

7.3.7.1 Description

This information element defines a single performance report entry.

The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).

7.3.7.2 Attributes

The attributes of the PerformanceReportEntry information element shall follow the indications provided in table 7.3.7.2-1.

Table 7.3.7.2-1: Attributes of the PerformanceReportEntry information element

Attribute	Qualifier	Cardinality	Content	Description
objectType	M	1	String	Defines the object type. The object types for this information element will be the NFV-MANO functional entity's measured object instances (refer to clause 8.2).
objectInstanceId	M	1	Identifier (Reference to ManoEntityInfo, ManoServiceInfo, ManoEntityInterface, or ManoConsumerInterfaceInfo)	The object instance for which the performance metric is reported. The object instances for this information element will be NFV-MANO functional entity's measured object instances (refer to clause 8.2).
performanceMetric	M	1	String	Name of the metric collected.
performanceValue	M	1..N	PerformanceValueEntry	List of performance values with associated timestamp and measurement context.

7.3.8 PerformanceValueEntry information element

7.3.8.1 Description

This information element defines a single performance value with its associated time stamp and measurement context (see clause 8.4).

7.3.8.2 Attributes

The attributes of the PerformanceValueEntry information element shall follow the indications provided in table 7.3.8.2-1.

Table 7.3.8.2-1: Attributes of the PerformanceValueEntry information element

Attribute	Qualifier	Cardinality	Content	Description
timeStamp	M	1	DateTime	Timestamp indicating when the data was collected.
performanceValue	M	1	Value	Value of the metric collected.
measurementContext	M	0..1	Not specified	Measurement context of the metric collected. The specific measurement context for each performance metric is defined in clause 8.4.

7.4 Information elements and notifications related to NFV-MANO state management

7.4.1 Introduction

This clause defines information elements and notifications related to NFV-MANO state management.

7.4.2 StateChangeNotification

7.4.2.1 Description

This notification informs the receiver that the NFV-MANO functional entity application and/or any of its NFV-MANO service interfaces has changed its state.

The object instances for this information element will be NFV-MANO functional entities.

The support of this notification is mandatory.

7.4.2.2 Trigger Conditions

The notification is produced when:

- The state of the NFV-MANO functional entity application changes.
- The state of an individual NFV-MANO service interface provided by the NFV-MANO functional entity changes.

7.4.2.3 Attributes

The attributes of the StateChangeNotification shall follow the indications provided in table 7.4.2.3-1.

Table 7.4.2.3-1: Attributes of the StateChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
manoEntityInterfaceId	M	0..1	Identifier (Reference to ManoEntityInterface)	Identifies the NFV-MANO service interface. It shall be present if the notification relates to the state changes of a specific NFV-MANO service interface. If the parameter is not present, the notification refers to the state changes of the NFV-MANO functional entity application.
stateChange	M	1	Not specified	State to which the managed object (NFV-MANO functional entity application or NFV-MANO service interface) has changed.

7.5 Information elements and notifications related to NFV-MANO fault management

7.5.1 Introduction

This clause defines information elements and notifications related to NFV-MANO fault management.

7.5.2 AlarmNotification

7.5.2.1 Description

This notification informs the receiver of alarms related to the NFV-MANO functional entity. Alarms are created in response to:

- Faults detected by the NFV-MANO functional entity.

The support of this notification is mandatory.

7.5.2.2 Trigger conditions

- An alarm has been created.
- An alarm has been updated, e.g. if the severity of the alarm has changed.

7.5.2.3 Attributes

The AlarmNotification shall follow the indications provided in table 7.5.2.3-1.

Table 7.5.2.3-1: Attributes of the AlarmNotification

Attribute	Qualifier	Cardinality	Content	Description
alarm	M	1	Alarm	Information about an alarm including AlarmId, identifier of the affected NFV-MANO functional entity and FaultDetails.

7.5.3 AlarmClearedNotification

7.5.3.1 Description

This notification informs the receiver of the clearing of an alarm related to the NFV-MANO functional entity, e.g. the alarm's perceived severity is set to "cleared" since the corresponding fault has been solved.

The support of this notification is mandatory.

7.5.3.2 Trigger conditions

- An alarm has been cleared.

7.5.3.3 Attributes

The AlarmClearedNotification shall follow the indications provided in table 7.5.3.3-1.

Table 7.5.3.3-1: Attributes of the AlarmClearedNotification

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier (Reference to Alarm)	Alarm identifier.
alarmClearedTime	M	1	DateTime	The timestamp indicating when the alarm was cleared.

7.5.4 Alarm information element

7.5.4.1 Description

The Alarm information element encapsulates information about an alarm.

The Managed Objects for this information element will be NFV-MANO functional entities.

7.5.4.2 Attributes

The Alarm information element shall follow the indications provided in table 7.5.4.2-1.

Table 7.5.4.2-1: Attributes of the Alarm information element

Attribute	Qualifier	Cardinality	Content	Description
alarmId	M	1	Identifier	Identifier of this Alarm information element.
managedObjectId	M	1	Identifier	Identifier of the affected managed object. The managed objects for this information element will be NFV-MANO functional entities.
alarmRaisedTime	M	1	DateTime	Timestamp indicating when the alarm is raised by the managed object.
alarmChangedTime	M	0..1	DateTime	Timestamp indicating when the alarm was last changed. It shall be present if the alarm has been updated.
alarmClearedTime	M	0..1	DateTime	Timestamp indicating when the alarm was cleared. It shall be present if the alarm has been cleared.
ackState	M	1	Enum	State of the alarm. VALUES: • ACKNOWLEDGED • UNACKNOWLEDGED
perceivedSeverity	M	1	Enum	Perceived severity of the managed object failure. VALUES: • CRITICAL • MAJOR • MINOR • WARNING • INDETERMINATE • CLEARED
eventTime	M	1	DateTime	Timestamp indicating when the fault was observed.
eventType	M	1	Enum	Type of the event. The allowed values for the eventType attribute use the event type defined in Recommendation ITU-T X.733 [2]. VALUES: • COMMUNICATIONS_ALARM • PROCESSING_ERROR_ALARM • ENVIRONMENTAL_ALARM • QOS_ALARM • EQUIPMENT_ALARM
faultType	M	0..1	String	Additional information related to the type of the fault.
probableCause	M	1	String	Information about the probable cause of the fault.
isRootCause	M	1	Boolean	Attribute indicating if this fault is the root for other correlated alarms. If TRUE, then the alarms listed in the attribute correlatedAlarmId are caused by this fault.
correlatedAlarmId	M	0..N	Identifier (Reference to Alarm)	List of identifiers of other alarms correlated to this fault.
faultDetails	M	0..N	Not specified	Provides additional information about the fault.

7.5.5 AlarmListRebuiltNotification

7.5.5.1 Description

This notification informs the receiver that the active alarm list has been rebuilt by the NFV-MANO functional entity. Upon receipt of this notification, the receiver needs to use the "Get Alarm List" operation to synchronize its view on current active alarms with that of the NFV-MANO functional entity.

The support of this notification is mandatory.

7.5.5.2 Trigger conditions

Active alarm list has been rebuilt by the NFV-MANO functional entity, e.g. if the NFV-MANO functional entity detects its storage holding the alarm list is corrupted.

7.5.5.3 Attributes

The AlarmListRebuiltNotification does not contain any attributes.

7.6 Information elements and notifications related to NFV-MANO log management

7.6.1 Introduction

This clause defines information elements and notifications related to NFV-MANO log management.

7.6.2 LogReportAvailabilityNotification information element

7.6.2.1 Description

This notification informs the receiver that the log report of the NFV-MANO functional entity is available. Delivery mechanism for the log report is not specified in present document.

The support of this notification is mandatory.

7.6.2.2 Trigger condition

The log report of the NFV-MANO functional entity is available.

7.6.2.3 Attributes

The LogReportAvailabilityNotification shall follow the indications provided in table 7.6.2.3-1.

Table 7.6.2.3-1: Attributes of the LogReportAvailabilityNotification

Attribute	Qualifier	Cardinality	Content	Description
objectInstanceId	M	1	Identifier	Object instance for which the log report is available. The object instances for this information element will be NFV-MANO functional entity instances.
loggingJobId	M	1	Identifier (Reference to LoggingJob)	References the logging job related to this log report.
location	M	1	Not specified	Location of the log report where it can be obtained. The specific format of the location depends on the delivery mechanism of the log report, but it shall minimally specify: the protocol over which the log report can be retrieved, the address information (e.g. URI), and credentials for retrieving the report. See note.
NOTE: In runtime, the credentials may be omitted in case these are provisioned out of band.				

7.6.3 LoggingJob information element

7.6.3.1 Description

This information element provides the details of the Logging Job.

The object instances for this information element will be NFV-MANO functional entities.

7.6.3.2 Attributes

The attributes of the LoggingJob information element shall follow the indications provided in table 7.6.3.2-1.

Table 7.6.3.2-1: Attributes of the LoggingJob information element

Attribute	Qualifier	Cardinality	Content	Description
loggingJobId	M	1	Identifier	Identifier of the LoggingJob.
startTime	M	0..1	DateTime	Specifies the time for the logging job to be started.
endTime	M	0..1	DateTime	Specifies the time for the logging job to be terminated.
logObjectSelector	M	1..N	Not specified	Selector to address the log object (e.g. an individual interface/ operation) in the NFV-MANO functional entity, or list of selectors to address multiple of those. The selector also allows to specify the type of logs to be collected, including: "message logging" and "provider-specific logging".
isEncrypted	M	1	Boolean	Specifies if the log report needs to be encrypted.
loggingConfig	M	0..N	KeyValuePair	Specifies the configuration of the logging job.
reportingCondition	M	0..1	Not specified	Defines the conditions and criteria about when, as part of the requested logging job, the log shall be compiled and the producer report about its availability. The criteria shall cover the capability to: i) report based on log size; ii) report based on time information (e.g. every 24 hours);

Attribute	Qualifier	Cardinality	Content	Description
				iii) report based on certain events. Examples of events are: explicit stop of the logging job, a threshold reached in a certain performance monitoring, etc.

8 Metrics and performance measurements

8.1 Introduction

The performance monitoring of the NFV-MANO functional entities is supported by the NFV-MANO Performance Management interface. The interface supports the handling of PM jobs, performance Thresholds, and the issue of notifications about the availability of the performance information. There are three types of information relevant to the performance management:

- the type of measured objects, e.g. relevant to the whole NFV-MANO functional entity, to a specific NFV-MANO service, etc.;
- the type of objects managed by the NFV-MANO functional entity and its NFV-MANO services, for which performance information can be obtained; and
- the performance measurement on a specific measured object and managed object type.

Clause 8.2 defines the measured object types for the performance measurements specified in the present document. Clause 8.3 specifies the objects managed by the NFV-MANO functional entity and its NFV-MANO services. Clause 8.4 defines generic performance measurements.

8.2 Measured object type definitions

8.2.1 ManoEntity

The measured object type "ManoEntity" is used to collect and report the performance measurements for one NFV-MANO functional entity and the resources supporting the execution of the NFV-MANO functional entity.

The `objectType`, when used in PM job or performance report, is equal to "ManoEntity".

The `objectInstanceId`, when used in PM job or performance report, corresponds to `manoEntityId` (see clause 7.2.3).

8.2.2 ManoService

The measured object type "ManoService" is used to collect and report the performance measurements for one NFV-MANO service of an NFV-MANO functional entity.

The `objectType`, when used in PM job or performance report, is equal to "ManoService".

The `objectInstanceId`, when used in PM job or performance report, corresponds to `manoServiceId` (see clause 7.2.10).

8.2.3 ManoInterfaceProducer

The measured object type "ManoInterfaceProducer" is used to collect and report the performance measurements for one interface produced by an NFV-MANO functional entity.

The `objectType`, when used in PM job or performance report, is equal to "ManoInterface".

The `objectInstanceId`, when used in PM job or performance report, corresponds to `manoEntityInterfaceId` (see clause 7.2.4).

8.2.4 ManoInterfaceConsumer

The measured object type "ManoInterfaceConsumer" is used to collect and report the performance measurements for one interface consumed by an NFV-MANO functional entity.

The `objectType`, when used in PM job or performance report, is equal to "ManoInterfaceConsumer".

The `objectInstanceId`, when used in PM job or performance report, corresponds to `manoConsumerInterfaceId` (see clause 7.2.12).

8.3 Performance object types by NFV-MANO services

8.3.1 Managed object types

The performance measurement definitions include the measurement group of "ManagedObject". The type of ManagedObject differs according to the NFV-MANO functional entity (either NFVO, VNFM, VIM or WIM), and the produced NFV-MANO services by the NFV-MANO functional entity. Some NFV-MANO services may not have specific managed objects.

Table 8.3.1-1 provides the types of managed objects associated to the NFV-MANO services. Only NFV-MANO services with associated managed objects relevant to performance measurements are represented in the table.

Table 8.3.1-1: Managed object types

NFV-MANO functional entity	NFV-MANO service	Managed object	ObjectName	Description
NFVO	NS lifecycle management	NS instance	NsInstanceMo	The NS instance is managed via the NS Lifecycle Management interface.
		VNF instance	VnfInstanceMo	The VNF instance that is managed via the NS Lifecycle Management interface when the VNF instance is part of an NS instance.
		PNF instance	PnfInstanceMo	The PNF instance that is managed via the NS Lifecycle Management interface when the PNF instance is part of an NS instance.
		VL instance	VirtualLinkInstanceMo	The VL instance of an NS instance that is managed via the NS Lifecycle Management interface.
		VNF snapshot	VnfSnapshotMo	The VNF snapshot that is managed via the NS Lifecycle Management interface.
		NS LCM Subscription	NsLcmSubMo	The subscription for notifications related to NS lifecycle changes managed via the NS Lifecycle Management interface.
	NS performance management	PM job	NsPmJobMo	The PM job is associated to an NS instance and is managed via the NS Performance Management interface.
		PM threshold	NsPmThresholdMo	The PM threshold is associated to an NS instance and is managed via the NS Performance Management interface.
		PM Subscription	NsPmSubMo	The subscription for notifications related to NS performance monitoring managed via the NS Performance Management interface.
	NS fault management	Alarm	NsAlarmMo	The Alarm encapsulates information about an alarm associated to an NS instance and it can be retrieved via the NS Fault Management interface.
		FM Subscription	NsFmSubMo	The subscription for notifications related to NS fault monitoring managed via the NS Fault Management interface.

NFV-MANO functional entity	NFV-MANO service	Managed object	ObjectName	Description
	NSD management	NSD	NsdMo	The NSD is onboarded and managed via the NSD Management interface.
		PNFD	PnfdMo	The PNFD is onboarded and managed via the NSD Management interface.
		NSD mgmt. Subscription	NsdSubMo	The subscription for notifications related to NSD on-boarding and/or changes which is managed via the NSD Management interface.
	VNF package management	VNF Package	VnfPackageMo	The VNF Package is onboarded and managed via the VNF Package Management interface.
		VNF Package mgmt. Subscription	VnfPackageSubMo	The subscription for notifications related on-boarding and/or changes of VNF Package management managed via the VNF Package Management interface.
	VNF snapshot package management	VNF Snapshot Package	VnfSnapshotPackageMo	The VNF Snapshot Package is created, onboarded and managed via the VNF Snapshot Package Management interface.
		VNF Snapshot Package mgmt. Subscription	VnfSnapshotPackageSubMo	The subscription for notifications related on-boarding and/or changes of VNF Snapshot Package management managed via the VNF Snapshot Package Management interface.
	VNF LCM granting	Grant	GrantMo	The Grant is handled via the VNF LCM Granting interface.
	NS LC operation granting	NS Grant	NsGrantMo	The NS Grant is handled via the NS Lifecycle Operation Granting interface.
	NS instance usage notification	NS instance usage notification subscription	NsiunSubMo	The subscription for notifications related to NS instance usage managed via the NS Instance Usage Notification interface.
	Policy management	Individual Policy	PolicyMo	The policy is managed via the Policy Management interface.
		Policy mgmt. Subscription	PolicySubMo	The subscription for notifications related to management of policies via the Policy Management interface.
	NFVI capacity information	NFVI Capacity threshold	NfviCiThresholdMo	The NFVI Capacity threshold is managed via the NFVI Capacity Information interface.
		NFVI capacity information subscription	NfviCiSubMo	The subscription for notifications related to NFVI capacity information changes.
VNFM	VNF lifecycle management	VNF instance	VnfInstanceMo	The VNF instance is managed via the VNF Lifecycle Management interface.
		VNF snapshot	VnfSnapshotMo	The VNF snapshot is managed via the VNF Lifecycle Management interface.
		VNF LCM Subscription	VnfLcmSubMo	The subscription for notifications related to VNF lifecycle changes managed via the VNF Lifecycle Management interface.
	VNF performance management	PM job	VnfPmJobMo	The PM job is associated to a VNF instance and is managed via the VNF Performance Management interface.
		PM threshold	VnfPmThresholdMo	The PM threshold is associated to a VNF instance and is managed via the VNF Performance Management interface.
		PM Subscription	VnfPmSubMo	The subscription for notifications related to VNF performance monitoring managed via the VNF Performance Management interface.
	VNF fault management	Alarm	VnfAlarmMo	The Alarm encapsulates information about an alarm associated to a VNF instance and it can be retrieved via the VNF fault management interface.

NFV-MANO functional entity	NFV-MANO service	Managed object	ObjectName	Description
		FM Subscription	VnfFmSubMo	The subscription for notifications related to VNF fault monitoring managed via the VNF Fault Management interface.
	Policy management	Individual Policy	PolicyMo	The policy is managed via the Policy Management interface.
		Policy mgmt. Subscription	PolicySubMo	The subscription for notifications related to management of policies via the Policy Management interface.
VIM	Virtualised Compute Resource management	Virtualised Container	VcMo	The Virtualised Container is managed via the Virtualised Compute Resource Management interface.
	Virtualised Compute Resource Change notification	Virtualised Compute change Subscription	VcChangeSubMo	The subscription for notifications related to virtualised compute resources changes managed via the Virtualised Compute Resources Change Notification interface.
	Virtualised Compute Flavour management	Virtualised Compute Flavour	VcFlavourMo	The Virtualised Compute Flavour is managed via the Virtualised Compute Flavour Management interface.
	Software Image management	Software image	SwImageMo	The software image is managed via the Software Image Management interface.
	Virtualised Network Resource management	Virtual Network	VnMo	The Virtual Network is managed via the Virtualised Network Resource Management interface.
		Network Subnet	NetSubMo	The Network Subnet is managed via the Virtualised Network Resource Management interface.
		Virtual Network Port	VnPortMo	The Virtual Network Ports are managed via the Virtualised Network Resource Management interface.
	Virtualised Network Resource Change notification	Virtualised Network change Subscription	VnChangeSubMo	The subscription for notifications related to virtualised network resources changes managed via the Virtualised Network Resources Change Notification interface.
	Network Forward Path Management	NFP	NfpMo	The NFP is managed via the Network Forwarding Path Management interface.
	Virtualised Storage Resource management	Virtual Storage	VsMo	The Virtual Storage is managed via the Virtualised Storage Resource Management interface.
	Virtualised Storage Resource Change notification	Virtualised Storage change Subscription	VsChangeSubMo	The subscription for notifications related to virtualised storage resources changes managed via the Virtualised Storage Resources Change Notification interface.
	Virtualised Resource Performance management	PM job	VrPmJobMo	The PM job is associated to a virtualised resource and is managed via the Virtualised Resource Performance Management interface.
		PM threshold	VrPmThresholdMo	The PM threshold is associated to a virtualised resource and is managed via the Virtualised Resource Performance Management interface.
		PM Subscription	VrPmSubMo	The subscription for notifications related to VR performance monitoring managed via the Virtualised Resource Performance Management interface.
	Virtualised Resource Fault management	Alarm	VrAlarmMo	The Alarm encapsulates information about an alarm associate to a virtualised resource and it can be retrieved via the Virtualised Resource Fault Management interface.

NFV-MANO functional entity	NFV-MANO service	Managed object	ObjectName	Description
		FM Subscription	VrFmSubMo	The subscription for notifications related to VR fault monitoring managed via the Virtualised Resource Fault Management interface.
	Virtualised Compute Resources Reservation management	Reserved Compute Pool	RsvComputePoolMo	The reserved Compute Pool is managed via the Virtualised Compute Resources Reservation Management interface.
		Reserved Virtualisation Container	RsvVcMo	The reserved Virtualisation Container is managed via the Virtualised Compute Resources Reservation Management interface.
	Virtualised Network Resources Reservation management	Reserved Virtual Network	RsvVnMo	The reserved Virtual Network is managed via the Virtualised Network Resources Reservation Management interface.
		Reserved Virtual Network Port	RsvVnPortMo	The reserved Virtual Network Port is managed via the Virtualised Network Resources Reservation Management interface.
	Virtualised Storage Resources Reservation management	Reserved Virtual Storage	RsvVsMo	The reserved Virtual Storage is managed via the Virtualised Storage Resources Reservation Management interface.
		Reserved Storage Pool	RsvStoragePoolMo	The reserved Virtual Storage Pool is managed via the Virtualised Storage Resources Reservation Management interface.
	Virtualised Resources Reservation Change notification	VR reservation change Subscription	RsvVrChangeSubMo	The subscription for notifications related to virtualised resource reservation changes managed via the Virtualised Resources Reservation Change Notification interface.
	Virtualised Compute Resource Quota management	Virtual Compute Quota	VcQuotaMo	The Virtual Compute Quota is managed via the Virtualised Compute Resources Quota Management Interface.
	Virtualised Network Resource Quota management	Virtual Network Quota	VnQuotaMo	The Virtual Network Quota is managed via the Virtualised Network Resources Quota Management Interface.
	Virtualised Storage Resource Quota management	Virtual Storage Quota	VsQuotaMo	The Virtual Storage Quota is managed via the Virtualised Storage Resources Quota Management Interface.
	Compute Host Reservation management	Reserved Compute Host	RsvComputeHostMo	The reserved Compute Host is managed via the Compute Host Reservation Management Interface
	Compute Host Capacity management	Compute Host Capacity mgmt. Subscription	ComputeHostCamSubMo	The subscription for notifications related to changes in compute host capacity via the Compute Host Capacity Management interface.
	Policy management	Individual Policy	PolicyMo	The policy is managed via the Policy Management interface.
		Policy mgmt. Subscription	PolicySubMo	The subscription for notifications related to management of policies via the Policy Management interface.

NFV-MANO functional entity	NFV-MANO service	Managed object	ObjectName	Description
WIM	MSCS management	MSCS	MscsMo	The MSCS is managed via the MSCS Management Interface.
		MSCS Reservation	RsvMscsMo	The Reserved MSCS is managed via the MSCS Management interface.
		MSCS management subscriptions	MscsSubMo	The subscription for notifications related to MSCS and MSCS Reservation changes managed via the MSCS Management interface.
	(MSCS) Capacity management	Network Capacity Threshold	MscsCapThresholdMo	The Network Capacity threshold is associated to a Network, Topology, Node or Link, and is managed via the (MSCS) Capacity Management interface
		Capacity management subscriptions	MscsCapSubMo	The subscription for notifications related to capacity management managed via the (MSCS) Capacity Management interface.
	(MSCS) Performance management	PM job	MscsPmJobMo	The PM job is associated to an MSCS or an MSNC and is managed via the (MSCS) Performance Management interface.
		PM threshold	MscsPmThresholdMo	The PM threshold is associated to an MSCS or an MSNC and is managed via the (MSCS) Performance Management interface.
		PM Subscription	MscsPmSubMo	The subscription for notifications related to MSCS or MSNC performance monitoring managed via the (MSCS) Performance Management interface.
	(MSCS) Fault management	Alarm	MscsAlarmMo	The Alarm encapsulates information about an alarm associated to an MSCS and it can be retrieved via the (MSCS) Fault Management interface.
		FM Subscription	MscsFmSubMo	The subscription for notifications related to MSCS fault monitoring managed via the (MSCS) Fault Management interface.

8.3.2 Workflow types

The performance measurement definitions include the measurement group of "Workflow". The type of Workflow differs according to the NFV-MANO functional entity (either NFVO, VNFM or VIM), and the produced NFV-MANO services by the NFV-MANO functional entity.

Table 8.3.2-1 provides the types of workflows associated to the NFV-MANO services. Only NFV-MANO services with associated workflows relevant to performance measurements are represented in the table.

Table 8.3.2-1: Workflow types

NFV-MANO functional entity	NFV-MANO service	Workflow	WorkflowName	Description
NFVO	NS lifecycle management	NS LCM	NsLcmWf	The NS LCM workflow that is executed to handle a specific NS LCM task.
VNFM	VNF lifecycle management	VNF LCM	VnfLcmWf	The VNF LCM workflow that is executed to handle a specific VNF LCM task.

8.4 Generic performance measurements

8.4.1 Introduction

Clause 8.4 specifies the set of performance measurements generic to any kind of NFV-MANO functional entity.

In spite of being the set of measurements related to NFV-MANO service defined in a generic way, specific measurement names related to a concrete NFV-MANO service are applied following the definition of the measured object types (see clause 8.2) and the performance object types by the NFV-MANO service (see clause 8.3). The "description" and "measurement name" fields in the specified performance measurements indicate the cases where differentiating the type of managed object is applicable.

8.4.2 NFV-MANO functional entity resource measurements

8.4.2.1 Mean CPU utilization

a) **Description:** This measurement provides the mean CPU utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity takes the arithmetic mean of the CPU utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** ComputeResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** CpuUtilizationMean.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *TickInterval:* the period of timed interrupts the processor's execution context can be recorded.
- *ExecutionContext:* the set of processor states, including: user (us), system (sy), idle (id), and wait (wa); and processes states, including: in run queue (r), blocked (b), swapped (w). See Linux® man pages [i.11] for more information about the relevant execution context fields.

8.4.2.2 Peak CPU utilization

a) **Description:** This measurement provides the peak CPU utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity selects the maximum metric among the CPU utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** ComputeResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** CpuUtilizationPeak.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *TickInterval:* the period of timed interrupts the processor's execution context can be recorded.
- *ExecutionContext:* the set of processor states, including: user (us), system (sy), idle (id), and wait (wa); and processes states, including: in run queue (r), blocked (b), swapped (w). See Linux® man pages [i.11] for more information about the relevant execution context fields.

8.4.2.3 Mean memory utilization

a) **Description:** This measurement provides the mean memory utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity takes the arithmetic mean of the memory utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** ComputeResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** MemoryUtilizationMean.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *SystemRAM:* the system RAM of the measured memory resources.
- *SystemSwapSpace:* the system SWAP space of the measured memory resources.

8.4.2.4 Peak memory utilization

a) **Description:** This measurement provides the peak memory utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity selects the maximum metric among the memory utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** ComputeResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** MemoryUtilizationPeak.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *SystemRAM:* the system RAM of the measured memory resources.
- *SystemSwapSpace:* the system SWAP space of the measured memory resources.

8.4.2.5 Mean storage utilization

a) **Description:** This measurement provides the mean storage (disk) utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity takes the arithmetic mean of the storage (disk) utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** StorageResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** StorageUtilizationMean.

h) **Measurement Context:** None.

8.4.2.6 Peak storage utilization

a) **Description:** This measurement provides the peak storage (disk) utilization of the resources supporting the execution of the NFV-MANO functional entity.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity selects the maximum metric among the storage (disk) utilization metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value (Unit: %).

e) **Measurement Group:** StorageResource.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** StorageUtilizationPeak.

h) **Measurement Context:** None.

8.4.2.7 Number of incoming packets

a) **Description:** This measurement provides the number of packets received at the resource supporting the execution of the NFV-MANO functional entity. This measurement is split into sub-counters per network interface card.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of incoming packets for a network interface card of the ComputeResource. The NFV-MANO functional entity generates the measurement for the subject ManoEntity by assigning the value of the collected number of incoming packets measurement(s) to the sub-counters per network interface card.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** NetworkInterface.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** NetPacketIncoming.*NetItfId*, where *NetItfId* is equal to the identifier of the measured network interface card. The identifier of the network interface card is not specified in the present document.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *InterfaceBitrate:* the nominal frequency of the network interface card bit clock in bits per second.
- *InterfaceStatus:* the network interface card status when the last measurement was collected.

8.4.2.8 Number of outgoing packets

a) **Description:** This measurement provides the number of packets transmitted at the resource supporting the execution of the NFV-MANO functional entity. This measurement is split into sub-counters per network interface card.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of transmitted packets for a network interface card of the ComputeResource. The NFV-MANO functional entity generates the measurement for the subject ManoEntity by assigning the value of the collected number of transmitted packets measurement(s) to the sub-counters per network interface card.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** NetworkInterface.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** NetPacketOutgoing.*NetItfId*, where *NetItfId* is equal to the identifier of the measured network interface card. The identifier of the network interface card is not specified in the present document.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *InterfaceBitrate:* the nominal frequency of the network interface card bit clock in bits per second.
- *InterfaceStatus:* the network interface card status when the last measurement was collected.

8.4.2.9 Number of incoming bytes

a) **Description:** This measurement provides the number of bytes incoming at the resource supporting the execution of the NFV-MANO functional entity. This measurement is split into sub-counters per network interface card.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of incoming bytes for a network interface card of the ComputeResource. The NFV-MANO functional entity generates the measurement for the subject ManoEntity by assigning the value of the collected number of incoming bytes measurement(s) to the sub-counters per network interface card.

d) **Measurement Unit:** Each measurement an integer value.

e) **Measurement Group:** NetworkInterface.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** NetBytesIncoming.*NetItfId*, where *NetItfId* is equal to the identifier of the measured network interface card. The identifier of the network interface card is not specified in the present document.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *InterfaceBitrate:* the nominal frequency of the network interface card bit clock in bits per second.
- *InterfaceStatus:* the network interface card status when the last measurement was collected.

8.4.2.10 Number of outgoing bytes

a) **Description:** This measurement provides the number of bytes transmitted at the resource supporting the execution of the NFV-MANO functional entity. This measurement is split into sub-counters per network interface card.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of transmitted bytes for a network interface card of the ComputeResource. The NFV-MANO functional entity generates the measurement for the subject ManoEntity by assigning the value of the collected number of transmitted bytes measurement(s) to the sub-counters per network interface card.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** NetworkInterface.

f) **Measured Object Type:** ManoEntity.

g) **Measurement Name:** NetBytesOutgoing.*NetItfId*, where *NetItfId* is equal to the identifier of the measured network interface card. The identifier of the network interface card is not specified in the present document.

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.
- *InterfaceBitrate:* the nominal frequency of the network interface card bit clock in bits per second.
- *InterfaceStatus:* the network interface card status when the last measurement was collected.

8.4.3 NFV-MANO service measurements

8.4.3.1 Mean number of managed objects

a) **Description:** This measurement provides the mean number of managed objects of a specific NFV-MANO service. The type of managed object will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.1).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity takes the arithmetic mean of the number of managed objects from the ManoService metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value.

e) **Measurement Group:** ManagedObject.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** ManagedObjectNumMean.*ObjectName*, where the *ObjectName* is equal to the name of the managed object of the measured ManoService (refer to clause 8.3.1).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.2 Peak number of managed objects

a) **Description:** This measurement provides the peak number of managed objects of a specific NFV-MANO service. The type of managed object will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.1).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity selects the maximum value of the number of managed objects from the ManoService collected in the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** ManagedObject.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** ManagedObjectNumPeak.*ObjectName*, where the *ObjectName* is equal to the name of the managed object of the measured ManoService (refer to clause 8.3.1).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.3 Mean number of active lifecycle workflows

a) **Description:** This measurement provides the mean number of active lifecycle workflows under execution by a specific NFV-MANO service. An active lifecycle workflow is a workflow that has not reached a final state according to the state transition of the lifecycle management operation occurrence, i.e. not in completed, failed or rolled back state. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity takes the arithmetic mean among the number of active workflows from the ManoService metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is a real value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumMean.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.4 Peak number of active lifecycle workflows

a) **Description:** This measurement provides the peak number of active lifecycle workflows under execution by a specific NFV-MANO service. An active lifecycle workflow is a workflow that has not reached a final state according to the state transition of the lifecycle management operation occurrence, i.e. not in completed, failed or rolled back state. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity selects the maximum value of the number of active workflows from the ManoService metrics collected in the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumPeak.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.5 Number of active lifecycle workflows

a) **Description:** This measurement provides the number of active (not completed) lifecycle workflows by a specific NFV-MANO service. An active lifecycle workflow is a workflow that has not reached a final state according to the state transition of the lifecycle management operation occurrence, i.e. not in completed, failed or rolled back state. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that are still active (not completed) by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumActive.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.6 Number of completed lifecycle workflows

a) **Description:** This measurement provides the number of completed lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have been completed by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumCompleted.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.7 Number of failed lifecycle workflows

a) **Description:** This measurement provides the number of failed (and therefore not completed) lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have failed by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumFailed.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.8 Number of temporary failed lifecycle workflows

a) **Description:** This measurement provides the number of temporary failed lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have entered in the temporary failed state by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumTempFailed.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.9 Number of rolling back lifecycle workflows

a) **Description:** This measurement provides the number of rolling back lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have entered in the rolling back state by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumRollingBack.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.10 Number of rolled back lifecycle workflows

a) **Description:** This measurement provides the number of rolled back lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have rolled back by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumRolledBack.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.11 Number of starting lifecycle workflows

a) **Description:** This measurement provides the number of starting lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have entered in the starting state by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumStarting.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.3.12 Number of processing lifecycle workflows

a) **Description:** This measurement provides the number of processing lifecycle workflows by a specific NFV-MANO service. The type of workflow will differ depending on the NFV-MANO functional entity and the ManoService (refer to clause 8.3.2).

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of workflows that have entered in processing state by the ManoService at the end of the collection period.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** Workflow.

f) **Measured Object Type:** ManoService.

g) **Measurement Name:** WorkflowNumProcessing.*WorkflowName*, where the *WorkflowName* is equal to the name of the workflow of the measured ManoService (refer to clause 8.3.2).

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.4 NFV-MANO interface producer measurements

8.4.4.1 Number of total incoming messages on a producer interface

a) **Description:** This measurement provides the number of total incoming messages on an interface produced by the NFV-MANO functional entity. The measurement is split into sub-counters per message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of incoming messages by the ManoInterface in the collection period. Per message type counters are increment according to the incoming message type. The total number of incoming messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceProducer.

f) **Measured Object Type:** ManoInterfaceProducer.

g) **Measurement Name:** NumInMessageProducerIf.*MessageType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.4.2 Number of total outgoing messages on a producer interface

a) **Description:** This measurement provides the number of total outgoing messages on an interface produced by the NFV-MANO functional entity. The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of outgoing messages by the ManoInterface in the collection period. Per message type counters are increment according to the outgoing message type. The total number of outgoing message equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceProducer.

f) **Measured Object Type:** ManoInterfaceProducer.

g) **Measurement Name:** NumOutMessageProducerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.4.3 Number of success outgoing messages on a producer interface

a) **Description:** This measurement provides the number of success outgoing messages on an interface produced by the NFV-MANO functional entity. The success outgoing message corresponds to a message with an action requested by the consumer, which was received, understood and accepted (e.g. 2xx success types in HTTP), and as a result the producer transmits the corresponding success outgoing message. The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of success outgoing messages by the ManoInterface in the collection period. Per message type counters are increment according to the message type of the success outgoing message. The total number of success outgoing messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceProducer.

f) **Measured Object Type:** ManoInterfaceProducer.

g) **Measurement Name:** NumSuccessOutMessageProducerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.4.4 Number of consumer errored outgoing messages on a producer interface

a) **Description:** This measurement provides the number of consumer errored outgoing messages on an interface produced by the NFV-MANO functional entity. The consumer errored outgoing message correspond to a message with an action requested by the consumer, which had raised in the producer interface an error caused by the consumer message (e.g. 4xx client error types in HTTP), and as result the producer transmits the corresponding consumer errored outgoing message. The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of consumer errored outgoing messages by the ManoInterface in the collection period. Per message type counters are increment according to the message type of the consumer errored outgoing message. The total number of consumer errored outgoing messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceProducer.

f) **Measured Object Type:** ManoInterfaceProducer.

g) **Measurement Name:** NumConsumerErrorOutMessageProducerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.4.5 Number of producer errored outgoing messages on a producer interface

a) **Description:** This measurement provides the number of producer errored outgoing messages on an interface produced by the NFV-MANO functional entity. The producer errored outgoing message corresponds to a message with an action requested by the consumer for which the producer had failed to fulfil the request (e.g. 5xx server error types in HTTP), and as a result the producer transmits the corresponding producer errored outgoing message. The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of producer errored outgoing messages by the ManoInterface in the collection period. Per message type counters are increment according to the message type of the producer errored outgoing message. The total number of producer errored outgoing messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceProducer.

f) **Measured Object Type:** ManoInterfaceProducer.

g) **Measurement Name:** NumProducerErrorOutMessageProducerIf.*MessageType.SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval*: the duration of the observation by the measurement system to assess the metric.

8.4.5 NFV-MANO interface consumer measurements

8.4.5.1 Number of total incoming messages on a consumer interface

a) **Description:** This measurement provides the number of total incoming messages by the NFV-MANO functional entity on an interface that is consumed from another NFV-MANO functional entity. The measurement is split into sub-counters per message type, and further by sub-type as applicable.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of incoming messages by the ManoInterfaceConsumer in the collection period. Per message type counters are increment according to the incoming message type. The total number of incoming messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceConsumer.

f) **Measured Object Type:** ManoInterfaceConsumer.

g) **Measurement Name:** NumInMessageConsumerIf.*MessageType.SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.5.2 Number of total outgoing messages on a consumer interface

a) **Description:** This measurement provides the number of total outgoing messages generated by the NFV-MANO functional entity on an interface that is consumed from another NFV-MANO functional entity. The measurement is split into sub-counters per message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of outgoing messages by the ManoInterfaceConsumer in the collection period. Per message type counters are increment according to the outgoing message type. The total number of outgoing messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceConsumer.

f) **Measured Object Type:** ManoInterfaceConsumer.

g) **Measurement Name:** NumOutMessageConsumerIf.*MessageType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.5.3 Number of success incoming messages on a consumer interface

a) **Description:** This measurement provides the number of success incoming messages received by the NFV-MANO functional entity on an interface that is consumed from another NFV-MANO functional entity. The success incoming message corresponds to a message that confirms the acceptance of a previous request (e.g. 2xx success types in HTTP). The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of success incoming messages by the ManoInterfaceConsumer in the collection period. Per message type counters are incremented according to the message type of the success incoming message. The total number of success incoming messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceConsumer.

f) **Measured Object Type:** ManoInterfaceConsumer.

g) **Measurement Name:** NumSuccessInMessageConsumerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.5.4 Number of consumer errored incoming messages on a consumer interface

a) **Description:** This measurement provides the number of consumer errored incoming messages received by the NFV-MANO functional entity on an interface that is consumed from another NFV-MANO functional entity. The consumer errored incoming message corresponds to a message that confirms the producer of the interface had raised an error caused by the consumer message (e.g. 4xx client error types in HTTP). The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of consumer errored incoming messages by the ManoInterfaceConsumer in the collection period. Per message type counters are incremented according to the message type of the consumer errored incoming message. The total number of consumer errored incoming messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceConsumer.

f) **Measured Object Type:** ManoInterfaceConsumer.

g) **Measurement Name:** NumConsumerErrorInMessageConsumerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval:* the duration of the observation by the measurement system to assess the metric.

8.4.5.5 Number of producer errored incoming messages on a consumer interface

a) **Description:** This measurement provides the number of producer errored incoming messages received by the NFV-MANO functional entity on an interface that is consumed from another NFV-MANO functional entity. The producer errored incoming message corresponds to a message that confirms the producer of the interface had failed to fulfil the request from the consumer message (e.g. 5xx client error types in HTTP). The measurement is split into sub-counters per message type, and further by sub-type as required by the message type.

b) **Collection Method:** SC.

c) **Trigger:** The NFV-MANO functional entity counts the number of producer errored incoming messages by the ManoInterfaceConsumer in the collection period. Per message type counters are incremented according to the message type of the producer errored incoming message. The total number of producer errored incoming messages equals the sum of all per message type measurements.

d) **Measurement Unit:** Each measurement is an integer value.

e) **Measurement Group:** InterfaceConsumer.

f) **Measured Object Type:** ManoInterfaceConsumer.

g) **Measurement Name:** NumProducerErrorInMessageConsumerIf.*MessageType*.*SubType*, where the *MessageType* identifies the message type by its specified name. The total number of messages value is identified by the *MessageType* = "Sum". When providing the measurement of a Notify message that delivers different types of notifications, the *SubType* identifies the specific notification type, e.g. VnfLcmOperationOccurrenceNotification. In this case, the total number of sub-type messages value is identified by the *SubType* = "Sum".

h) **Measurement Context:**

- *MeasurementInterval*: the duration of the observation by the measurement system to assess the metric.

8.5 Specific performance measurements

None.

9 Security Consideration

9.1 Introduction

The management of NFV-MANO introduces functionality beyond the scope of NFV-MANO services and interfaces, and provides the capability for an external entity (e.g. as part of the OSS and controlled by the network operator), or another NFV-MANO functional entity to perform operations, administration and maintenance of the managed NFV-MANO functional entity. Therefore, the capability, with its individual functionalities (refer to requirements in clause 5), allows controlling, configuring and changing the behaviour and capabilities of the managed NFV-MANO functional entity. Changing the behaviour and capabilities of the NFV-MANO functional entity can impact the deployment and use of Network Services, VNF instances and virtualised resources. Because of this, it is crucial that security considerations are defined.

9.2 Security assessment

Annex D provides a summary of the threat, risk and vulnerability analysis as well as additional considerations according to the scope of the present document.

9.3 Security requirements

Table 9.3-1 lists the set of applicable requirements related to security in the realization of the NFV-MANO management system.

Table 9.3-1: NFV-MANO management security requirements

Identifier	Requirement
Nfvmano.oam.sec.001	The NFV-MANO management system shall apply the requirements for access controls and communications security (see clauses 8.5 and 8.6 in ETSI GS NFV-SEC 012 [3]).
Nfvmano.oam.sec.002	The NFV-MANO management system shall apply the requirements for authentication control (see clause 8.4 in ETSI GS NFV-SEC 012 [3]).
Nfvmano.oam.sec.003	The NFV-MANO management system shall support, according to the access and authentication control requirements, the use of policies for access control to the NFV-MANO management interfaces, based on the network operator deployment needs.
Nfvmano.oam.sec.004	The NFV-MANO management system shall ensure that data provenance is logged.
Nfvmano.oam.sec.005	The NFV-MANO management system shall ensure that collected data is authentic. See note.
Nfvmano.oam.sec.006	The NFV-MANO management system shall provide means to detect and mitigate denial of service attacks.
Nfvmano.oam.sec.007	The NFV-MANO management system shall ensure secure logging as described in clause 8.1 in ETSI GS NFV-SEC 012 [3].
NOTE: Collected data includes information on fault, performance, logs, timestamps, etc.	

Annex A (informative): NFV-MANO functional entity management aspects

A.1 Introduction

The present annex introduces diverse aspects related to the management of NFV-MANO functional entities.

A.2 State management aspects

A.2.1 NFV-MANO functional entity state model

A.2.1.1 Overview

The interface "NFV-MANO configuration and information management" allows a consumer to request changing the state of the NFV-MANO functional entity application or provided NFV-MANO service interfaces, i.e. the "managed objects".

For illustrative purposes and related to the state management capabilities supported by the "NFV-MANO configuration and information management" interface, following is a description of possible states in which a managed object can be and the operations used to change among the different states, when applicable. The support of all states/operations or a subset of them may depend on the actual NFV-MANO functional entity and its provided NFV-MANO service interfaces.

NOTE: Specification details and list of specific stable and transition states are part of the protocol design.

A.2.1.2 States

The list of states are:

- STARTED_UNLOCKED: the managed object is operational and is not administratively prohibited from use.
- SHUTDOWN_UNLOCKED: the managed object is not operational and is not administratively prohibited from use.
- STARTED_LOCKED: the managed object is operational but it is administratively prohibited from use.
- SHUTDOWN_LOCKED: the managed object is not operational and is administratively prohibited from use.
- SHUTTING-DOWN: the managed object is in the transition to shut down in order to become not operational. The state transition finishes when the managed object is "discharged" from service, i.e. not handling active sessions.
- RESTARTING_UNLOCKED: the managed object is in the transition to shut down and start again in order to become operational. The state transition finishes when the managed object is discharged from service and has started.
- RESTARTING_LOCKED: the managed object is in the transition to shut down and start again in order to become operational. The state transition finishes when the managed object has started.
- LOCKING: the managed object is in the transition to become administratively prohibited from use.

A.2.1.3 State management operations

The list of operations are:

- LOCK: to lock the managed object in order to stop accepting new requests and release it from performing its service. This state corresponds to the meaning as defined in Recommendation ITU-T X.731 [i.10].
- UNLOCK: to unlock the managed object in order to permit accepting requests and performing its service. This state corresponds to the meaning as defined in Recommendation ITU-T X.731 [i.10].
- START: to start the managed object and change its state to started.
- STOP: to stop the managed object and change its state to shut down. The stop can be done gracefully or forcefully depending on possible input parametrization.
- RESTART: to stop and start again the management object. End state of the managed object is started/enabled.

EXAMPLE: The lock state change can be used to set the managed object "under maintenance". The unlock state change can be used to set the managed object "under normal operation".

A.2.1.4 State diagram

Figure A.2.1.4-1 illustrates the state diagram of the NFV-MANO functional entity application and/or its NFV-MANO service interface(s) according to the list of states and operations described in clauses A.2.1.2 and A.2.1.3.

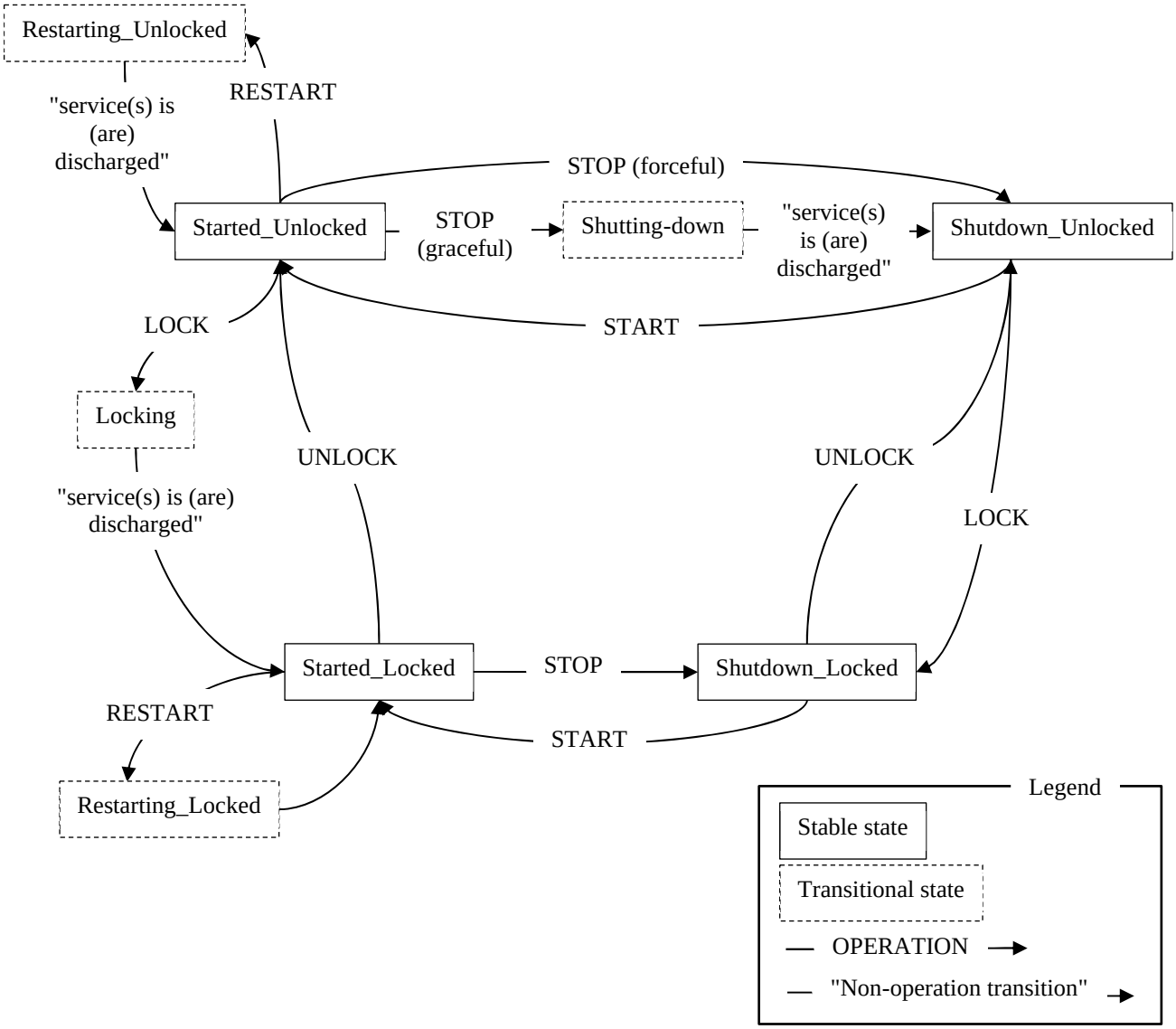

Figure A.2.1.4-1: State diagram of the NFV-MANO functional entity application and/or its NFV-MANO service interface(s)

Annex B (informative): Information flows

B.1 Introduction

The present annex introduces information flows that illustrate the use of the interfaces and information elements specified in the present document.

B.2 Configuration management

B.2.1 Configuration of the NFV-MANO peering and API learning

The configuration of the NFV-MANO functional entity peering and NFV-MANO service API learning can be performed via two sub-procedures:

1) Automatic configuration of the API endpoints using the API discovery endpoint.

2) Explicit configuration of the API endpoints performed by an external MANO monitoring entity (MANO Monitor) or the network operator.

Figure B.2.1-1 illustrates the steps of the two sub-procedures. In both procedures, it is assumed that the MANO Monitor knows about the existence of the involved NFV-MANO functional entities and it has management access to them. The example illustrated in the flows involves an NFVO and a VNFM. In this case, the NFVO needs to learn about the NFV-MANO service interface APIs produced by the VNFM.

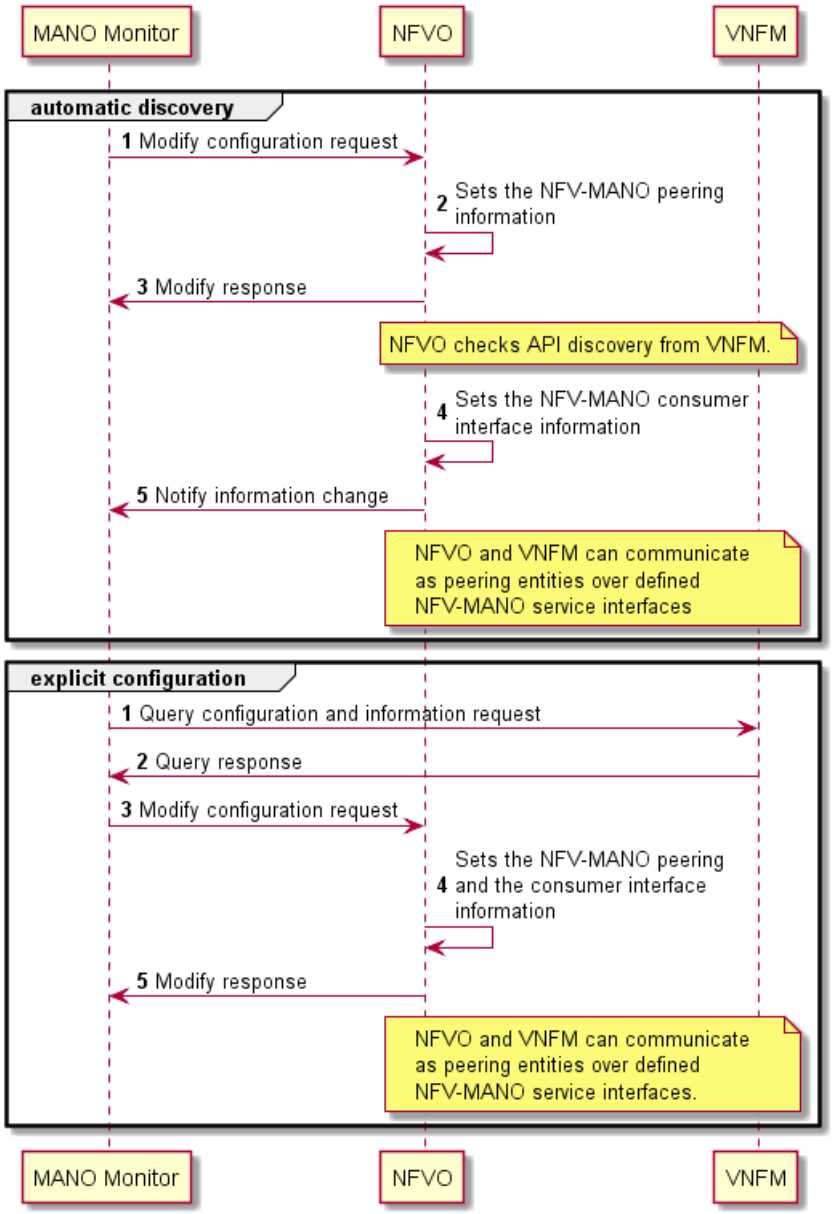

Figure B.2.1-1: Example information flows of NFV-MANO service interface API configuration

The information flow comprises the following steps.

For the "automatic discovery" case:

1) The MANO Monitor sends a "Modify configuration request" to the NFVO (see clause 6.2.2) which contains the information to establish the VNFM as a peering entity to the NFVO. The information includes: the type of peering NFV-MANO functional entity, i.e. a VNFM, the identifier of the VNFM, and the information to access the API discovery endpoint.

2) The NFVO sets the configuration according to the request.

3) The NFVO sends to the MANO Monitor a response (see clause 6.2.2) about the successful modification of the configuration.

   Once the NFVO knows about the API discovery endpoint of the VNFM, the NFVO can query to the VNFM through such API discovery service.

4) With the information acquired via the API discovery service, the NFVO sets the information of the NFV-MANO services interfaces that can be consumed from the VNFM.

5) If the MANO Monitor is subscribed to receive notifications about changes of configuration/information, the NFVO sends a notification to the MANO Monitor informing about the configuration/information data changes (refer to clauses 6.2.6 and 7.2.2).

From this point onwards, the NFVO and VNFM can interact as peering entities through the defined NFV-MANO service interfaces.

NOTE 1: Notifications about changes of configuration/information can also be sent as a result of the configuration modification done in the step 2).

For the "explicit configuration" case:

1) The MANO monitor queries to the VNFM the configuration and information about the NFV-MANO functional entity and the produced NFV-MANO service interfaces (see clause 6.2.3).

2) The VNFM processes the request and provides a successful query response with the information requested (see clause 6.2.3).

3) The MANO monitor sends a "Modify configuration request" to the NFVO (see clause 6.2.2) which contains the information to establish the VNFM as a peering entity to the NFVO. The information includes: the type of peering NFV-MANO functional entity, i.e. a VNFM, the identifier of the VNFM, and the information of the NFV-MANO service interfaces that can be consumed from the VNFM.

4) With the information acquired, the NFVO sets the information of the NFV-MANO services interfaces that can be consumed from the VNFM.

5) The NFVO provides a response to the MANO Monitor (see clause 6.2.2) about the successful modification of the configuration.

From this point onwards, the NFVO and VNFM can interact as peering entities through the defined NFV-MANO service interfaces.

NOTE 2: Notifications about changes of configuration/information can also be sent as a result of the configuration modification done in the step 4).

Annex C (informative): Performance measurement definition template

C.1 Introduction

The present annex introduces the template used to define the performance measurements.

C.2 Template

a) **Description:** This clause contains the description of the performance measurement.

b) **Collection Method:** This clause contains the method in which this measurement is obtained.

Status Counter (SC): The entity receives or collects a metric at each predetermined interval. A measurement is generated from processing (e.g. arithmetic mean, peak) all of the samples received or collected in the collection period.

Transparent Forwarding (TF): The entity maintains a measurement count that stores the content of the metric that it received.

Object Mapping (OM): The entity receives a metric for measured object A in the collection period and maps the received metric from measured object A to measured object B. A measurement is generated for measured object B by processing the metric(s), which may be mapped from one or more measured object(s) A to a single measured object B. It is noted that:

- The source metric for measured object A and the target measurement for measured object B may or may not contain subcounters. How the mapping is done for the case that either of the source metric and target measurement contain subcounters is to be defined case by case in the trigger of the measurement definition.
- Multiple source metrics for measured object A may be mapped to a single target measurement for measured object B. How the mapping is done for this case is to be defined in the trigger of the measurement definition.

c) **Trigger:** This clause contains the trigger which causes the counter to be updated.

d) **Measurement Unit:** This clause contains the unit of the measurement value.

e) **Measurement Group:** This clause contains the group to which a measurement belongs.

f) **Measured Object Type:** This clause describes the object of a measurement. See clause 8.2 for the measured object types defined for the performance measurements specified in the present document.

g) **Measurement Name:** This clause describes the name of a measurement.

The measurement name is used to identify a measurement. In case the sub-counter is used, the measurement is identified by <measurement type>.<sub-counter name>.

The measurement name is used to identify the performanceMetric in the performance report entry (see clause 7.3.7).

In the create PM Job operation, the measurement type is the content of performanceMetric to identify the type of measurement(s) to be collected (see clause 6.3.2.2). The PM Job is applicable to the sub-counters, if the measurement contains sub-counters.

h) **Measurement Context:** This clause describes the context information of a measurement at the time that the measurement is generated.

The measurement context is only provided in case the measurement producer has knowledge about the context information.

Each measurement may have its specific context, so the detailed measurement context is to be defined in each measurement definition.

Annex D (informative): Security assessment

D.1 Introduction

The present annex provides the security assessment related to the scope of the present document.

D.2 Risk analysis and assessment

Annex A of ETSI GR NFV-IFA 021 [i.1] provides an initial risk analysis and assessment of the NFV-MANO management. A summary of the threat, risk and vulnerability analysis is introduced in the present clause, as well as additional considerations according to the scope of the present document (see clause 1).

Table D.2-1: Threat, Risk, Vulnerability Analysis (from the template defined in annex A of ETSI GS NFV-SEC 006 [i.14])

A Security Environment		
a.1 Assumptions		
a.1.1	A set of management networks providing connectivity for management purposes among the NFV-MANO functional entities and other OSS external entities responsible for managing NFV-MANO.	See clause 4.2.
a.1.2	Internal attackers have access to the management network.	See a.1.1 in table 1 of ETSI GS NFV-SEC 014 [i.15].
a.1.3	Internal attackers are attached to the management network.	See a.1.7 in table 1 of ETSI GS NFV-SEC 014 [i.15].
a.1.4	Internal attackers have access to the NFV-MANO functional entities.	Specialized from a.1.3, and a.1.5 in table 1 of ETSI GS NFV-SEC 014 [i.15].
a.1.5	The NFV-MANO functional entity application is implemented as software.	See clause 4.3. Specialized from a.1.2 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1].
a.1.6	The NFV-MANO functional entity may be implemented as a virtualised entity.	Specialized from a.1.11 in table 1 of ETSI GS NFV-SEC 014 [i.15].
a.2 Assets		
a.2.1	NFV-MANO functional entities: these are the NFVO, VNFM and VIM. These assets offer interfaces for consuming NFV-MANO services as well as are responsible for storing relevant NFV-MANO information and artefacts (e.g. VNF Packages, NSD, VNFD, images, etc.).	See clause 4.1. Specialized from a.2.1, a.2.2, a.2.3 and a.2.4 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1].
a.2.2	External entity consuming interfaces for management of an NFV-MANO functional entity.	See clause 4.2.2. Specialized from a.2.5 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1].
a.2.3	Internal NFV-MANO functional entity consuming interfaces for management of a peering NFV-MANO functional entity.	See clause 4.2.3.
a.2.4	The credentials of authorized administrators with legitimate access to the NFV-MANO functional entities.	Specialized from a.2.2 in table 1 of ETSI GS NFV-SEC 014 [i.15].
a.2.5	NFV-MANO management interfaces: for fault, performance, configuration and information, state, log, and communication supervision management types of functionality.	Specialized from a.2.6 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1]. See clauses 5 and 6.
a.2.6	Fault alarm: fault information reported to a consumer including information to identify the object on which the fault occurred, the type of fault that was identified, the cause of the fault, the timestamp information about when the event causing the fault was observed, as well as timing information about the alarm that is raised.	See clause 7.5.4. From a.2.8 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1].
a.2.7	Performance metrics: performance measurements that need to be reported/acquired.	See clause 8. From a.2.9 in table A.1-1 of ETSI GR NFV-IFA 021 [i.1].

A Security Environment		
a.2	Assets	
a.2.8	Log report: contains the requested information logged by the NFV-MANO functional entity. Logs can be of two main types: messaging logs, and provider-specific logs.	See clauses 6.6.1 and 7.6.2.
a.3	Threat agents	
a.3.1	Unauthorized user of assets.	
a.3.1.1	Agent can be human, e.g. an administrator with access to the assets.	
a.3.1.2	Agent can be a piece of software, e.g. a malicious computer program installed during an earlier access and programmed to run later.	
a.3.2	(Industrial) espionage agent.	
a.3.3	Sabotage agent.	
a.3.4	Internal threat agent, e.g. corrupt employee.	
a.4	Threats	
a.4.1	Unauthorized read (viewing/copying/consuming of data and interfaces).	Refer to threat agents a.3.1, a.3.2 and a.3.4. Refer to all assets in a.2.
a.4.2	Unauthorized write action (Masquerade ("spoofing"), forgery, loss or corruption of information).	Refer to threat agents a.3.3 and a.3.4. Refer to all assets in a.2.
a.4.3	Unauthorized access.	Refer to thread agents a.3.1, a.3.2, a.3.3. Refer to all assets in a.2.
a.4.4	Repudiation (endpoint and threat agents).	Refer to threat agent a.3.4. Refer to assets a.2.5 to a.2.8.
a.4.5	Denial of service.	Refer to threat agents a.3.3 and a.3.4. Refer to assets a.2.1 to a.2.3, and a.2.5.
B Security Objectives		
b.1	Security objectives for the assets.	
b.1.1	The system should ensure that only authorized and authenticated entities can access (read or write) the provided interfaces and that data is exchanged in a confidential manner. Therefore, requirements for access controls and communications security (see clauses 8.5 and 8.6 in ETSI GS NFV-SEC 012 [3]) should be followed.	
b.1.2	The system should ensure the authenticity and integrity of all data exchanged on the interfaces. Therefore, requirements for authentications controls (see clause 8.4 in ETSI GS NFV-SEC 012 [3]) should be followed.	
b.1.3	The system should prevent replay of any data. Therefore, requirements for authentications controls (see clause 8.4 in ETSI GS NFV-SEC 012 [3]) should be followed.	
b.1.4	The system should be accountable for the data provided, that is why the system should ensure collected data (e.g. fault, performance, log data, timestamps) is authentic.	
b.1.5	The system should provide means to detect and mitigate denial of service attacks.	
b.1.6	The system should ensure secure logging as described in clause 8.1 in ETSI GS NFV-SEC 012 [3].	

Annex E (informative): Change History

Date	Version	Information about changes
January 2018	0.0.1	Skeleton.
February 2018	0.1.0	Implemented NFVIFA(17)0001068, NFVIFA(17)0001069, NFVIFA(18)0000015r4, NFVIFA(18)0000046, NFVIFA(18)0000047r1.
March 2018	0.2.0	Implemented NFVIFA(18)0000085, NFVIFA(18)0000086r3.
May 2018	0.3.0	Implemented NFVIFA(18)000215r2, NFVIFA(18)000225r2, NFVIFA(18)000226r1, NFVIFA(18)000227r1, NFVIFA(18)000292, NFVIFA(18)000293, NFVIFA(18)000219r3, NFVIFA(18)000294r3, NFVIFA(18)000295r3.
May 2018	0.4.0 (Stable Draft)	Implemented: NFVIFA(18)000350r1, NFVIFA(18)000351, NFVIFA(18)000405, NFVIFA(18)000406r1. NFVIFA(18)000434, NFVIFA(18)000436, NFVIFA(18)000437r1, NFVIFA(18)000438r1, NFVIFA(18)000449 .
June 2018	0.5.0	Implemented: NFVIFA(18)000498, NFVIFA(18)000499, NFVIFA(18)000500, NFVIFA(18)000501, NFVIFA(18)000502, NFVIFA(18)000528r3, NFVIFA(18)000543r2, NFVIFA(18)000544, NFVIFA(18)000545r2, NFVIFA(18)000572, NFVIFA(18)000573, NFVIFA(18)000574, NFVIFA(18)000575, NFVIFA(18)000578r1, NFVIFA(18)000623.
July 2018	0.6.0	Implemented: NFVIFA(18)000677, NFVIFA(18)000678, NFVIFA(18)000679, NFVIFA(18)000680, NFVIFA(18)000681r1, NFVIFA(18)000682.
July 2018	0.7.0	Implemented: NFVIFA(18)000538r2.
July 2018	0.7.1 (Final Draft for Approval)	No changes introduced with respect to 0.7.0, only upgrade for "Final Draft for Approval".
October 2018	3.1.2	Starting version for 2H2018 specification work. Unmodified with respect to published version 3.1.1.
November 2018	3.1.3	Implemented: NFVIFA(18)000891r2, NFVIFA(18)000892r2, NFVIFA(18)000940r2, NFVIFA(18)000942.
May 2019	3.2.2	Starting version for 1H2019 specification work. Unmodified with respect to published version 3.2.1.
July 2019	3.2.3	Implemented: NFVIFA(19)000509r1, NFVIFA(18)000941.
October 2019	3.3.2	Starting version for 2H2019 specification work. Unmodified with respect to published version 3.3.1.
October 2019	3.3.3	Implemented: NFVIFA(19)000805r1, NFVIFA(19)000766.
February 2020	3.3.4	Implemented: NFVIFA(19)000890, NFVIFA(19)000833, NFVIFA(19)000911, NFVIFA(19)000998. Rapporteur action to delete Annex E “authors & contributors” according to a Secretariat decision in OCG(19)069_059.
March 2020	3.3.5	Implemented: NFVIFA(20)000160r3.
March 2021	3.4.2	Implemented contributions approved at IFA#226 and IFA#227: • NFVIFA(21)000077: IFA031ed351 Release alignments with FEAT10 multi-site connectivity. • NFVIFA(21)000098r1: IFA031ed351 Release alignments with FEAT15 VNF snapshotting. • NFVIFA(21)000122r1: IFA031ed351 Inter-stages maintenance with SOL009 ed3.3.1. • NFVIFA(21)000123: IFA031ed351 Further alignments with Rel. 3 features.
March 2021	3.4.3	Implemented contributions approved at IFA#230: • NFVIFA(21)000172: IFA031ed351 Adding software image and signature verification support in VimSpecificInfo. • NFVIFA(21)000185: IFA031ed351 Correction to CR in 122r1.
July 2021	3.5.2	Starting version for 2H2021 specification work. Unmodified with respect to published version v3.5.1.

History

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