ETSI TS 128 500 V16.0.0 (2020-08)

TECHNICAL SPECIFICATION

LTE;
Telecommunication management;
Management concept, architecture and requirements for
mobile networks that include virtualized network functions
(3GPP TS 28.500 version 16.0.0 Release 16)

Reference
RTS/TSGS-0528500vg00

Keywords
LTE

ETSI

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Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

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Contents

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Introduction

Traditionally, telecommunication equipment is provided as equipment with integrated software and hardware. Virtualization technologies decouple the software and hardware, and the network function software can be executed on COTS hardware.

The mobile network will be composed of virtualized network functions and non-virtualized network elements in the future. Virtualized network functions, like traditional non-virtualized network elements, need also to be managed.

Due to the decoupling of network function software and hardware, ETSI ISG NFV introduces the NFV Management and Orchestration architecture, which interacts with 3GPP network management system, to realize the management of virtualized network functions lifecycle and resource allocation. 3GPP specifies the management solution of mobile networks that include virtualized network functions and clarifies the relationship between 3GPP management architecture and ETSI ISG NFV Management and Orchestration architecture.

The present document specifies the management concept, requirements and architecture for mobile networks that include virtualized network functions.

1 Scope

The present document specifies the management concepts, the management requirements and use cases from operators' perspective for mobile networks that include virtualized network functions which can be part of EPC or IMS, and provides the management architecture for these mobile networks.

2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non-specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1]   3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2]   ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV); Management and Orchestration; Functional Requirements Specification".

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

[4]   ETSI GS NFV 003 V1.2.1: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[5]   3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".

[6]   3GPP TS 32.401: "Telecommunication management; Performance Management (PM); Concept and requirements".

[7]   3GPP TS 32.111-1: "Telecommunication management; Fault Management; Part 1: 3G fault management requirements".

[8]   3GPP TS 32.150: "Telecommunication management; Integration Reference Point (IRP) Concept and definitions".

[9]   ETSI GS NFV-IFA 013 v2.1.1: "Network Function Virtualization (NFV); Management and Orchestration; Os-Ma-nfvo Reference Point - Interface and Information Model Specification".

[10]   ETSI GS NFV-IFA 008 v2.1.1: "Network Functions Virtualisation (NFV); Management and Orchestration; Ve-Vnfm Reference Point - Interface and Information Model Specification".

[11]   3GPP TS 28.510: " Telecommunication management; Configuration Management (CM) for mobile networks that include virtualized network functions; Requirements".

[12]   3GPP TS 32.102: "Telecommuncations management; Architecture"

3 Definitions, symbols and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1], TS 32.101 [5], TS 32.111-1 [7], TS 32.150 [8], TS 32.401 [6] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

Consumer Role: See service consumer in clause 5 of 3GPP TS 32.101 [5]. See consumer in ETSI GS NFV-MAN 001 [3]).

LifeCycle Management (LCM): Defined in ETSI GS NFV 003 [4].

   NOTE 1: How to define the lifecycle management of 3GPP network and entity is FFS.

Network Functions Virtualisation Infrastructure (NFVI): Defined in ETSI GS NFV 003 [4].

Network Functions Virtualisation Management and Orchestration (NFV-MANO): Defined in ETSI GS NFV 003 [4].

Network Functions Virtualisation Orchestrator (NFVO): Defined in ETSI GS NFV 003 [4].

NS: Network Service defined in ETSI GS NFV 003 [4].

   NOTE 2: The NS defined by ETSI NFV documents is not equivalent to 3GPP services. The latter requires the former for network orchestration in case the network includes virtualized network functions.

Physical Network Function (PNF): Defined in ETSI GS NFV 003 [4].

   NOTE 3: From 3GPP perspective, non-virtualized NE is a typical example of PNF.

Producer Role: See service producer in clause 5 of 3GPP TS 32.101 [5]. See producer in ETSI GS NFV-MAN 001[3]).

Scaling: Defined in ETSI GS NFV 003 [4].

Virtual Machine (VM): Defined in ETSI GS NFV 003 [4].

Virtualised Infrastructure Manager (VIM): Defined in ETSI GS NFV 003 [4].

Virtualised Network Function (VNF): Defined in ETSI GS NFV 003 [4].

   NOTE 4: From 3GPP perspective, it corresponds to the application level function of NE, which is defined in 3GPP TS 32.101 [5].

Virtualised Network Function Manager (VNFM): Defined in ETSI GS NFV 003 [4].

Virtualised Network Function Package (VNF Package): Defined in ETSI GS NFV 003 [4].

VNF Healing: Defined in ETSI GS NFV-IFA010 [2].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

CAPEX	CAPital EXpenditure
COTS	Commercial Off-The-Shelf
LCM	LifeCycle Management
NFV	Network Functions Virtualization
NFVO	Network Functions Virtualization Orchestrator

NS	Network Service
NSD	NS Descriptor
OPEX	OPerating EXpense
OSS	Operations Support System
VIM	Virtualized Infrastructure Manager
VNF	Virtualized Network Function
VNFM	Virtualized Network Function Manager

4 Background and concepts

4.1 Background

It is expected that future implementation options for the entities of the 3GPP system include various technologies for virtualization. Network and service providers make use of different information in several different ways which also may vary from network to network and from time to time. Hence, entities of the 3GPP system that have been implemented with virtualization options should be managed in the same manner as entities implemented with non-virtualization options, to the extent possible.

Virtualized 3GPP entities still require some underlying hardware resources. One of the NFV business objectives is that VNFs are procured independently from the underlying hardware resources. The underlying hardware resources are expected to be administered independently from the virtualized entities required for the 3GPP system.

4.2 Concepts

4.2.1 NE and VNF

1. The components of NE can be shown as below (see Figure 4.2.1-1), where a Network Function (NF) is a processing function in a network which has defined functional behaviour and defined interfaces:
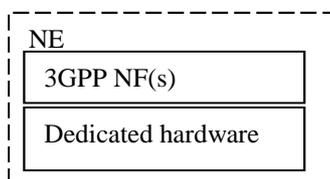
Figure 4.2.1-1: NE components

2. A VNF is NF(s) that runs on a NFV Infrastructure (NFVI) (see Figure 4.2.1-2):
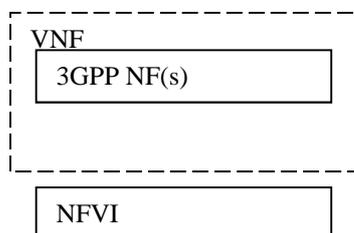
Figure 4.2.1-2: VNF running on NFVI

Note: A VNF holds the following: a) functionality of the NF(s), b) elements for supporting the NF functionalities (the set a) and b) referred as application part of the VNF), and c) elements enabling VNF to run on NFVI (referred as virtualization-specific part of the VNF). Examples of elements for supporting the NF functionalities are library, database, protocol stacks. From this perspective, for the same type of NF, the function of a VNF is equivalent to the NF realized by an NE. The VNF set-a and set-b are managed by EM using the Type 1 interface (subclause 5.1.2.1 of [5]) in case the EM is not realized by the above mentioned VNF. In the case the EM and NF are realized within one VNF, the managing interface between EM and NF is not defined. The VNF set-c is managed by VNFM using the ETSI NFV defined Ve-Vnfm-vnf Reference Point (subclause 5.3 of [10]) between VNFM and VNF.

3. Examples for the NE instance

The same telecommunication function of an NE instance could be carried as illustrated in the following examples (see also Figure 4.2.1-3):

EXAMPLE 1: One VNF instance composed of one or more VNFC instances running on NFVI.

EXAMPLE 2: NF(s) running on dedicated hardware, where the the NF is 3GPP defined mobile network function (as described in Figure 7.3.3.1 in TS 32.102 [12]).
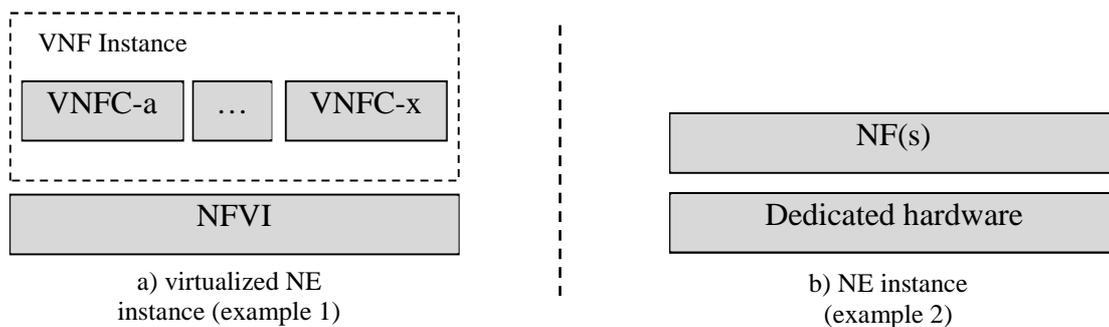
Figure 4.2.1-3 Examples of NE instances: a) virtualized and b) non-virtualized.

4.2.2 The relationship between NE and VNF

From 3GPP perspective, VNF contains the NE's Network Function(s). The relation between NE instance and VNF instance depends on the relation between the NFs of NE and the functions contained within VNF.

Relation1: The NE instance is 1:1 related to VNF instance if the VNF contains the whole Network Function(s) of the NE.

5 Business level requirements

5.1 Requirements

5.1.1 General requirements

REQ-NFV-CON-1 Operator shall be able to manage mobile networks that include virtualized network functions and shall be able to identify whether the managed nodes are virtualized or not.

REQ-NFV-CON-2 The management of mobile networks that include virtualized network functions should reuse the 3GPP existing management solutions as much as possible.

REQ-NFV-CON-3 NM and EM in 3GPP management system managing the virtualized 3GPP entities shall be able to manage physical 3GPP entities also.

REQ-NFV-CON-4 3GPP management system shall support a capability allowing operators to manage mobile networks that include virtualized network functions with the assistance from NFV-MANO.

REQ-NFV-CON-5 The reference points between 3GPP management system and NFV-MANO shall support a capability allowing 3GPP management system to request information required for management from NFV-MANO.

REQ-NFV-CON-6 The performance of the 3GPP management system should be adequate to achieve the objective of 3GPP service time to market.

REQ-NFV-CON-7 The virtualized resources from NFVI, on which the VNF relies, should be collaboratively managed by 3GPP management system and NFV-MANO.

> NOTE: Management of the virtualized resources from NFVI is NFV-MANO's responsibility, and "collaboratively managed" refers to the need for NFV-MANO to take into account the requirements from 3GPP management system about the VNF's virtualized resources during the VNF lifecycle management and deliver to 3GPP management system VNF performance data related to virtualized resources, VNF fault information related to virtualized resources and VNF instance information.

5.1.2   FM requirements

REQ-NFV_FM_SYS-CON-1 The Operator shall be able to manage and deal with the virtualized network function alarms and NFVI alarms, which are not related to virtualized network function, through 3GPP management system and NFV-MANO respectively.

REQ-NFV_FM_SYS-CON-2 3GPP management system shall be able to receive the virtualized network function alarm which includes the correlated virtualized resource fault information and process the alarm.

REQ-NFV_FM_SYS-CON-3 The virtualized network function alarm, which 3GPP management system acquired, shall include correct alarm type, alarm severity and possible cause information.

REQ-NFV_FM_SYS-CON-4 3GPP management system shall be able to request NFV-MANO to recover the virtualized network function when VNF automatic recovery is not enabled in NFV-MANO.

REQ-NFV_FM_SYS-CON-5 3GPP management system shall be able to receive the virtualized network function alarms when NFV-MANO performs VNF automatic recovery.

REQ-NFV_FM_SYS-CON-7 NFV-MANO shall support the subscription capability allowing 3GPP management system to subscribe to the VNF instance fault report related to virtualized resource(s) and virtualization-specific failures.

5.1.3   CM requirements

REQ-NFV_CM_SYS-CON-1 3GPP management system shall be able to manage both physical and virtualized 3GPP entities with corresponding managed objects and attributes.

REQ-NFV_CM_SYS-CON-2 3GPP management system shall be able to perform necessary virtualized 3GPP entity configuration due to the VNF lifecycle management operation from NFV-MANO.

REQ-NFV_CM_SYS-CON-3 3GPP management system shall be able to re-configure involved neighbour physical and virtualized 3GPP entities if needed due to one NS or VNF LCM operation.

REQ-NFV_CM_SYS-CON-4 In order to minimize 3GPP service disruption when a VNF instance is scaled, the scaling shall not modify the existing connections with other network entities.

REQ-NFV_CM_SYS-CON-5 3GPP management system shall be able to request NFV-MANO to modify non-application information and configuration about a VNF instance managed by NFV-MANO (supported by requirements Os-Ma-nfvo.NsLcm.019 and Os-Ma-nfvo.NsLcm.020 in [9], and Ve-Vnfm-em.VnfLcm.008 and Ve-Vnfm-em.VnfCm.001 in [10]).

REQ-NFV_CM_SYS-CON-6 3GPP management system shall be able to query NFV-MANO non-application information about a VNF instance managed by NFV-MANO (supported by requirement Os-Ma-nfvo.NsLcm.015 in [9] and Ve-Vnfm-em.VnfLcm.004 in [10]).

5.1.4   PM requirements

REQ-NFV_PM_SYS-CON-1 The key performance indicators which are defined for physical entities shall be applicable to virtualized entities in 3GPP core network.

REQ-NFV_PM_SYS-CON-2 3GPP management system shall support the performance measurements for virtualized 3GPP entity and 3GPP management system shall be informed of the performance measurement result of virtualized resources on which the virtualized 3GPP entity relies.

REQ-NFV_PM_SYS-CON-3 3GPP management system shall be able to request the VNF LCM operation towards NFV-MANO to mitigate the VNF performance bottleneck according to the results of the VNF performance measurements.

REQ-NFV_PM_SYS-CON-4 NFV-MANO shall be able to provide VNF PM data related to virtualized resource to 3GPP management system.

REQ-NFV_PM_SYS-CON-5 NFV-MANO shall support the subscription capability allowing 3GPP management system to subscribe to the VNF performance measurement report related to virtualized resource.

5.1.5   LCM requirements

REQ-NFV_LCM_SYS-CON-1 3GPP management system shall be able to request NFV-MANO to perform NS LCM operations (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-2 3GPP management system shall be able to request NFV-MANO to perform NSD management operations (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-3 3GPP management system shall be able to request NFV-MANO to perform VNF package/software management operations (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-4 3GPP management system shall be able to request NFV-MANO to perform VNF LCM operations (defined in ETSI GS NFV-IFA 008 [10]).

REQ-NFV_LCM_SYS-CON-5 3GPP management system shall support the capability to receive NS lifecycle change notifications from NFV-MANO (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-6 3GPP management system shall support the capability to receive the NSD management notifications from NFV-MANO (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-7 3GPP management system shall be able to request updating the NS instance (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-8 3GPP management system shall support the VNF package/software management notifications from NFV-MANO (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-9 3GPP management system shall support the capability to receive the VNF LCM change notifications from NFV-MANO (defined in ETSI GS NFV-IFA 008 [10]).

REQ-NFV_LCM_SYS-CON-10 3GPP management system shall be able to request scaling a virtualized network function to NFV-MANO (defined in ETSI GS NFV-IFA 008 [10]).

REQ-NFV_LCM_SYS-CON-11 3GPP management system shall be able to request executing the VNF Healing of a virtualized network function to NFV-MANO.**REQ-NFV_LCM_SYS-CON-12** 3GPP management system shall have the authority to determine the termination of a VNF instance(s).

REQ-NFV_LCM_SYS-CON-13 NFV-MANO shall have the capability allowing 3GPP management system to enable/disable the auto-scaling towards the corresponding VNF instance(s).

REQ-NFV_LCM_SYS-CON-14 NFV-MANO shall support the subscription capability allowing 3GPP management system to subscribe to the NS lifecycle change notifications (defined in ETSI GS NFV-IFA 013 [9]).

REQ-NFV_LCM_SYS-CON-15 NFV-MANO shall support the subscription capability allowing 3GPP management system to subscribe to the VNF lifecycle change notifications (defined in ETSI GS NFV-IFA 008 [10]).

REQ-NFV_LCM_SYS-CON-16 NFV-MANO shall have the capability allowing 3GPP management system to provide the affinity and anti-affinity information in the NSD.

REQ-NFV_LCM_SYS-CON-17 Operator shall be able to instantiate and manage multiple NS created using the same NSD but with specific parameterization (location, capacity, addresses).

5.2   Actor roles

See detailed actors and roles for each use case in clause 5.4.

5.3   Telecommunications resources

See detailed telecommunications resources for each use case in clause 5.4.

5.4   High-level use cases

5.4.1   FM use cases

5.4.1.1   Use case of VNF Healing triggered by 3GPP management system

NOTE: In the context of this use case, VNF Healing [2] refers to corrective actions performed by the NFV-MANO to recover a VNF which fails to perform as expected, and it concerns the actions for which the NFV-MANO is responsible, e.g. corrective action(s) toward virtualised resources, instantiation of VNFC, configuration of VNF non-application specific parameters, etc.

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To execute VNF Healing for a virtualized network function.	
Actors and Roles	3GPP management system requests to execute the VNF Healing.	
Telecom resources	3GPP management system. NFV-MANO. VNF.	
Assumptions	3GPP management system is subscribed to VNF lifecycle change notifications from the NFV-MANO.	
Pre-conditions	The subject VNF instance is not being healed at the moment.	
Begins when	A faulty virtualization-specific aspect of the VNF has been notified to 3GPP management system.	
Step 1 (M)	3GPP management system determines that VNF Healing of the VNF is needed.	
Step 2 (M)	3GPP management system requests the NFV-MANO to execute the VNF Healing based on the information in the request.	
Step 3 (M)	NFV-MANO notifies 3GPP management system about the end and the result of the VNF Healing execution.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	The VNF Healing procedure in step 2 fails.	
Post-conditions	The faulty virtualization-specific aspect of the VNF is recovered.	
Traceability	**REQ-NFV_LCM_SYS-CON-11**	

5.4.1.2 Use case of virtualization-specific aspect failure detection and notification by NFV-MANO

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To notify the 3GPP management system of a virtualization-specific failure of a virtualized network functions.	
Actors and Roles	3GPP management system receives the fault report. NFV-MANO notifies about VNF-related virtualization faults.	
Telecom resources	3GPP management system. NFV-MANO. VNF.	
Assumptions	3GPP management system is subscribed to VNF-related virtualization-specific fault reports from the NFV-MANO.	
Pre-conditions	N/A	
Begins when	A virtualization-specific fault affecting the VNF is notified to NFV-MANO.	
Step 1 (M)	NFV-MANO creates VNF-related virtualization fault report about the faulty virtualization-specific aspect.	
Step 2 (M)	NFV-MANO sends the VNF-related virtualization fault report to the 3GPP management system.	
Ends when	All the steps identified above are successfully completed.	
Exceptions		
Post-conditions	The 3GPP management system is notified about the virtualization-specific failure of the subject VNF.	
Traceability	**REQ-NFV_FM_SYS-CON-7**	

5.4.1.3 Use case of alarms correlation by 3GPP management system

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To correlate VNF alarms in a mobile network that includes virtualized network functions.	
Actors and Roles	3GPP management system correlates VNF alarms.	
Telecom resources	NFV-MANO VNF NFVI	
Assumptions	3GPP management system has the alarm correlation function. 3GPP management system is subscribed to VNF-related virtualized resource fault reports from the NFV-MANO. The virtualized resource failure affects the corresponding VNF.	
Pre-conditions		
Begins when	NFV-MANO detects the virtualized resource fault affecting the VNF.	
Step 1 (M)	NFV-MANO creates VNF fault report related to virtualized resource and sends it to the 3GPP management system.	
Step 2 (M)	3GPP management system receives the VNF fault report related to virtualized resource. 3GPP management system also receives VNF application alarm(s) of a faulty NE.	
Step 3 (M)	3GPP management system implements alarm correlation based on the virtualized resource alarm(s) from NFV-MANO and VNF application alarm(s) from NE.	
Step 4 (M)	3GPP management system generates the final VNF application fault report including the above correlated alarm(s).	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	3GPP management system will process the alarm(s) based on the final fault report.	
Traceability	**REQ-NFV_FM_SYS-CON-2, REQ-NFV_FM_SYS-CON-7**	

5.4.2 CM use cases

Editor's note: The following UCs (i.e. 5.4.2.1, 5.4.2.2, 5.4.2.3, 5.4.2.4) will be revisited when the relationship between MO and VNF instance is clear.

5.4.2.1 Use case of adding a MO related to a VNF

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	To add a MO related to a VNF.	
Actors and Roles	3GPP management system.	
Telecom resources	3GPP management system. VNF.	
Assumptions		
Pre conditions	N/A	
Begins when	Operator has decided to add a MO related to the VNF.	
Step 1 (M)	3GPP management system creates the MO related to the VNF. Note: the MO creation operation here means Basic CM IRP.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post Conditions	The MO is available for 3GPP management system.	
Traceability	**REQ-NFV_CM_SYS-CON-2**	

5.4.2.2 Use case of associating the MO with a certain VNF instance

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	To associate the MO with a certain VNF instance.	
Actors and Roles	3GPP management system.	
Telecom resources	3GPP management system. VNF.	
Assumptions		
Pre conditions	3GPP management system has known the VNF instance identifier.	
Begins when	Operator has decided to associate the MO with a certain VNF instance.	
Step 1 (M)	3GPP management system associates the MO with a certain VNF instance. NOTE: The associating operation may happen during the process of creation of MO or after it.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post Conditions	The MO is associated with The VNF instance. And the MO can be managed by 3GPP management system.	
Traceability	**REQ-NFV_CM_SYS-CON-2**	

5.4.2.3 Use case of configuring the VNF by 3GPP management system

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	To configure the VNF with MO attributes.	
Actors and Roles	3GPP management system.	
Telecom resources	3GPP management system. VNF.	
Assumptions		
Pre conditions	3GPP management system has added a MO related to the VNF.	
Begins when	Operator has decided to configure the VNF.	
Step 1 (M)	3GPP management system configures the VNF with MO attributes.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post Conditions	The VNF has been configured by 3GPP management system.	
Traceability	**REQ-NFV_CM_SYS-CON-2**	

5.4.2.4 Use case of removing the MO of a VNF from managed nodes

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	To remove the MO of a VNF from managed nodes.	
Actors and Roles	3GPP management system.	
Telecom resources	3GPP management system. VNF.	
Assumptions		
Pre conditions	3GPP services provided by the VNF instance have been released. NFV-MANO has already terminated the VNF instance.	
Begins when	Operator has decided to remove the MO of the VNF instance from managed nodes.	
Step 1 (M)	3GPP management system removes the MO of the VNF instance.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post Conditions	The MO of the VNF instance has been removed from managed nodes.	
Traceability	**REQ-NFV_CM_SYS-CON-2**	

5.4.2.5 Modify non-application information and configuration of a VNF instance managed by NFV-MANO

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To modify by 3GPP management system non-application information and configuration of a subject VNF instance. Such an information and configuration is managed by NFV-MANO (see clause 9.4.2 in ETSI GS NFV-IFA 008 [10]); for instance, VNF instance name and meta data.	
Actors and Roles	3GPP management system requests the modification of VNF instance information and/or configuration.	
Telecom resources	3GPP management system. NFV-MANO	
Assumptions	N/A	
Pre-conditions	N/A	
Begins when	3GPP management system determines to modify certain non-application information and/or configuration held by NFV-MANO of a subject VNF instance.	
Step 1 (M)	3GPP management system sends a request to NFV-MANO to modify the non-application information and/or configuration about the subject VNF instance (see related interface requirements in clause 5.2.1.1 in ETSI GS NFV-IFA 008 [10] and in clause 5.3.2 in ETSI GS NFV-IFA 013 [9]).	
Step 2 (M)	NFV-MANO modifies the requested information and/or configuration about the subject VNF instance.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The non-application information and/or configuration of the subject VNF instance managed by NFV-MANO instance has been modified.	
Traceability	REQ-NFV_CM_SYS-CON-5	

5.4.2.6 Retrieve non-application information of a VNF instance managed by NFV-MANO

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To retrieve by 3GPP management system from NFV-MANO non-application information of a subject VNF instance. Such information about a subject VNF instance is information managed by NFV-MANO (see clause 9.4.2 in ETSI GS NFV-IFA 008 [10]).	
Actors and Roles	3GPP management system queries the VNF instance information.	
Telecom resources	3GPP management system. NFV-MANO	
Assumptions	N/A	
Pre-conditions	N/A	
Begins when	3GPP management system determines to retrieve certain information about a subject VNF instance that is managed by NFV-MANO.	
Step 1 (M)	3GPP management system sends a request to NFV-MANO querying the needed non-application information about the subject VNF instance (see related interface requirements in clause 5.2.1.1 in ETSI GS NFV-IFA 008 [10] and in clause 5.3.2 in ETSI GS NFV-IFA 013 [9]).	
Step 2 (M)	NFV-MANO returns to 3GPP management system the information requested about the subject VNF instance.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	3GPP management system has the non-application information about the subject VNF instance managed by NFV-MANO.	
Traceability	REQ-NFV_CM_SYS-CON-6	

5.4.3   PM use cases

5.4.3.1   Use case of mitigating the VNF performance bottleneck

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To mitigate the VNF performance bottleneck.	
Actors and Roles	3GPP management system.	
Telecom resources	NFV-MANO VNF	
Assumptions	3GPP management system is set up to collect VNF performance measurements and NFV-MANO is set up to collect VNF performance measurements related to virtualized resource.	
Pre-conditions	VNF application threshold crossing trigger and VNF-related virtualized resource threshold crossing trigger have been set up by corresponding system(s) (i.e. 3GPP management system or NFV-MANO system).	
Begins when	The VNF performance measurement report(s), VNF performance measurement report(s) related to virtualized resource or the thresholds crossing alarm(s) are generated.	
Step 1 (M)	3GPP management system receives the VNF performance measurement report(s), VNF performance measurement report(s) related to virtualized resource or the thresholds crossing alarm(s).	
Step 2 (M)	3GPP management system decides to optimize the VNF performance and mitigate the VNF performance bottleneck.	
Step 3 (M)	3GPP management system requests VNF LCM operation (e.g. expansion) towards NFV-MANO.	
Ends when	NFV-MANO executes the VNF LCM operation.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The VNF performance bottleneck has been mitigated after the VNF LCM operation.	
Traceability	**REQ-NFV_PM_SYS-CON-3**	

5.4.3.2 Use case for collection of VNF PM data related to virtualized resource from NFV-MANO

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	3GPP management system gets the VNF PM data related to virtualized resource.	
Actors and Roles	3GPP management system	
Telecom resources	3GPP management system NFV-MANO	
Assumptions	NFV-MANO is set up to collect VNF-related virtualized resource performance measurements and generates the report of VNF PM data related to virtualized resource.	
Pre-conditions	The collection mechanism for VNF PM data related to virtualized resource has been established both at 3GPP management system and NFV-MANO.	
Begins when	3GPP management system needs the VNF PM data which are related to virtualized resource and sets the PM job for them. And VNF PM data related to virtualized resource is generatedby NFV-MANO.	
Step 1 (M)	NFV-MANO provides the VNF PM data related to virtualized resource to 3GPP manamement system.	
Step 2 (M)	3GPP management system receives the VNF PM data related to virtualized resource.	
Ends when	Ends when all mandatory steps identified above are successfully completed.	
Exceptions	None.	
Post-conditions	3GPP management system has the performance data desired.	
Traceability	**REQ-NFV_PM_SYS-CON-2, REQ-NFV_PM_SYS-CON-4**	

5.4.4　LCM use cases

5.4.4.1　Use case of NS instance Deployment

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To deploy a NS instance in a mobile network that includes virtualized network functions	
Actors and Roles	3GPP management system (NM part).	
Telecom resources	NFV-MANO.	
Assumptions	Existing VNF instance(s) could be used by the new NS instance. Any NSD may be reused for instantiating multiple NS instances. 3GPP management system is subscribed to receive NS lifecycle change notifications.	
Pre-conditions	The NSD to be used for the NS instantiation has been on-boarded on NFV-MANO.	
Begins when	3GPP management system determines that a new NS instance is to be instantiated.	
Step 1 (M)	3GPP management system determines the type and capacity of a NS instance, and sets NS instantiation request with proper parameters.	
Step 2 (M)	3GPP management system sends NS instantiation request to NFV-MANO.	
Step 3 (M)	NFV-MANO instantiates the NS instance based on request from 3GPP management system.	
Ends when	3GPP management system receives notification from NFV-MANO that a new NS instance is instantiated.	
Exceptions	One of the steps identified above fails.	
Post-conditions	A new NS instance is ready for service.	
Traceability	**REQ-NFV_LCM_SYS-CON-1, REQ-NFV_LCM_SYS-CON-5, REQ-NFV_LCM_SYS-CON-17**	

5.4.4.2 Use case of updating an NS instance to a different NSD version

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	The network operator through 3GPP management system can decide when and has the capacity to update the NS instance (created based on an NSD of certain version) to correspond to a different NSD version.	
Actors and Roles	3GPP management system.	
Telecom resources	NFV-MANO	
Assumptions		
Pre-conditions	The information, to update an existing NS instance, to correspond to a different NSD version exists. The different NSD version has been on-boarded on NFV-MANO.	
Begins when	3GPP management system needs to update an existing NS instance (created based on an NSD of certain version) to correspond to the different NSD version.	
Step 1 (M)	3GPP management system requests to NFV-MANO to update the NS instance to correspond to the different NSD version, instructing NFV-MANO not to synchronize automatically the NS instance to the different NSD version.	
Step 2 (M)	NFV-MANO executes the NS update operation and acknowledges to 3GPP management system the successful update of the NS instance to correspond to the different NSD version.	
Step 3 (M)	3GPP management system requests to NFV-MANO to update the NS instance based on the different NSD version.	
Step 4 (M)	NFV-MANO executes the NS update operation and acknowledges to 3GPP management system the successful NS instance update.	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The NS instance has been updated to correspond to the different NSD version.	
Traceability	**REQ-NFV_LCM_SYS-CON-1,** REQ-NFV_LCM_SYS-CON-7	

5.4.4.3   Use cases of NE deployment in the context of NFV

5.4.4.3.1   Use case of NE deployment in the scenario of Managed Object(s) creation is after the VNF instantiation

Use Case Stage	Evolution/Specification	<<Uses>> Related use
Goal	To deploy a NE in a mobile network that includes virtualized network functions	
Actors and Roles	3GPP management system (NM, EM) creates and configures Managed Object(s) for the corresponding VNF instance. NFV-MANO system instantiates VNF instance according to the request from 3GPP management system.	
Telecom resources	3GPP management system NFV-MANO system	
Assumptions	3GPP management system and NFV-MANO system are in operational status.	
Pre-conditions	Operator has decided the type and capacity of the NE to be deployed.	
Begins when	Operator decides to deploy a new NE.	
Step 1 (M)	3GPP management system sends the VNF instantiation request to NFV-MANO system.	
Step 2 (M)	NFV-MANO system instantiates the VNF instance.	
Step 3 (M)	3GPP management system receives the result of VNF instantiation from NFV-MANO system.	
Step 4 (M)	3GPP management system creates Managed Object(s) for the instantiated VNF instance when needed.	
Step 5 (M)	3GPP management system configures the VNF instance with Managed Object attributes when needed.	
Ends when	Ends when all mandatory steps identified above are successfully completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The new NE is deployed and ready for providing service.	
Traceability	TBD	

5.4.4.4   Use case for notifications about VNF lifecycle changes

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To monitor by 3GPP management system of lifecycle changes on VNF instances.	
Actors and Roles	3GPP management system subscribes to and receives VNF lifecycle change notifications.	
Telecom resources	3GPP management system. NFV-MANO system. VNF.	
Assumptions		
Pre-conditions	NFV-MANO system is running.	
Begins when	3GPP management system determines to monitor VNF lifecycle changes on a managed VNF instance.	
Step 1 (M)	3GPP management system requests a subscription to NFV-MANO system to receive VNF lifecycle change notifications regarding a managed VNF instance.	
Step 2 (M)	NFV-MANO system creates a subscription and acknowledges the subscription to 3GPP management system.	
Step 3 (M)	When managed VNF instance has a lifecycle change, NFV-MANO system creates and sends VNF lifecycle change notification including information to identify the VNF instance subject to lifecycle change, the type of procedure, and whether it is the start or end of the procedure.	
Ends when	3GPP management system unsubscribes to VNF lifecycle change notifications regarding the managed VNF instance.	
Exceptions		
Post-conditions	The 3GPP management system has information about VNF lifecycle changes of the managed VNF instance.	
Traceability	**REQ-NFV_LCM_SYS-CON-9, REQ-NFV_LCM_SYS-CON-15**	

NOTE: VNF lifecycle change notifications are supported by NFV-MANO system [2].

5.4.4.5 Use case of VNF instance scaling through operation request by 3GPP management system

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To expand/contract a VNF instance by scaling the VNF instance.	
Actors and Roles	3GPP management system detects the need for scaling and sends the VNF scaling request.	
Telecom resources	3GPP management system. NFV-MANO system. VNF. NFVI.	
Assumptions	3GPP management system is subscribed to VNF lifecycle change notifications from the NFV-MANO system.	
Pre-conditions	The subject VNF instance is not being scaled at the moment. VNFM (part of NFV-MANO system) does not have any auto-scaling scripts or the policy for auto-scaling is not in use or active. Note: Determining whether "the subject VNF instance is not being scaled" can be done through the lifecycle change notification as described in clause 5.4.4.4 of TS 28.500. Determining whether "there is no auto-scaling scripts or policy for auto-scaling is not used or active" can be done by sending a query request for the subject VNF instance from the 3GPP management system to the NFV-MANO system as described in clause 6.4.7 of TS 28.510 [11].	"Use case for notifications about VNF lifecycle changes" (see clause 5.4.4.4 of TS 28.500) "Retrieve VNF instance information from VNFM by EM" (see clause 6.4.7 in TS 28.510 [11])
Begins when	3GPP management system detected the need to scale and have determined the scaling action (expand/contract).	
Step 1 (M)	3GPP management system sends to NFV-MANO system a request to expand/contract the managed VNF instance.	
Step 2 (M)	NFV-MANO system executes the scaling of the VNF instance.	
Step 3 (M)	NFV-MANO system notifies 3GPP management system about the end of the VNF scaling execution.	
Ends when	All the steps identified above are successfully completed.	
Exceptions		
Post-conditions	The VNF instance has been scaled (expansion/contraction).	
Traceability	**REQ-NFV_LCM_SYS-CON-4, REQ-NFV_LCM_SYS-CON-9, REQ-NFV_LCM_SYS-CON-10**	

5.4.4.6 Use case of enabling/disabling the auto-scaling of the corresponding VNF instance(s)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	According to the management requirement, operators need to enable/disable the auto-scaling of a VNF instance(s).	
Actors and Roles	3GPP management system requests the enabling/disabling the auto-scaling of the corresponding VNF instance(s) for an NE.	
Telecom resources	NFV-MANO, VNF	
Assumptions	The auto-scaling, which means automatic procedure controlled and executed by NFV-MANO to scale the capacity of a VNF instance.	
Pre-conditions		
Begins when	The operator decides to enable/disable the auto-scaling of the corresponding VNF instance(s) for an NE.	
Step 1 (M)	3GPP management system requests NFV-MANO to enable/disable the auto-scaling of the corresponding VNF instance(s) for the subject NE.	
Step 2 (M)	NFV-MANO enables/disables the auto-scaling function towards the specific VNF instance(s).	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The auto-scaling of the corresponding VNF instance(s) for an NE is enabled/disabled.	
Traceability	**REQ-NFV_LCM_SYS-CON-13**	

5.4.4.7 Determination on the termination of the corresponding VNF instance(s)

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	The operator determines to terminate a VNF instance(s) based on the operator's needs or the pre-configuration policy.	
Actors and Roles	3GPP management system requests the termination of the corresponding VNF instance(s) for an NE.	
Telecom resources	NFV-MANO, VNF	
Assumptions	The operator makes the decision to terminate the corresponding VNF instance(s) for an NE.	
Pre-conditions		
Begins when	3GPP management system completes the preparation for the VNF termination.	
Step 1 (M)	3GPP management system requests NFV-MANO to terminate the corresponding VNF instance(s).	
Step 2 (M)	NFV-MANO completes the termination operation towards the specific VNF instance(s).	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails.	
Post-conditions		
Traceability	**REQ-NFV_LCM_SYS-CON-12**	

6 Management architecture

6.1 Overview

The following clauses elaborate the management architecture of mobile networks which include virtualized network functions and clarify the relationship between 3GPP management architecture and NFV-MANO framework (ETSI GS NFV-MAN 001 [3]).

The following clauses focus on the aspects of the NFV introduction in mobile network and the impacts to the existing 3GPP management system, which is composed of NM and DM/EM (as shown in figure 6.1.1-1). Hence, they mainly address the functionalities to 3GPP management system and the requirements on the NFV-MANO through related reference points (i.e. Os-Ma-nfvo, Ve-Vnfm-em, Ve-Vnfm-vnf). They do not address any of the definitions of the NFV-MANO framework and interfaces. The detailed descriptions for those are in-scope of ETSI NFV documents, which are referred to below.

6.1.1 Management architecture

Figure 6.1.1-1 illustrates the management architecture of mobile networks that include virtualized network functions.
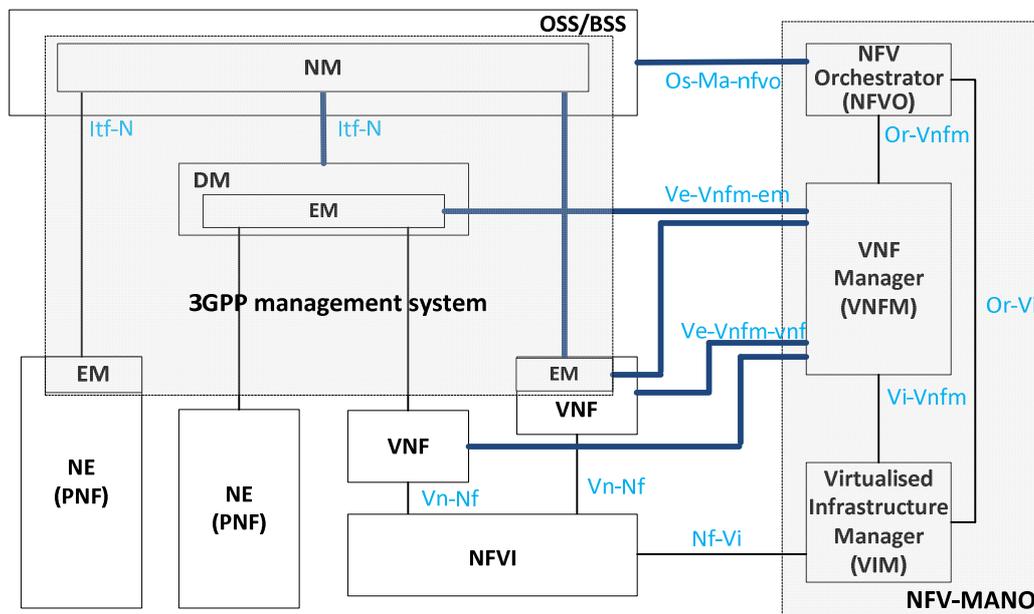
Figure 6.1.1-1: The mobile network management architecture mapping relationship between 3GPP and NFV-MANO architectural framework

Physical mobile network management mainly relies on the interface Itf-N. With the introduction of NFV, mobile network management needs to also specify the virtualized network functions management. It involves not only one interface Itf-N, but also the interaction with NFV-MANO through defined reference points.

The management architecture in present document aligns with the NFV-MANO framework (ETSI NFV-MAN 001 [3]) with emphasis on the following aspects:

1) Mobile network is composed of physical and virtualized network elements. Application-specific aspects of both VNFs and PNFs, corresponding to physical NEs, shall be managed by 3GPP management system.

2) The architecture identifies the following entities which are defined in TS 32.101 [5], both of them are needed to extend the management functionalities for virtualized network and VNF:

   - NM, which plays one of the roles of OSS/BSS and is the consumer of reference point Os-Ma-nfvo.

   - DM/EM, if the EM includes the extended functionality, it can manage both PNF(s) and VNF(s).

3) The architecture identifies the following entities that share interfaces with NM, DM/EM and VNF:

  - NFV Orchestrator (NFVO)

  - VNF Manager (VNFM)

4) The architecture identifies the following main interfaces/reference points:

  - Itf-N, the interface between NM and DM/EM

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

NOTE: In 3GPP specification, NM plays one of the roles of OSS/BSS.

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

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

6.1.2 Functional blocks in the management architecture

6.1.2.1 NM

NM plays one of the roles of OSS/BSS. It provides the functions for the management of mobile network which includes virtualized network functions. The NM supports FCAPS management functions of the mobile network (e.g. IMS, EPC) and 3GPP service (e.g. data service, voice service) and supports the management of mobile network lifecycle. NM initiates the lifecycle management of ETSI-defined NS and VNF, which are related to mobile network, through interaction with NFV-MANO.

6.1.2.2 EM/DM

EM/DM is responsible for FCAPS management functionality for a VNF on an application level and physical NE on a domain and element level. This mainly includes:

  - Fault management for VNF and physical NE.

  - Configuration management for VNF and physical NE.

  - Accounting management for VNF and physical NE.

  - Performance measurement and collection for VNF and physical NE.

  - Security management for VNF and physical NE.

EM/DM participates in lifecycle management functionality for a VNF. This includes:

  - Request the lifecycle management operation for a VNF to VNFM.

  - Exchange of information regarding the VNF and Virtualized Resources associated with the VNF.

6.1.2.3 NFV-MANO

NFV-MANO is composed of NFV Orchestrator (NFVO), VNF Manager (VNFM) and VIM. The main functionalities of those are defined in ETSI GS NFV-MAN 001 [3].

6.1.2.4 NFVI

NFVI is composed of the hardware and software components that together provide the infrastructure resources where VNFs are deployed. The infrastructure resources contain the hardware resources, virtualization layer software and the virtualized resources which the VNF relies on. The main functionalities are defined in ETSI GS NFV-MAN 001 [3].

6.2 Management interfaces

6.2.1 Overview

The following clauses describe the high level functionalities of the Itf-N interface, the Os-Ma-nfvo, Ve-Vnfm-em and Ve-Vnfm-vnf reference points from 3GPP perspective.

6.2.2 Itf-N

The interface is used for FCAPS exchanges between NM and EM/DM, which includes both VNF and physical NE FCAPS management functions.

6.2.3 Os-Ma-nfvo

This reference point is used for NS lifecycle management, NS performance management, NS fault management, NSD management and VNF Package management produced by NFVO as defined by ETSI GS NFV-IFA 013 [9].

6.2.4 Ve-Vnfm-em and Ve-Vnfm-vnf

These reference points are mainly used for VNF lifecycle management, the information delivery of VNF and VR failure or performance measurement information and virtualization configuration, etc.

Annex A:
Change history

Change history							
Date	**Meeting**	**TDoc**	**CR**	**Rev**	**Cat**	**Subject/Comment**	**New version**
2017-01	SA#74					Version under change control	14.0.0
2017-03	SA#75	SP-170143	0001	1	F	Clarify interface/reference point related to VNF capabilities	14.1.0
2018-06	-	-	-	-	-	Update to Rel-15 version (MCC)	**15.0.0**
2020-07	-	-	-	-	-	Update to Rel-16 version (MCC)	**16.0.0**

History

Document history		
V16.0.0	August 2020	Publication