



GROUP SPECIFICATION

## **Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Management data analytics Service Interface and Information Model Specification**

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**ETSI**

650 Route des Lucioles  
F-06921 Sophia Antipolis Cedex - FRANCE

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Tel.: +33 4 92 94 42 00 Fax: +33 4 93 65 47 16

Siret N° 348 623 562 00017 - APE 7112B  
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## Foreword

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

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## 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 service requirements for the Management Data Analytics Function (MDAF) in NFV-MANO domain, which is also abbreviated as NFV-MDAF. It also specifies corresponding service interfaces produced by the NFV-MDAF, as well as the information elements exposed by the service interface operations.

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## 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 in the [ETSI docbox](#).

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 5; Management and Orchestration; Functional requirements specification".

### 2.2 Informative references

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The following referenced documents may be useful in implementing an ETSI deliverable or add to the reader's understanding, but are not required for conformance to the present document.

- [i.1] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".
- [i.2] ETSI GR NFV-IFA 041: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on Enabling Autonomous Management in NFV-MANO".
- [i.3] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".
- [i.4] ETSI GS NFV-IFA 027: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Performance Measurements Specification".
- [i.5] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Or-vnfm reference point - Interface and Information Model Specification".

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## 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.1] and the following apply:

**Management Data Analytics Function (MDAF):** function that processes and analyses management data to provide analytics outputs

NOTE 1: The MDAF can exploit Artificial Intelligence (AI) and/or Machine Learning (ML) models in its analytics process.

NOTE 2: The analytics outputs can enable next step actions for network operations and maintenance.

NOTE 3: To distinguish the similar terminology from other standard organizations, e.g. the MDA services (MDAS) or MDA function (MDAF) in network management domain as specified by 3GPP, the MDAF functionality in NFV-MANO is notated as Network Functions Virtualisation Management Data Analytics Function, which is abbreviated as NFV-MDAF.

### 3.2 Symbols

Void.

### 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.1] and the following apply:

AI	Artificial Intelligence
MDA	Management Data Analytics
NFV-MDAF	Network Functions Virtualisation Management Data Analytics Function
ML	Machine Learning

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## 4 Overview

### 4.1 Introduction

ETSI GR NFV-IFA 041 [i.2] studies various aspects of management data analytics in the context of NFV and describes the functionality related to the management data analytics. Such functionality is composed into the following NFV-MANO function:

- Network Functions Virtualisation Management Data Analytics Function (NFV-MDAF)

The NFV-MDAF is responsible for processing and analysing management data in NFV-MANO domain to provide analytics outputs upon requests from a consumer. Within the NFV-MDAF, AI/ML models may be used for handling data analytics process, by transforming the input data to the NFV-MDAF to actionable recommendations and intelligent analytics output corresponding to an analytics subject. The functional requirements for the NFV-MDAF specified in ETSI GS NFV-IFA 010 [1] shall apply.

The present document specifies the requirements on the services to be provided by the NFV-MDAF, and on the associated management service interfaces exposed to NFV-MANO functional blocks (i.e. the NFVO) and/or other OSS entities external to NFV-MANO.

## 4.2 MDA services

The NFV-MDAF offers one or multiple MDA services, which are exposed by corresponding data analytics service interface named MDA-1. ML model training services may be offered by the NFV-MDAF but these are not specified in the present document version.

Figure 4.2-1 illustrates the MDA-1 interface exposed by the MDA Producer to offer its MDA services to the MDA Consumer. The NFV-MDAF acts as the MDA Producer, and the MDA Consumer can be either the NFVO or other OSS entities external to NFV-MANO.

In the context of the present document, MDA services are exposed through northbound management interfaces produced by the NFV-MDAF, which is capable to handle the management data analytics request for the NFV-MANO management domain.

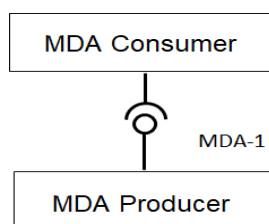


Figure 4.2-1: Interface model of MDA services

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## 5 NFV-MDAF service requirements

### 5.1 Introduction

Clause 5 of the present document specifies the set of requirements applicable to interfaces exposing MDA services offered by the NFV-MDAF.

### 5.2 General MDA service requirements

Table 5.2-1 specifies requirements applicable to the services provided by the NFV-MDAF.

Table 5.2-1: MDA service requirements

Identifier	Requirement
MdaSvc.001	The NFV-MDAF shall provide a data analytics service in NFV-MANO domain.

### 5.3 Data analytics service interface requirements

Table 5.3-1 specifies the requirements applicable to the interface of the data analytics service produced by the NFV-MDAF.

Table 5.3-1: Data analytics service interface requirements

Identifier	Requirement
DaMgt.001	The data analytics service interface produced by the NFV-MDAF shall support data analytics operations on a certain type.
DaMgt.002	The data analytics service interface produced by the NFV-MDAF shall support providing notifications about events related to data analytics processing to the MDA Consumer.
DaMgt.003	The data analytics service interface produced by the NFV-MDAF shall support managing subscriptions to notifications about events related to data analytics processing.
DaMgt.004	The data analytics service interface produced by the NFV-MDAF shall support querying and retrieving data analytics outputs.

## 6 NFV-MDAF service interfaces

### 6.1 Introduction

Clause 6 of the present document defines the service interfaces exposed by the NFV-MDAF towards the MDA Consumer.

**NOTE:** The fact that information elements and attributes are presented in tabular form does not preclude protocol designs in which these information elements and attributes are encoded in different parts of request and response messages. For example, in a RESTful interface, parts of them can be encoded in the URL, in the message header, in the message body or any combination thereof.

### 6.2 Data analytics service interface (MDA-1)

#### 6.2.1 Description

This interface allows the MDA Consumer to invoke data analytics operations towards the NFV-MDAF. This interface is named MDA-1, as described in clause 4.2.

#### 6.2.2 Data analytics operation

##### 6.2.2.1 Description

This operation initiates a data analytics process on a certain type of analytics. Table 6.2.2.1-1 lists the information flow exchanged between the MDA Consumer and the NFV-MDAF.

**Table 6.2.2.1-1: Data analytics operation**

Message	Requirement	Direction
DataAnalyticsRequest	Mandatory	MDA Consumer → NFV-MDAF
DataAnalyticsResponse	Mandatory	NFV-MDAF → MDA 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: Data analytics operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
mDAType	M	1	String	The type of a data analytics process. Examples of types of data analytics include "Network service alarm incident analysis", "Network service health analysis", "Network service resource utilization analysis", "Network service orchestration efficiency analysis", "Network service performance analysis", "Network service energy efficiency analysis", etc.
controlAttributes	M	1	ControlAttributes	Control attributes associated to a data analytics process, to guide the output of the data analytics process.

**NOTE:** The type of a data analytics process indicates the subject (e.g. NS alarm incident) to be analysed. Machine-processable values of strings are left up to protocol design stage to be determined.

### 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: Data analytics operation output parameters**

Parameter	Qualifier	Cardinality	Content	Description
analyticsId	M	1	Identifier	The identifier generated by the NFV-MDAF used to identify the data analytics process and the associated data analytics output. This identifier is later used in the associated notification informing about the data analytics process.

### 6.2.2.4 Operation results

In case of success, a data analytics process has been initiated in the NFV-MDAF. If the control attributes cannot fit in with the type of the data analytics, the operation shall be rejected.

In case of failure, appropriate error information is returned.

## 6.2.3 Notify operation

### 6.2.3.1 Description

This operation notifies a subscriber about events related to data analytics changes, e.g. the start or result of a data analytics process (asynchronous operation).

This operation distributes notifications to subscribers. It is a one-way operation issued by the producer (NFV-MDAF) that cannot be invoked as an operation by the consumer (MDA Consumer). In order to receive notifications, the consumer (MDA Consumer) shall perform an explicit Subscribe operation beforehand.

Table 6.2.3.1-1 lists the information flow exchanged between the NFV-MDAF and the MDA Consumer.

**Table 6.2.3.1-1: Notify operation**

Message	Requirement	Direction
Notify	Mandatory	NFV-MDAF → MDA Consumer

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

- DataAnalyticsChangeNotification (see clause 7.2.2).

## 6.2.4 Subscribe operation

### 6.2.4.1 Description

This operation enables the MDA Consumer to subscribe with a filter for the notifications sent by the NFV-MDAF which are related to data analytics changes.

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-MDAF and the MDA Consumer.

**Table 6.2.4.1-1: Subscribe operation**

Message	Requirement	Direction
SubscribeRequest	Mandatory	MDA Consumer → NFV-MDAF
SubscribeResponse	Mandatory	NFV-MDAF → MDA 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 data analytics change notifications to subscribe to. This filter can contain identifiers of the NFV-MANO object instances (e.g. NS instances), MDA types of interest, certain types of data analytics change information related to specified NFV-MANO object instances or MDA types and their corresponding information elements. See note.
NOTE: An example of the filter is to select data analytics change notifications related to analyticsOutput information of an NS instance, including its typeSpecificOutput attributes of healthStatus, performanceStatistics, unhealthyObjects and unhealthCause from NS health analysis.				

### 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 realized.

### 6.2.4.4 Operation results

After successful subscription, the consumer (MDA Consumer) is registered to receive notifications related to data analytics changes.

The result of the operation shall indicate if the subscription has been successful or not with a standard success/error result. 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 Description

This operation enables the MDA Consumer to terminate a particular subscription.

Table 6.2.5.1-1 lists the information flow exchanged between the MDA Consumer and the NFV-MDAF.

**Table 6.2.5.1-1: Terminate Subscription operation**

Message	Requirement	Direction
TerminateSubscriptionRequest	Mandatory	MDA Consumer → NFV-MDAF
TerminateSubscriptionResponse	Mandatory	NFV-MDAF → MDA 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

After successful termination of a subscription, the identified subscription does not exist anymore, and the MDA 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.

## 6.2.6 Query Subscription Info operation

### 6.2.6.1 Description

This operation enables the MDA Consumer to query information about subscriptions.

Table 6.2.6.1-1 lists the information flow exchanged between the MDA Consumer and the NFV-MDAF.

**Table 6.2.6.1-1: Query Subscription operation**

Message	Requirement	Direction
QuerySubscriptionInfoRequest	Mandatory	MDA Consumer → NFV-MDAF
QuerySubscriptionInfoResponse	Mandatory	NFV-MDAF → MDA Consumer

### 6.2.6.2 Input parameters

The input parameters sent when invoking the operation shall follow the indications provided in table 6.2.6.2-1.

**Table 6.2.6.2-1: 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. Details are part of the protocol design.

### 6.2.6.3 Output parameters

The output parameters returned by the operation shall follow the indications provided in table 6.2.6.3-1.

**Table 6.2.6.3-1: 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.

### 6.2.6.4 Operation results

After successful operation, the NFV-MDAF 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 data analytics change that the MDA Consumer has access to and that are matching the filter shall be returned.

## 6.2.7 Query data analytics output operation

### 6.2.7.1 Description

This operation enables the MDA Consumer to query the NFV-MDAF information about data analytics outputs. The applicable data analytics outputs can be chosen based on filtering criteria, and the information can be restricted to selected attributes.

Table 6.2.7.1-1 lists the information flow exchanged between the MDA Consumer and the NFV-MDAF.

**Table 6.2.7.1-1: Query data analytics output operation**

Message	Requirement	Direction
QueryDataAnalyticsOutputRequest	Mandatory	MDA Consumer → NFV-MDAF
QueryDataAnalyticsOutputResponse	Mandatory	NFV-MDAF → MDA 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 data analytics output operation input parameters**

Parameter	Qualifier	Cardinality	Content	Description
filter	M	1	Filter	Filter to select the data analytics outputs about which information is queried.
attributeSelector	M	0..N	String	Provides a list of attribute names. If present, only these attributes are returned for the data analytics output(s) matching the filter. If absent, the complete information is returned for the data analytics output(s) matching the filter.

### 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 data analytics output operation output parameters**

Parameter	Qualifier	Cardinality	Content	Description
analyticsOutput	M	0..N	AnalyticsOutput	The information items about the selected data analytics outputs that are returned. If attributeSelector is present, only the attributes listed in the attributeSelector are returned for the selected data analytics output(s). See note.
NOTE: The lower cardinality is "0" since there can be no matches to the provided filter.				

### 6.2.7.4 Operation results

In case of success, information related to the data analytics outputs that match the filter is returned. In case of failure, appropriate error information is returned.

## 7 Information elements

### 7.1 Information elements related to data analytics

#### 7.1.1 Introduction

This clause defines information elements related to data analytics.

#### 7.1.2 ControlAttributes information element

##### 7.1.2.1 Description

The ControlAttributes information element provides control information for the data analytics output.

NOTE: The present document version does not specify the support to control when or the periodicity at which the NFV-MDAF will provide the data analytics output.

##### 7.1.2.2 Attributes

The ControlAttributes information element shall follow the indications provided in table 7.1.2.2-1.

**Table 7.1.2.2-1: Attributes of the ControlAttributes information element**

Attribute	Qualifier	Cardinality	Content	Description
analyticsCollectionInterval	M	1	Not specified	Specifies the time interval of management data to be used in the data analytics process. For instance, it enables the consumer to indicate that the processing of the data analytics output is requested to consider analytics data generated in a given interval of time, e.g. the last 24 hours. See note 3.
locationAreald	M	0..N	Identifier	Indicates location areas from which available management data is to be involved in the data analytics process. See note 1 and note 2.
objectInstanceid	M	0..N	Identifier	Identifies the NFV-MANO managed object instances (e.g. NS instances, VNF instances) to be involved in the data analytics process. See note 1.
threshold	M	0..N	Not specified	Indicates the threshold to trigger data analytics process, e.g. resource threshold in NS resource utilization analysis, energy-related measurement threshold in NS energy efficiency analysis.

NOTE 1: At least one of the following attributes shall be present: locationAreald or objectInstanceid.  
 NOTE 2: Examples of location areas are NFVI-PoPs, resource zones, CIS clusters, container namespaces, etc.  
 NOTE 3: The present document does not specify how to control to/from the NFV-MDAF the availability of "historical" analytics data to be considered for the data analytics process.

#### 7.1.3 AnalyticsOutput information element

##### 7.1.3.1 Description

This information element provides information about output of a data analytics process.

##### 7.1.3.2 Attributes

The AnalyticsOutput information element shall follow the indications provided in table 7.1.3.2-1.

Table 7.1.3.2-1: Attributes of the AnalyticsOutput information element

Attribute	Qualifier	Cardinality	Content	Description
mDAType	M	1	String	The type of a data analytics process. Examples of types of data analytics include "Network service alarm incident analysis", "Network service health analysis", "Network service resource utilization analysis", "Network service orchestration efficiency analysis", "Network service performance analysis", "Network service energy efficiency analysis", etc.
analyticsId	M	1	Identifier	Identifier of the data analytics output.
analyticsOutputGenerationTime	M	0..1	DateTime	The time when the data analytics output is generated. See note.
typeSpecificOutput	M	0..1	Not specified	The output information specific to the type of data analytics. See note.
recommendedActions	M	0..1	Not specified	Recommended actions to follow up according to the output of data analytics.
NOTE: This attribute shall be present if the data analytics output represents the results of a successful data analytics process.				

## 7.2 Information elements and notifications related to data analytics changes

### 7.2.1 Introduction

This clause defines notifications related to data analytics changes.

### 7.2.2 DataAnalyticsChangeNotification

#### 7.2.2.1 Description

This notification informs the receiver of events related to data analytics processing. The support of the notification is mandatory.

#### 7.2.2.2 Trigger conditions

This notification is produced by the NFV-MDAF when there is an event caused by the data analytics process, e.g. the result of the data analytics (i.e. availability of a corresponding data analytics output).

If this is a notification about the start of a data analytics process, the notification shall be sent before any action (including sending the input information collection requests for data analytics purpose) is taken, however, after acknowledging the data analytics request to the MDA Consumer (see clause 6.2.2).

If this is a notification about the result of a data analytics process, the notification shall be sent after all other actions of data analytics have been executed. This notification can also be raised in case of an unsuccessful data analytics process to provide appropriate error information.

#### 7.2.2.3 Attributes

The DataAnalyticsChangeNotification information element shall follow the indications provided in table 7.2.2.3-1.

Table 7.2.2.3-1: Attributes of the DataAnalyticsChangeNotification

Attribute	Qualifier	Cardinality	Content	Description
notificationStatus	M	1	Enum	Indicates whether this notification reports about the start or the result of a data analytics process. VALUES: START: Informs about the start of the data analytics RESULT: Informs about the result of the data analytics
analyticsId	M	1	Identifier (Reference to AnalyticsOutput)	Reference to the data analytics process and output to which this notification is associated.
analysisStatus	M	1	Not specified	Indicates the analysis status. In case the notification represents the result of a data analytics process that was not successful, the notification shall contain appropriate error information.
analyticsOutput	M	0..1	AnalyticsOutput	The output of the data analytics process. Shall be present in case the "notificationStatus" is set to "RESULT".

## Annex A (informative): Examples of MDA use cases

### A.1 Introduction

The clauses under Annex A describe examples of NFV-MANO related MDA use cases. Enabling data as input data for the NFV-MDAF data analytics process and analytics outputs provided by the NFV-MDAF as part of data analytics process results are elaborated in respective use case examples. AI/ML models within the NFV-MDAF are used to derive intelligent analytics output (causes) and recommendations (follow-up actions or policies) based on the input data to the NFV-MDAF during the analytics process.

### A.2 Network service alarm incident analysis

#### A.2.1 Overview

This use case describes the analysis of Network Service (NS) alarm incidents with assistance of the NFV-MDAF. Alarms can be propagated over multiple layers in NFV-MANO if a source fault occurs. In addition, the same source fault can give rise to the performance deterioration of the NS. The NFV-MDAF analyses a series of alarms and deteriorated performance measurements to provide the analytics output indicating the root cause of network service alarm incidents. For a more detailed use case description, refer to clause 5.3.2 of ETSI GR NFV-IFA 041 [i.2].

#### A.2.2 Enabling data

The enabling data applied in this use case are provided in table A.2.2-1.

**Table A.2.2-1: Enabling data for network service alarm incident analysis**

Data category	Description	Data Source
Alarm notifications	Alarm information, e.g. the alarm notifications sent by NFV-MANO entities.	NFVO/VNFM/VIM/CISM/PIM (see clause 8.5.4 alarm information element of ETSI GS NFV-IFA 013 [i.3] as an example of alarm notification)
Performance measurements	The deteriorated or abnormal performance measurements based on certain performance monitoring threshold.	NFVO/VNFM/VIM/CISM/PIM (see performance measurements as specified in ETSI GS NFV-IFA 027 [i.4])

#### A.2.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.2.3-1.

**Table A.2.3-1: Analytics output for network service alarm incident analysis**

Information elements	Description
nSIncidentSourceObject	Indicates the objects managed by NFV-MANO which are the root cause of the NS alarm incident.
sourceFaultType	Indicates the type of source fault that has caused the NS alarm incident (see note).
eventTime	Indicates the timestamp when the failure is reported.
issueID	Holds the identifier of the reported failure. When provided in a data analytics output, this identifier provides information to the MDA Consumer for traceability of the NS alarm incident.
perceivedSeverity	Indicates the relative level of severity of the incident.
recommendedActions	Holds the recommended actions to failure prevention and recovery in respect to the analysed NS alarm incidents.
NOTE: sourceFaultType can be mapped to the eventType and optional faultType of an alarm (see clause 8.5.4 alarm information element of ETSI GS NFV-IFA 013 [i.3]).	

## A.3 Network service health analysis

### A.3.1 Overview

This use case describes the analysis of NS instance health with assistance of the NFV-MDAF. NS health is a high-level metric of the NS runtime status, which reflects whether or not the NS runs normally during its lifetime. The NFV-MDAF can collect NS health related information (e.g. alarms, performance measurements, etc.) in advance, or collect information based on the request of NS health analysis from the MDA Consumer. Based on the NS health analytics output provided by the NFV-MDAF, the MDA Consumer can further initiate lifecycle operations (e.g. NS scaling or healing) of an unhealthy NS to bring it back to its normal state. For a more detailed use case description, refer to clause 5.3.3 of ETSI GR NFV-IFA 041 [i.2].

### A.3.2 Enabling data

The enabling data applied in this use case are provided in table A.3.2-1.

**Table A.3.2-1: Enabling data for network service health analysis**

Data category	Description	Data Source
State	State of the NS instance to be analysed, e.g. INSTANTIATED, NOT_INSTANTIATED.	NFVO (see clause D.3 NS state model of ETSI GS NFV-IFA 013 [i.3])
Performance measurements	Performance measurements associated to the NS instance.	NFVO (see performance measurements as specified in ETSI GS NFV-IFA 027 [i.4])
Alarm notifications	Alarm notifications associated to the NS instance.	NFVO (see clause 8.5.4 alarm information element of ETSI GS NFV-IFA 013 [i.3] as an example of alarm notification)
Configurations	Configuration parameters of the constituent objects (e.g. VNF instances) of the NS instance.	NFVO/VNFM/CISM/VIM/WIM/PIM (see clause 7.3.5 update NS operation of ETSI GS NFV-IFA 013 [i.3] as an example of modifying information data and/or configurable properties of a VNF instance belonging to the NS instance)

Data category	Description	Data Source
VNF indicators	VNF indicators associated to the constituent VNF instances of the NS instance.	VNFM (see clause 7.7 VNF indicator interfaces of ETSI GS NFV-IFA 007 [i.5])

### A.3.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.3.3-1.

**Table A.3.3-1: Analytics output for network service health analysis**

Information elements	Description
healthStatus	Indicates the health status of the NS instance, e.g. HEALTHY, SUB_HEALTHY, NOT_HEALTHY.
analyticsStatistics	Indicates the processed and computed statistics by the NFV-MDAF, of certain enabling data associated to the specified type of data analytics process (i.e. "Network service health analysis" for this use case) in a time period, e.g. the total incoming/outgoing bytes (or packages) of SAP associated to the NS instance in the last 24 hours.
unhealthyObjects	Indicates the constituent objects of the NS instance which are in SUB_HEALTHY or NOT_HEALTHY status.
unhealthCause	Indicates the analysed cause(s) for respective unhealthy objects.
recommendedActions	Indicates the recommended actions to recover unhealthy objects, e.g. to scale or heal constituent VNF instances of the NS instance.

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## A.4 Network service resource utilization analysis

### A.4.1 Overview

This use case describes the analysis of NS instance resource utilization with assistance of the NFV-MDAF. The NFV-MDAF collects NS instance's resource utilization related information (e.g. performance measurements, VNF indicators, etc.) periodically based on the analytics request from the NFVO. Based on the NS resource utilization analytics output provided by the NFV-MDAF, the NFVO can further initiate operations for resolving NS resource utilization issues identified in the analysis. As a pre-condition, thresholds for identifying the under-utilized or over-utilized status of NS instance's resources can be configured by the NFV-MDAF against the NFVO managing the corresponding NS instance. For a more detailed use case description, refer to clause 5.3.4 of ETSI GR NFV-IFA 041 [i.2].

### A.4.2 Enabling data

The enabling data applied in this use case are provided in table A.4.2-1.

**Table A.4.2-1: Enabling data for network service resource utilization analysis**

Data category	Description	Data Source
Performance measurements	Performance measurements associated to the NS instance to be analysed, such as virtual compute related measurements for each constituent VNF instance of the NS instance, network data volume related measurements of an SAP belonging to the NS instance, network data volume related measurements of an external CP belonging to the constituent VNF instances of the NS instance.	NFVO/VNFM (see performance measurements as specified in ETSI GS NFV-IFA 027 [i.4])
VNF indicators	VNF indicators associated to the constituent VNF instances of the NS.	VNFM (see clause 7.7 VNF indicator interfaces of ETSI GS NFV-IFA 007 [i.5])

### A.4.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.4.3-1.

**Table A.4.3-1: Analytics output for network service resource utilization analysis**

Information elements	Description
resourceUtilizationStatus	Indicates the resource utilization status of the NS instance, e.g. NORMAL, UNDER_UTILIZED, OVER_UTILIZED.
resourceType	Indicates the resource type associated to resourceUtilizationStatus, e.g. COMPUTE, STORAGE or NETWORK.
analyticsStatistics	Indicates the processed and computed statistics by the NF-MDAF, of certain enabling data associated to the specified type of data analytics process (i.e. "Network service resource utilization analysis" for this use case) in a time period, e.g. mean CPU usage of VNF instances associated to the NS instance in the past 24 hours.
abnormalUtilizationCause	Indicates the analysed cause(s) for respective abnormal resource utilization (when the resourceUtilizationStatus value is either UNDER_UTILIZED or OVER_UTILIZED).
recommendedActions	Indicates the recommended actions to resolve the NS instance's resource utilization issues, e.g. to scale the NS instance or update corresponding NFV-MANO policies impacted by NS instance resource utilization issues.

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## A.5 Network service orchestration efficiency analysis

### A.5.1 Overview

This use case describes the analysis of NS instance orchestration efficiency with assistance of the NFV-MDAF. NS orchestration efficiency analysis focuses on optimizing resource allocation, deployment workflows and lifecycle management processes related to an NS instance. The NFV-MDAF collects orchestration-related data (e.g. deployment logs, resource allocation patterns, policy violations) to identify bottlenecks, inefficiencies or policy conflicts in the NS orchestration process. Based on the analytics output, the MDA Consumer can optimize orchestration strategies to improve NS deployment speed, resource utilization and operational reliability.

### A.5.2 Enabling data

The enabling data applied in this use case are provided in table A.5.2-1.

**Table A.5.2-1: Enabling data for network service orchestration efficiency analysis**

Data category	Description	Data Source
Orchestration event logs	Detailed log records of NS life cycle operations (e.g. instantiation, scaling, termination).	NFVO
Resource allocation data	Resource usage patterns of VNF instances and NS components.(e.g. CPU/memory utilization trends, storage I/O patterns, network bandwidth consumption). Examples: Sustained CPU utilization > 80 % (resource contention), memory allocation exceeding 90 % of baseline (potential bottleneck), or underutilized storage resources (< 30 % usage over 24 hours).	NFVO/VNFM (see resource related performance measurements of VNF/VNFC instances in ETSI GS NFV-IFA 027 [i.4])
Deployment time metrics	Time taken for NS deployment, scaling, and healing operations. Time duration taken for NS deployment operations (e.g. time from orchestration request to completion of VNF instantiation).	NFVO (derived from operation timestamps in ETSI GS NFV-IFA 013 [i.3])
Policy	Orchestration policies applied to NS instances (e.g. scaling thresholds).	NFVO (see policy management interfaces defined in ETSI GS NFV-IFA 013 [i.3])
Failure occurrence logs	Records of failed orchestration attempts and their root causes.	NFVO/VNFM

### A.5.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.5.3-1.

**Table A.5.3-1: Analytics output for network service orchestration efficiency analysis**

Information elements	Description
Resource allocation efficiency Score	Quantitative score (0-100) measuring optimal resource utilization for VNF instances. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = Resource waste &lt; 5 % (e.g. CPU/memory overprovisioning &lt; 5 %)</li> <li>- [99-1] = Resource waste 5-30 %(linear distribution)</li> <li>- 0 = Resource waste &gt; 30 % (persistent underutilization)</li> </ul>
Deployment speed Score	Score (0-100) evaluating NS lifecycle operation efficiency. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = Deployment &lt; 10 s (no failures)</li> <li>- [99-1] = Deployment 10-60 s(linear distribution)</li> <li>- 0 = Deployment &gt; 60 s or repeated failures</li> </ul>
Policy compliance Score	Score (0-100) gauging adherence to orchestration policies and SLAs. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = 0 policy conflicts/SLA violations in 24 hours</li> <li>- [80,60,40,20] = 1-4 non-critical policy violations</li> <li>- 0 = ≥ 5 critical policy violations or SLA breaches.</li> </ul>
Resource Utilization Patterns	Trends in resource allocation efficiency over time (e.g. CPU over provisioning).
Recommended Optimizations	Suggested changes to orchestration workflows or policies (e.g. parallelizing VNF instantiation).

## A.6 Network service performance analysis

### A.6.1 Overview

This use case describes the analysis of NS instance performance characteristics with assistance of the NFV-MDAF. Performance analysis evaluates metrics like latency, throughput, and error rates to identify performance bottlenecks and trends of an NS instance. The NFV-MDAF aggregates performance measurements from multiple sources and provides actionable insights to maintain or improve NS Quality of Service (QoS). Based on the analytics output, the MDA Consumer can trigger performance optimization actions (e.g. traffic rerouting, resource scaling).

### A.6.2 Enabling data

The enabling data applied in this use case are provided in table A.6.2-1.

**Table A.6.2-1: Enabling data for network service performance analysis**

Data category	Description	Data Source
Performance measurements	Key performance indicators (KPIs) of the NS instance and its constituent VNFs/VNFCs.	NFVO/VNFM/VIM/CISM/PIM (see ETSI GS NFV-IFA 027 [i.4])
Resource utilization data	CPU/memory usage of VNF instances and network bandwidth.	NFVO/VNFM/VIM/CISM/PIM (see performance measurements and resource metrics specified in ETSI GS NFV-IFA 027 [i.4])
Traffic patterns	Inbound/outbound traffic volume and flow characteristics.	VIM (derived from network monitoring in ETSI GS NFV-IFA 013 [i.3])
SLA compliance data	Deviations from Service Level Agreement (SLA) parameters (e.g. latency guarantees, availability targets) between the service provider and end-user, or between NFV-MANO components (e.g. VIM resource allocation promises to the NFVO).	NFVO

### A.6.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.6.3-1.

**Table A.6.3-1: Analytics output for network service performance analysis**

Information elements	Description
Latency performance	Quantitative score (0-100) measuring end-to-end network delay efficiency. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = End-to-end latency &lt; 50 ms (e.g. real-time service standards)</li> <li>- [99-1] = Latency 50-500 ms (linear distribution)</li> <li>- 0 = Latency &gt; 500 ms (service unavailability)</li> </ul>
Throughput efficiency Score	Score (0-100) evaluating network bandwidth utilization and packet handling capacity. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = Throughput &gt; 90 % of guaranteed bandwidth (e.g. 1Gbps link with 950 Mbps throughput)</li> <li>- [99-1] = Throughput 30-90 % of guarantee (linear distribution)</li> <li>- 0 = Throughput &lt; 30 % with packet drops (critical congestion)</li> </ul>
Resource utilization Score	Score (0-100) gauging efficiency of VNF and network resource usage. Scoring criteria: <ul style="list-style-type: none"> <li>- 100 = Average CPU/memory utilization &lt; 70 % (optimal headroom)</li> <li>- [99-1] = Utilization 70-95 % (linear distribution)</li> <li>- 0 = Utilization &gt; 95 % (sustained resource contention)</li> </ul>
performanceTrends	Time-series analysis of performance metrics/KPIs related to an NS instance showing the trend of improvement/deterioration.
anomaliesDetected	Identified performance outliers with timestamps and severity levels.
rootCauseAnalysis	Root cause(s) of performance degradation (e.g. VNF CPU bottleneck).
optimizationSuggestions	Recommended actions to improve performance (e.g. scaling VNF instances).
capacityPlanningData	Forecasted resource requirements based on historical performance data.

## A.7 Network service energy efficiency analysis

### A.7.1 Overview

This use case describes the analysis of NS energy efficiency with assistance of the NFV-MDAF. NS energy efficiency is the optimization of energy consumption in the provisioning and management of a network service, aiming to maximize data transmission and processing efficiency while minimizing power usage. NS energy efficiency is critical in reducing operational costs, lowering carbon emissions and promoting sustainable NFV infrastructure.

In this process, per analytics request from the MDA Consumer, the NFV-MDAF periodically collects energy-related performance measurements (e.g. energy efficiency KPIs, energy consumption metrics) associated to an NS instance. When the NS energy-related performance measurements in a collection period exceeds an energy-related performance measurement threshold of the NS, the NFV-MDAF analyses the NS energy efficiency degradation by using other OAM information of the NS, such as the NS performance metrics (e.g. NS resource utilization), the NS alarm information (e.g. CPU temperature alarms), and/or the NS log information (e.g. NS resource logs). Based on the NS energy efficiency analytics output provided by the NFV-MDAF, the MDA Consumer further creates NS energy efficiency optimization policies or initiates corresponding operations.

### A.7.2 Enabling data

The enabling data applied in this use case are provided in table A.7.2-1.

**Table A.7.2-1: Enabling data for network service energy efficiency analysis**

Data category	Description	Data Source
Energy efficiency KPIs	Energy efficiency KPIs associated to the NS instance(s) to be analysed.	NFVO (see NS energy efficiency KPI as specified in clause 8.4.2 of ETSI GS NFV-IFA 027 [i.4])
Energy consumption measurements	Energy consumption measurements associated to the NS instance(s) to be analysed.	NFVO (see NS instance energy consumption measurements as specified in clause 7.3.6 of ETSI GS NFV-IFA 027 [i.4])
Data volume measurements	Data volume (e.g. number of incoming/outgoing bytes of an SAP) of the NS instance(s) to be analysed.	NFVO (see data volume measurements as specified in clause 7.3.2 and 7.3.3 of ETSI GS NFV-IFA 027 [i.4])
Performance measurements	Performance measurements associated to the NS instance(s).	NFVO (see NS instance performance measurements as specified in clause 7.3 of ETSI GS NFV-IFA 027 [i.4])
Alarms	Alarm notifications of the NS instance(s).	NFVO (see clause 8.5.4 alarm information element of ETSI GS NFV-IFA 013 [i.3] as an example of alarm notification)
Logs	Log information of the NS instance(s).	NFVO

### A.7.3 Analytics output

The information elements of analytics output specific to this use case are provided in table A.7.3-1.

**Table A.7.3-1: Analytics output for network service energy efficiency analysis**

Information elements	Description
energyEfficiencyStatus	Indicate the energy efficiency status of the NS instance(s), e.g. HIGH, NORMAL, LOW.
lowEnergyEfficiencyCause	Indicate the analysed cause(s) for NS energy efficiency degradation (the NS energyEfficiencyStatus is LOW).
recommendedActions	Indicate the recommended policies or actions to optimize the NS energy efficiency, e.g. to migrate the low energy efficiency objects (e.g. VNFs or VNFCs) of the NS instance to other physical resources or virtual machines with low utilization in the same NFVI-PoP, or perform NS energy consumption control via load balancing.

## Annex B (informative): Change history

Date	Version	Information about changes
March 2022	0.0.1	First draft, introducing the skeleton, scope and definition of the GS. NFVIFA(22)000098, NFVIFA(22)000099r1, NFVIFA(22)000121r1
May 2022	0.0.2	Early draft including the following contributions until IFA#282 meeting: NFVIFA(22)000256r1, NFVIFA(22)000262r1, NFVIFA(22)000282r2
November 2022	0.0.3	Early draft including the following contributions until IFA#311 meeting: NFVIFA(22)000627, NFVIFA(22)000786r2, NFVIFA(22)000790r2, NFVIFA(22)000810r1
December 2022	0.0.4	Stable draft including the following contributions until IFA#313 meeting: NFVIFA(22)000840r2, NFVIFA(22)000856r2, NFVIFA(22)000874r1, NFVIFA(22)000875r2, NFVIFA(22)000878
January 2023	0.0.5	Final draft including the following contributions until IFA#320 meeting: NFVIFA(22)000961, NFVIFA(22)000962, NFVIFA(22)000964, NFVIFA(23)000006, NFVIFA(23)000014r1, NFVIFA(23)000030, NFVIFA(23)000031r2, NFVIFA(23)000032, NFVIFA(23)000036r1
November 2023	5.0.1	Release 5 initial draft version created from published version 4.4.1.
December 2023	5.0.2	Early draft including the following contributions until IFA#362 meeting: NFVIFA(22)000705r1, NFVIFA(22)000706r1
April 2024	5.0.3	Final draft including the following contributions in the WG final review for ed511: NFVIFA(24)000259.
June 2024	5.1.2	Initial ed521 draft version created from published version 5.1.1.
July 2025	5.3.2	Derived from v5.1.2, initial draft version in ed541 with including the following contributions until IFA#432 F2F meeting in NFV#50: NFVIFA(25)000162r2, NFVIFA(25)000163r2.
September 2025	5.3.3	Stable draft including the following contribution until IFA#442-F2F meeting: NFVIFA(25)000208r1
November 2025	5.3.4	Stable draft including the following contributions until IFA#449 interim-e meeting: NFVIFA(25)000283r1, NFVIFA(25)000290r1 Extra minor clarification in clause A.7.1 as a rapporteur's action.
November 2025	5.3.5	Final draft including the following contributions until IFA#453 meeting: NFVIFA(25)000348r1_IFA047ed541_Clarifying_the_role_of_AI_ML_model_in_the_NFV-MDAF

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## History

<b>Version</b>	<b>Date</b>	<b>Status</b>
V5.1.1	June 2024	Publication
V5.4.1	January 2026	Publication