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**LTE;  
Telecommunication management;  
Life Cycle Management (LCM) for mobile networks  
that include virtualized network functions;  
Requirements  
(3GPP TS 28.525 version 15.0.0 Release 15)**



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# Foreword

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# Introduction

The present document is part of a TS-family covering the 3<sup>rd</sup> Generation Partnership Project Technical Specification Group Services and System Aspects, Telecommunication Management; as identified below:

**TS 28.525: Telecommunication management; Life Cycle Management (LCM) for mobile networks that include virtualized network functions; Requirements.**

TS 28.526: Telecommunication management; Life Cycle Management (LCM) for mobile networks that include virtualized network functions; Procedures.

TS 28.527: Telecommunication management; Life Cycle Management (LCM) for mobile networks that include virtualized network functions; Stage 2.

TS 28.528: Telecommunication management; Life Cycle Management (LCM) for mobile networks that include virtualized network functions; Stage 3.

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# 1 Scope

The present document (together with the relevant requirements described in [2], [3] and [4]) specifies the requirements applicable to Lifecycle Management (LCM) for mobile networks that include virtualized network functions.

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# 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] 3GPP TS 28.500: "Telecommunication management; Concept, architecture and requirements for mobile networks that include virtualized network functions".
- [3] 3GPP TS 32.101: "Telecommunication management; Principles and high level requirements".
- [4] 3GPP TS 32.102: "Telecommunication management; Architecture".
- [5] ETSI GS NFV-IFA 010 (V2.2.1) (2016-09): "Network Functions Virtualisation (NFV); Management and Orchestration; Functional Requirements Specification".
- [6] ETSI GS NFV-IFA 013 (V2.1.1) (2016-10): "Network Function Virtualisation (NFV); Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".
- [7] 3GPP TS 28.520: "Telecommunication management; Performance Management (PM) for mobile networks that include virtualized network functions; Requirements".
- [8] ETSI GS NFV-IFA 008 (V2.1.1) (2016-10): "Network Function Virtualisation (NFV); Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".
- [9] ETSI GS NFV-IFA 011 (V2.1.1) (2016-10): "Network Functions Virtualisation (NFV); Management and Orchestration; VNF Packaging Specification".
- [10] ETSI GS NFV-IFA 014 (V2.1.1) (2016-10): "Network Functions Virtualisation (NFV); Management and Orchestration; Network Service Templates Specification".
- [11] 3GPP TS 28.510: "Telecommunication management; Configuration Management (CM) for mobile networks that include virtualized network functions; Requirements".
- [12] 3GPP TS 28.515: "Telecommunication management; Fault Management (FM) for mobile networks that include virtualized network functions; Requirements".
- [13] 3GPP TS 32.501: "Telecommunication management; Self-configuration of network elements; Concepts and requirements".

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## 3 Definitions and abbreviations

### 3.1 Definitions

For the purposes of the present document, the terms and definitions given in 3GPP TR 21.905 [1], 3GPP TS 28.500 [2] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1] or in 3GPP TS 28.500 [2].

### 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP TR 21.905 [1], 3GPP TS 28.500 [2] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in 3GPP TR 21.905 [1] or in 3GPP TS 28.500 [2].

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## 4 Concepts and background

3GPP mobile network management standards incorporate the Life Cycle Management (LCM) provided by the ETSI NFV defined NFVO and VNFM functional blocks, facilitating the installation, dimensioning, layer 2 and 3 interconnection, healing and recovery of 3GPP-defined network functions that are virtualized.

Some requirements specified in TS 28.500 [2], TS 28.510 [11], TS 28.515 [12], TS 28.520 [7] and TS 28.525 specifications on telecommunication management for mobile networks that include virtualized network functions, are related to or using the LCM exposed by NFVO and VNFM functional blocks. The LCM operation requests, responses and notifications can carry parameters. In the context of the 3GPP mobile network management standards, the parameters used in the LCM operation requests, responses and notifications are not the 3GPP-defined network function parameters.

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## 5 Business level requirements

### 5.1 Requirements

**REQ-NFV\_LCM-CON-1** VNFM shall have a capability to handle subscription and un-subscription to VNF lifecycle change notifications (see requirements Vnm.VnfLcm.001 in [5] and Ve-Vnm-em.VnfLcn.001 in [8]).

**REQ-NFV\_LCM-CON-2** VNFM shall have the capability to process a request for scaling a virtualized network function (see requirements Vnm.VnfS.001, Vnm.VnfS.002, Vnm.VnfS.003, Vnm.VnfS.004 in [5] and Ve-Vnm-em.VnfLcm.001 in [8]).

**REQ-NFV\_LCM-CON-3** VNFM shall have the capability to notify about lifecycle changes of a virtualized network function (see requirements Vnm.VnfLcm.001 in [5], Ve-Vnm-em.VnfLcn.002, Ve-Vnm-em.VnfLcn.003 and Ve-Vnm-em.VnfLcn.004 in [8]).

**REQ-NFV\_LCM-CON-4** EM shall have a capability allowing NM to enable/disable the auto-scaling of the corresponding VNF instance(s) for an NE.

**REQ-NFV\_LCM-CON-5** VNFM shall provide a capability allowing EM to enable/disable the auto-scaling of a specific VNF instance(s) (see requirement Ve-Vnm-em.VnfCm.001 in [8] and clause 7.1.12 in [9]).

**REQ-NFV\_LCM-CON-6** NFVO shall have the capability allowing NM to request instantiation of a NS (see requirements Nfvo.NsI.001 in [5] and Os-Ma-nfvo.NsLcm.001 in [6]).

**REQ-NFV\_LCM-CON-7** NFVO shall have the capability allowing NM to request termination of a NS (see requirements Nfvo.NsT.001 in [5] and Os-Ma-nfvo.NsLcm.002 in [6]).

**REQ-NFV\_LCM-CON-8** NFVO shall have the capability allowing NM to request querying a NS (see requirement Os-Ma-nfvo.NsLcm.003 in [6]).

**REQ-NFV\_LCM-CON-9** NFVO shall have the capability allowing NM to request scaling of a NS (see requirements Nfvo.NsS.001, Nfvo.NsS.002 and Os-Ma-nfvo.NsLcm.004 in [6]).



**REQ-NFV\_LCM-CON-10** NFVO shall have the capability allowing NM to request updating of a NS (see requirements Nfvo.NsU.001 and Os-Ma-nfvo.NsLcm.005 in [6]).

**REQ-NFV\_LCM-CON-11** NFVO shall have the capability allowing NM to request healing of a NS (see requirement Os-Ma-nfvo.NsLcm.010 in [6]).

**REQ-NFV\_LCM-CON-12** NFVO shall have the capability allowing NM to request scaling of a virtualized network function as part of NS scaling (see requirements Nfvo.NsS.003 in [5] and Os-Ma-nfvo.NsLcm.014 in [6]).

NOTE 1: Disabling auto-scaling means VNFM is not allowed to start new auto-scaling operation to scale the corresponding VNF instance(s).

NOTE 2: Enabling auto-scaling means VNFM is allowed to start new auto-scaling operation to scale the corresponding VNF instance(s).

**REQ-NFV\_LCM-CON-13** NFVO shall provide a capability allowing NM to request enabling/disabling the auto-scaling of specific VNF instance(s) as part of NS updating (see requirement Os-Ma-nfvo.NsLcm.020 in [6] and clause 7.1.12 in [9]).

**REQ-NFV\_LCM-CON-14** NM shall have the capability to synchronize with the NFVO changes performed by 3GPP management system related to configuration and information managed by NFV-MANO about NS and VNF instances.

**REQ-NFV\_LCM-CON-15** VNF instance shall support the capability to use MvPnP (see requirements in clause 5.2 of [13]) to establish connection to its managing Element Manager without manual configuration.

**REQ-NFV\_LCM-CON-16** The VNFM shall have a capability to allow EM to query information held by the VNFM about a VNF instance.

**REQ-NFV\_LCM-CON-17** The NFVO shall have a capability to allow NM to query information about a VNF instance as part of NS querying (see requirement Nfvo.VnfLcm.006 in ETSI GS NFV-IFA 010 [5] and Os-Ma-nfvo.NsLcm.015 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM-CON-18** The NFVO shall have a capability to allow NM to request modifying non-application configuration attributes of a VNF instance as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.020 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM-CON-19** The NFVO shall have a capability to allow NM to request modifying non-application information about a VNF instance as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.019 in ETSI GS NFV-IFA 013 [6]).

## 5.2 Actor roles

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

## 5.3 Telecommunications resources

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

## 5.4 High-level use cases

### 5.4.1 Enabling/disabling the auto-scaling of the corresponding VNF instance(s) for an NE

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Enable/Disable the auto-scaling of a VNF instance(s).	
<b>Actors and Roles</b>	NM requests the enabling/disabling the auto-scaling of the corresponding VNF instance(s) for an NE.	
<b>Telecom resources</b>	EM, NM, VNFM	
<b>Assumptions</b>	The auto-scaling, which means automatic procedure controlled and executed by the VNFM to scale the capacity of a VNF instance, is supported by VNFM.	
<b>Pre-conditions</b>		
<b>Begins when</b>	The operator decides to enable/disable the auto-scaling of the corresponding VNF instance(s) for an NE.	
<b>Step 1 (M)</b>	NM requests EM to enable/disable the auto-scaling of the corresponding VNF instance(s) for the subject NE.	
<b>Step 2 (M)</b>	EM requests VNFM to enable/disable the auto-scaling of the specific VNF instance(s).	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The auto-scaling of the corresponding VNF instance(s) for an NE is enabled/disabled.	
<b>Traceability</b>	REQ-NFV_LCM-CON-4, REQ-NFV_LCM-CON-5	

### 5.4.2 NS scaling using VNF LCM operation (that is a part of NS LCM operation) based on PM data monitoring at NM level

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	To execute VNF LCM operation as a part of NS LCM operation when the threshold crossing of VNF application PM data is detected.	
<b>Actors and Roles</b>	NM requests the VNF LCM operation as a part of NS LCM operation. NFVO executes the VNF LCM operation as a part of NS LCM operation based on the request from NM.	
<b>Telecom resources</b>	NM, NFVO, VNF	
<b>Assumptions</b>	NM is receiving VNF application specific performance measurements. The VNF is a part of a NS.	
<b>Pre-conditions</b>	NM monitors VNF application specific PM data.	
<b>Begins when</b>	NM detected threshold crossing on a VNF application performance measurement.	
<b>Step 1 (M)</b>	NM sends the NFVO a NS scaling request including target VNF instance and type of scaling (e.g., expansion).	
<b>Step 2 (M)</b>	NFVO sends to NM a notification about the start of the NS scaling execution.	
<b>Step 3 (M)</b>	The NFVO executes the procedure to scale the NS instance.	
<b>Step 4 (M)</b>	NFVO sends to NM a notification about the end of the NS scaling execution.	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>		
<b>Post-conditions</b>	Threshold crossing condition of VNF application is resolved as a result of NS scaling operation.	
<b>Traceability</b>	REQ-NFV_LCM-CON-12	

### 5.4.3 Enabling/disabling the auto-scaling of the corresponding VNF instance(s) through NFVO as part of NS LCM

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Enable/Disable the auto-scaling functionality of a VNF instance(s) as part of NS LCM operation.	
<b>Actors and Roles</b>	NM requests, as part of NS LCM, to enable/disable the auto-scaling of the corresponding VNF instance(s).	
<b>Telecom resources</b>	NM. NFVO. VNFM.	
<b>Assumptions</b>	The auto-scaling, which means automatic procedure controlled and executed by the VNFM to scale the capacity of a VNF instance, is supported.	
<b>Pre-conditions</b>	N/A	
<b>Begins when</b>	The operator decides to enable/disable the auto-scaling of the certain VNF instance(s).	
<b>Step 1 (M)</b>	NM requests NFVO, as part of NS LCM, to enable/disable the auto-scaling of the corresponding VNF instance(s).	
<b>Step 2 (M)</b>	NFVO (together with VNFM) enables/disables the auto-scaling of the specific VNF instance(s).	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The auto-scaling of the corresponding VNF instance(s) is enabled/disabled.	
<b>Traceability</b>	REQ-NFV_LCM-CON-13	

### 5.4.4 VNF application software update use cases

#### 5.4.4.1 Introduction

There are two possibilities with regards to the relation between VNF application software and VNF Package:

- a) the VNF application software is part, or
- b) it is not a part of the VNF package.

The use cases in clause 5.4.4 introduce the different VNF application software update cases.

#### 5.4.4.2 VNF application software update when application software is not part of VNF Package

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Update the VNF application software when the application software is not part of the VNF Package.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NM, EM and VNF	
<b>Assumptions</b>	1) The VNF application software is not part of the VNF package. 2) The VNF application software update does not require a change of the VNF's underlying virtualized resources or internal VNFC(s) topology/composition.	
<b>Pre-conditions</b>	The new application software is available.	
<b>Begins when</b>	Operator decides to update the application software and instructs the NM to do so.	
<b>Step 1 (M)</b>	NM requests EM to update the application software.	
<b>Step 2 (M)</b>	EM updates the application software.	
<b>Step 3 (M)</b>	EM notifies NM about the completion of the application software update.	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The VNF application software is updated.	
<b>Traceability</b>	FFS	

### 5.4.4.3 VNF application software update when application software is part of VNF Package

#### 5.4.4.3.1 VNF application software update when application software is part of VNF Package and performing synchronization with NFV-MANO by NM

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Update the VNF instance application software (software) when the software is part of the VNF Package.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	EM NFV-MANO system VNF	
<b>Assumptions</b>	1) The software is part of the VNF package. 2) The software update does not require a change of the VNF's underlying virtualised resources or internal VNFC(s) topology/composition.	
<b>Pre-conditions</b>	The new VNF package, with the updated software, is on boarded on NFV-MANO. See NOTE1.	
<b>Begins when</b>	Operator decides to update the software (with the new VNF package) and instructs the NM to do so.	
<b>Step 1 (M)</b>	NM requests EM to update the software.	
<b>Step 2 (M)</b>	EM acted to update the software.	
<b>Step 3 (M)</b>	EM notifies NM about the completion of the software update.	
<b>Step 4 (M)</b>	NM confirms the normality of 3GPP service and requests NFVO to update the VNF instance information. The updated VNF instance information would capture information of the new VNF package. See NOTE2.	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The software and the VNF instance information are updated.	
<b>Traceability</b>	REQ-NFV_LCM-CON-14	

NOTE 1: It is assumed that the package integrity is verified as part of the on-boarding process.

NOTE 2: How NFVO updates the VNF instance information and whether there is a need for additional steps on NFV-MANO to avoid introducing any security threat or failure (e.g. run-time integrity check) is out of the scope of the present document.

## 5.4.5 Providing initial configuration data in VNF instantiation use cases

### 5.4.5.1 Introduction

There are several possibilities with regards to providing the initial configuration data (e.g. IP address of the managing EM) to the VNF in instantiation use cases. Some of the possibilities (those described in clauses 5.4.5.3.1 and 5.4.5.3.2) rely on functionalities provided by the VNFM while others (described in clause 5.4.5.2) may be considered independent from the ETSI NFV defined functional blocks.

### 5.4.5.2 Managing EM IP address provided to instantiated VNF using MVPNP

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Enable connection of newly instantiated VNF to the managing Element Manager	
<b>Actors and Roles</b>	VNF	
<b>Telecom resources</b>	IP networks: Non-Secure Operator Network, External Network, and its elements like DHCP server optionally DNS, CA/RA servers, Security Gateway(s) (each protecting one or more Secure Operator Networks); Secure Operator Network and its elements such as DHCP server, DNS server, Element Manager(s)	
<b>Assumptions</b>	The vendor of 3GPP NE implemented as a VNF prefers to utilize the MVPnP standardized mechanisms for VNF connection to the Element Manager. There may be one or more IP Autoconfiguration Services like DHCP and Router Advertisements and zero or more DNS servers.	
<b>Pre-conditions</b>	IP connectivity exists between the involved telecom resources. The involved telecom resources are functional. The relevant information is stored and available: <ul style="list-style-type: none"> <li>- Vendor Certificate at the VNF</li> <li>- Operator Certificate at the CA/RA (in case VNF connects to operator secure network via SeGW)</li> <li>- For the External Network or Non-Secure Operator Network (in case VNF connects to operator secure network via SeGW): <ul style="list-style-type: none"> <li>- (Outer) IP autoconfiguration information at the IP Autoconfiguration Service</li> <li>- FQDN of the initial OAM SeGW at the VNF and/or FQDN or IP address of the initial OAM SeGW at the IP Autoconfiguration Service</li> <li>- FQDN of the CA/RA servers at the VNF and/or FQDN or IP address of the CA/RA servers at the IP Autoconfiguration Service</li> <li>- If FQDNs need to be resolved, corresponding IP address(es) at the DNS server(s)</li> </ul> </li> <li>- For the Secure Operator Network: <ul style="list-style-type: none"> <li>- (Inner) IP autoconfiguration information at the IP Autoconfiguration Service or at the initial OAM SeGW</li> <li>- FQDN or IP address of the initial EMS at the VNF and/or DHCP Server of the Secure Operator Network.</li> <li>- If FQDNs need to be resolved, corresponding IP address(es) at the DNS server(s)</li> <li>- Configuration and software for the VNF at the EM(s)</li> </ul> </li> </ul>	
<b>Begins when</b>	VNFM instantiates a new VNF instance implementing 3GPP NE	
<b>Step 1 (M)</b>	If a VLAN ID is available, the VNF uses it. Otherwise the VNF uses the native VLAN where PnP traffic is sent and received untagged	
<b>Step 2 (M)</b>	The VNF acquires its IP address through stateful or stateless IP autoconfiguration. This may provide 0 or more DNS server addresses.	
<b>Step 3 (M)</b>	The VNF acquires the IP address of the CA/RA server. The FQDN of the CA/RA server may be pre-configured in the VNF or the FQDN or IP address of the CA/RA server may be provided by the IP Autoconfiguration Service. FQDNs are resolved through the DNS if necessary. Information provided by the IP Autoconfiguration Services shall supersede those pre-configured at the VNF.	
<b>Step 4 (M)</b>	The VNF performs Certificate Enrolment.	
<b>Step 5 (M)</b>	The VNF acquires the IP address of the OAM SeGW. The FQDN of the OAM SeGW may be pre-configured in the VNF or the FQDN or the IP address of the OAM SeGW may be provided by the IP Autoconfiguration Service. FQDNs are resolved through the DNS if necessary.	
<b>Step 6 (M)</b>	The VNF establishes a secure connection (tunnel) to the Security Gateway given by Step 5. The VNF receives its (inner) IP autoconfiguration information (which may be the same as the outer IP address obtained in step2) and optionally the address of one or more DNS servers within the Secure Operator Network from the Configuration Parameters of IKEv2 during tunnel establishment.	
<b>Step 7 (M)</b>	The VNF acquires the IP address of the correct Element Manager by either, issuing a DHCP request including the VNF provider information, resolving FQDNs via DNS if necessary, or by having a pre-configured FQDN (including the VNF provider information) resolved via DNS.	

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Step 8 (M)</b>	<p>The VNF establishes a connection to the provided EM and acquires its configuration and software if any.</p> <p>The configuration may contain an address to another EM that this specific node shall use as EM.</p> <p>The configuration may contain an address to another SeGW that should be used before connecting to the EM.</p> <p>The VNF may then</p> <ul style="list-style-type: none"> <li>- release the connection to the current EM and OAM SeGW and then restart (returning to step 1),</li> <li>- release the connection to the current EM and OAM SeGW and then return to step 6,</li> <li>- release the connection to the current EM and then repeat step 8, or</li> <li>- continue with step 9.</li> </ul>	
<b>Step 9 (M)</b>	<p>The VNF establishes necessary application (e.g. 3GPP signaling) layer connection(s) to the neighbor NEs using the transport (VLAN ID, IP addresses) and security parameters provided in step 8.</p>	
<b>Ends when</b>	<p>Ends when all mandatory steps identified above are successfully completed or when an exception occurs.</p>	
<b>Exceptions</b>	<p>One of the steps identified above fails.</p>	
<b>Post-conditions</b>	<p>One or more secure connections exist between the VNF and the Element Manager.</p> <p>The 3GPP NE (VNF instance) is being managed by EM.</p> <p>Via the connection to the Element Manager the VNF instance can receive further instructions to become operational and carry user traffic, e.g. the administrativeState is set to "unlocked".</p>	
<b>Traceability</b>	<p>REQ-NFV_LCM-CON-15</p>	

## 5.4.5.3 Managing EM IP address provided to instantiated VNF by VNFM

## 5.4.5.3.1 Managing EM IP address provided to VNFM by EM as VNF configuration data

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Enable connection of newly instantiated VNF to the managing EM	
<b>Actors and Roles</b>	EM	
<b>Telecom resources</b>	VNFM VNF Managing EM	
<b>Assumptions</b>	The vendor of 3GPP NE implemented as a VNF prefers to utilize the ETSI NFV standardized mechanisms for initial VNF configuration.	
<b>Pre-conditions</b>	The pre-conditions applicable to VNF instantiation requested by EM have been satisfied.	
<b>Begins when</b>	Operator decides to instantiate new VNF implementing 3GPP NE	
<b>Step 1 (M)</b>	EM requests VNFM to create a new VNF identifier (according to [8] clause 7.2.2)	
<b>Step 2 (M)</b>	VNFM creates a new VnfInfo object and returns the VNF instance identifier to the EM (according to [8] clause 7.2.2.4)	
<b>Step 3 (M)</b>	EM provides the managing EM IP address to the VNFM as a parameter of modify VNF configuration operation (according to [8] clause 7.6.2) together with VNF instance identifier received in step 2	
<b>Step 4 (M)</b>	VNFM updates the VnfInfo object with configuration data (managing EM IP address) received from EM and returns the operation result to EM (according to [8] clause 7.6.2.4)	
<b>Step 5 (M)</b>	EM request VNFM to instantiate a new VNF and provides specific VNF instance identifier received in step 2 (according to [8] clause 7.2.3)	
<b>Step 6 (M)</b>	VNFM initiates the VNF instantiation and returns the operation result to EM (according to [8] clause 7.2.3.4). The VNF instance is not associated to any NS, (see NOTE in clause 7.2.3.4 in [8]).	
<b>Step 7 (M)</b>	VNFM provides the newly instantiated VNF with the managing EM IP address using set initial configuration operation (according to [8] clause 6.2.2, see note 1)	
<b>Step 8 (O)</b>	If EM is subscribed to the VNF LCM notifications (according to [8] clause 7.3.2), VNFM notifies EM about the progress of VNF instantiation (according to [8] clause 7.3.3)	
<b>Step 9 (M)</b>	Newly instantiated VNF connects to the managing EM	
<b>Ends when</b>	Managing EM is able to manage the 3GPP NE (VNF instance)	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The 3GPP NE (VNF instance which is not associated to any NS) is being managed by EM	
<b>Traceability</b>		

NOTE 1: Step depends on the VNF behaviour that is outside of scope of 3GPP.

### 5.4.5.3.2 Managing EM IP address provided to VNFM by EM as VNF instantiation parameter

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Enable connection of newly instantiated VNF to the managing EM	
<b>Actors and Roles</b>	EM	
<b>Telecom resources</b>	VNFM VNF Managing EM	
<b>Assumptions</b>	The vendor of 3GPP NE implemented as a VNF prefers to utilize the ETSI NFV standardized mechanisms for initial VNF configuration.	
<b>Pre-conditions</b>	The pre-conditions applicable to VNF instantiation requested by EM have been satisfied.	
<b>Begins when</b>	Operator decides to instantiate new VNF implementing 3GPP NE	
<b>Step 1 (M)</b>	EM requests VNFM to create a new VNF identifier (according to [8] clause 7.2.2)	
<b>Step 2 (M)</b>	VNFM creates a new VnfInfo object and returns the VNF instance identifier to the EM (according to [8] clause 7.2.2.4)	
<b>Step 3 (M)</b>	EM request VNFM to instantiate a new VNF and provides specific VNF instance identifier received in step 2 and provides the managing EM IP address to the VNFM as additional parameter of instantiation (according to [8] clause 7.2.3)	
<b>Step 4 (M)</b>	VNFM maps the managing EM IP address value received as additional parameter of instantiation to the VNF configuration data (see note 1).	
<b>Step 5 (M)</b>	VNFM updates the VnfInfo object with configuration data (managing EM IP address) received from EM, initiates the VNF instantiation and returns the operation result to EM (according to [8] clause 7.2.3.4)	
<b>Step 6 (M)</b>	VNFM provides the newly instantiated VNF with the managing EM IP address using set initial configuration operation (according to [8] clause 6.2.2, see note 2)	
<b>Step 7 (O)</b>	If EM is subscribed to the VNF LCM notifications (according to [8] clause 7.3.2), VNFM notifies EM about the progress of VNF instantiation (according to [8] clause 7.3.3)	
<b>Step 8 (M)</b>	Newly instantiated VNF (but not associated to any NS, see NOTE in clause 7.2.3.4 in [8]) connects to the managing EM	
<b>Ends when</b>	Managing EM is able to manage the 3GPP NE (VNF instance)	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The 3GPP NE (VNF instance which is not associated to any NS) is being managed by EM	
<b>Traceability</b>		

NOTE 1: The mechanism for mapping additional parameter of instantiation into VNF configuration data is out of scope of 3GPP.

NOTE 2: Step depends on the VNF behaviour that is outside of scope of 3GPP.

## 6 Specification level requirements

### 6.1 Requirements

#### 6.1.1 Requirements for ltf-N

None.

#### 6.1.2 Requirements for Os-Ma-nfvo

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-1** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS instantiation request based on on-boarded NSD and parameterization specific for an NS (see requirement Os-Ma-nfvo.NsLcm.001 in [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-2** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS instantiation request using existing VNF instances (see requirement Os-Ma-nfvo.NsLcm.008 in [6]).



- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-3** The Os-Ma-nfvo reference point shall have the capability allowing NM to send VNF Package on-boarding request (see requirement Os-Ma-nfvo.VnfPkgm.001 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-4** The Os-Ma-nfvo reference point shall have the capability allowing NM to receive notification on the VNF Package on-boarding (see requirement Os-Ma-nfvo.VnfPkgm.006 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-5** The Os-Ma-nfvo reference point shall have the capability allowing NFVO to send information about VNF instances that constitute a NS (see requirements Os-Ma-nfvo.NsLcm.003 and Os-Ma-nfvo.NsLcm.015 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-6** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS termination request (see requirement Os-Ma-nfvo.NsLcm.002 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-7** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS query request (see requirement Os-Ma-nfvo.NsLcm.003 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-8** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS scaling request (see requirement Os-Ma-nfvo.NsLcm.004 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-9** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS updating request (see requirement Os-Ma-nfvo.NsLcm.005 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-10** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS healing request (see requirement Os-Ma-nfvo.NsLcm.010 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-11** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NS scaling request with scaling of VNF instances as part of NS scaling (see requirement Os-Ma-nfvo.NsLcm.014 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-12** The Os-Ma-nfvo reference point shall have the capability allowing NM to enable VNF Package (see requirement Os-Ma-nfvo.VnfPkgm.003 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-13** The Os-Ma-nfvo reference point shall have the capability allowing NM to disable VNF Package (see requirement Os-Ma-nfvo.VnfPkgm.002 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-14** The Os-Ma-nfvo reference point shall have the capability allowing NM to send NSD on-boarding request (see requirement Os-Ma-nfvo.Nsd.001 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-15** The Os-Ma-nfvo reference point shall have the capability allowing NM to receive acknowledgement on the NSD on-boarding (see requirement Os-Ma-nfvo.Nsd.001 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-16** The Os-Ma-nfvo reference point shall have the capability allowing NM to send a request with instantiating a VNF instance as part of the update of a NS (see requirement Os-Ma-nfvo.NsLcm.012 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-17** The Os-Ma-nfv reference point shall have the capability allowing NFVO to notify the addition, deletion or modification of the VNF instance, as result of the NS lifecycle change (see requirement Os-Ma-nfvo.NsLcn.002 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-18** The Os-Ma-nfvo reference point shall have the capability allowing NM to remove an existing VNF instance from a NS instance as part of the update of a NS (see requirement Os-Ma-nfvo.NsLcm.013 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-19** The Os-Ma-nfvo reference point shall have the capability allowing NM to subscribe/un-subscribe to NS instance lifecycle change notifications (see requirement Os-Ma-nfvo.NsLcn.001 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-20** The Os-Ma-nfvo reference point shall have the capability allowing NM to receive notifications regarding NS instance lifecycle changes (see requirement Os-Ma-nfvo.003 and Os-Ma-nfvo.NsLcn.001 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-21** The Os-Ma-nfvo reference point shall have the capability allowing NM to update an NSD (see requirement Os-Ma-nfvo.Nsd.004 in [6]).
- REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-22** The Os-Ma-nfvo reference point shall have the capability allowing NM to associate a different NSD version to an NS instance as part of NS update (see requirement Os-Ma-nfvo.NsLcm.025 in [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-23** The Os-Ma-nfvo reference point shall have the capability allowing NM to request the creation of a new VL instance interconnecting specific external CPs of specific VNF instances belonging to the same NS instance as part of the update of a NS.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-24** The Os-Ma-nfvo reference point shall have the capability allowing NM to request the addition of an existing VNF instance as part of the update of a NS (see requirement Os-Ma-nfvo.NsLcm.013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-25** The Os-Ma-nfvo reference point shall have the capability allowing NM to request the creation of a new SAP instance exposing specific external CP of a specific VNF instance belonging to the NS instance as part of the update of a NS.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-26** The Os-Ma-nfvo reference point shall have the capability allowing NM to request the instantiation of a new NS instance by adding existing VNF instances and new VL instances interconnecting specific external CPs of specific VNF instances.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-27** The Os-Ma-nfvo reference point shall have the capability allowing NM to request the instantiation of a new NS instance by adding existing NS instances and new VL instances interconnecting specific SAPs of specific nested NS instances.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-28** The Os-Ma-nfvo reference point shall have the capability allowing NM to create a new version of already on-boarded PNFD using Update PNFD operation (see requirement Os-Ma-nfvo.Nsd.010 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-29** The Os-Ma-nfvo reference point shall have the capability allowing NM to request creation of a NS instance identifier, and an associated instance of an NsInfo information element to enable further NS instantiation (see requirement Os-Ma-nfvo.NsLcm.021 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-30** The Os-Ma-nfvo reference point shall have the capability allowing NM to update the user defined data on PNFD using Update PNFD operation (See requirement Os-Ma-nfvo.Nsd.010 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-31** The Os-Ma-nfvo reference point shall have the capability allowing NM to delete one or more PNFDs (see requirement Os-Ma-nfvo.Nsd.011 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-32** The Os-Ma-nfvo reference point shall have the capability allowing NM to query the NFVO on certain attributes of one or more PNFDs (see requirement Os-Ma-nfvo.Nsd.012 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-33** The Os-Ma-nfvo reference point shall have the capability allowing NM to subscribe to receive notifications sent by the NFVO about changes of the NSD(s) (see requirement Os-Ma-nfvo.Nsd.013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-34** The Os-Ma-nfvo reference point shall have the capability allowing NM to receive notifications sent by the NFVO about changes of the NSD(s) (see requirements Os-Ma-nfvo.Nsd.007, Os-Ma-nfvo.Nsd.008 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-35** The Os-Ma-nfvo reference point shall have the capability allowing NM to request deletion of a NS instance identifier (See requirement Os-Ma-nfvo.NsLcm.022 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-36** The Os-Ma-nfvo reference point shall support a capability allowing NM to retrieve information about a VNF instance as part of NS querying (see requirement Os-Ma-nfvo.NsLcm.015 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-37** The Os-Ma-nfvo reference point shall support a capability allowing NM to request modifying non-application configuration attributes of a VNF instance as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.020 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-38** The Os-Ma-nfvo reference point shall support a capability allowing NM to request modifying non-application information about a VNF instance as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.019 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request to add an existing VNF instance to a NS with connectivity to other VNF instance or PNF as part of NS update.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request the addition of the external connectivity to a PNF or VNF instance as part of NS update.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request the addition of virtual link to a NS instance as part of NS update.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request to change of the external connectivity to a PNF or VNF instance as part of NS update.

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request the on-boarding of PNFD (covered by requirement Os-Ma-nfvo.Nsd.009 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request the addition of the VNFFG as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.027 in ETSI GS NFV-IFA 013 [6]).

**REQ-NFV\_LCM\_Os-Ma-nfvo-FUN-x** The Os-Ma-nfvo reference point shall support a capability allowing NM to request the update of the VNFFG as part of NS update (covered by requirement Os-Ma-nfvo.NsLcm.027 in ETSI GS NFV-IFA 013 [6]).

### 6.1.3 Requirements for Ve-Vnfm-em

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-1** The Ve-Vnfm-em reference point shall support a capability allowing EM to send VNF instantiation request (see requirement Ve-Vnfm-em.VnfLcm.002 in [8]).

NOTE: According to [8], the new VNF instance is instantiated but not associated to any NS (see note in clause 7.2.3.4 in [8]). The note in clause 7.2.3.4 in [8] reads: "In the present document, the operation result of the VNF instantiation request by EM cannot be determined to have the same result as VNF instantiation request as part of the NS LCM update operation performed through the NFVO (see clauses 7.3.5 and 8.3.4.10 in ETSI GS NFV-IFA 013 [i.5]), in particular in what concerns re-using the newly VNF instance at the NFVO level and associating it to a corresponding NS."

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-2** The Ve-Vnfm-em reference point shall support a capability allowing VNFM to inform EM the result of VNF instantiation (see requirement Ve-Vnfm-em.VnfLcn.001 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-3** The Ve-Vnfm-em reference point shall support a capability allowing EM to request the scaling of a VNF instance indicating the type of VNFC to scale and the number of scaling steps (see requirement Ve-Vnfm-em.VnfLcm.001 and clause 7.2.7.2 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-4** The Ve-Vnfm-em reference point shall support a capability allowing VNFM to notify about VNF instance lifecycle changes indicating the type of lifecycle procedure, whether it is the start or the end of the procedure, and the results of lifecycle procedure with indication of errors if the procedure is not successful (see requirement Ve-Vnfm-em.VnfLcn.002 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-5** The Ve-Vnfm-em reference point shall support a capability allowing EM to subscribe/un-subscribe to VNF instance lifecycle change notifications (see clause 7.5 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-6** The Ve-Vnfm-em reference point shall support a capability allowing EM to send VNF termination request (see requirement Ve-Vnfm-em.VnfLcm.003 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-7** The Ve-Vnfm-em reference point shall support a capability allowing VNFM to inform EM the result of VNF termination (see requirement Ve-Vnfm-em.VnfLcn.002 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-8** The Ve-Vnfm-em reference point shall support a capability allowing EM to request VNFM to enable/disable the auto-scaling of a specific VNF instance(s) (see requirement Ve-Vnfm-em.VnfCm.001 in [8] and clause 7.1.12 in [9]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-9** The Ve-Vnfm-em reference point shall support a capability allowing EM to request VNFM to create the VNF identifier (see requirement Ve-Vnfm-em.VnfLcm.001 in [8]).

**REQ-NFV\_LCM\_Ve-Vnfm-em-FUN-10** The Ve-Vnfm-em reference point shall support a capability allowing EM to retrieve from VNFM, information about a VNF instance, including VNFC instances and the configured virtual resources supporting the subject VNF instance.

### 6.1.4 Requirements for Ve-Vnfm-vnf

None.

## 6.2 Actor roles

See detailed actors and roles for each use case in clause 6.4.

## 6.3 Telecommunications resources

See detailed telecommunication resources for each use case in clause 6.4.

## 6.4 Use cases

### 6.4.1 VNF Instance use cases

#### 6.4.1.1 VNF identifier creation

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	EM requests to create a VNF identifier.	
Actors and Roles	EM	
Telecom resources	VNFM	
Assumptions	N/A	
Pre-conditions	NFVO is running.	
Begins when	EM decides to request to create a VNF identifier.	
Step 1 (M)	EM sends a request to VNFM to create the VNF identifier (see clause 7.2.2 [8])	
Step 2 (M)	VNFM returns <code>vnfInstanceId</code> to EM to indicate the creation of VNF identifier (see clause 7.2.2.3 [8])	
Ends when	Ends when EM receives the <code>vnfInstanceId</code> .	
Exceptions	One of the steps identified above fails.	
Post-conditions	The VNF identifier is created.	
Traceability	REQ-NFV_LCM_Ve-Vnfm-em-FUN-9	

## 6.4.1.2 VNF instantiation

## 6.4.1.2.1 VNF instantiation initiated through Ve-Vnfm-em

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	Create a VNF instance based on the local needs of the EM (e.g. for VNF validation prior to deployments in production environment).	
Actors and Roles	EM	
Telecom resources	VNFM	
Assumptions	The association of the new VNF instance to a NS instance enabling the VNF LCM granting operations and VR management is out of scope of 3GPP.	
Pre-conditions	The VNF Package for the VNF instantiation is enabled and is available to the VNFM. EM is subscribed to the VNF LCM notifications (see clause 7.3.2 [8]).	
Begins when	EM decides to instantiate a new VNF instance.	
Step 1 (M)	EM requests VNFM to create a new VNF instance Identifier (see clause 7.2.2 [8]) using the VNFD Id to identify the VNF Package to be used for instantiation.	
Step 2 (M)	VNFM responds to EM with new VNF instance Identifier	
Step 3 (M)	EM requests VNFM to instantiate the new VNF (see clause 7.2.3 [8]).	
Step 4 (M)	VNFM responds to EM with the operation result containing the lifecycle operation occurrence Id	
Step 5 (M)	VNFM sends the VNF lifecycle change notification to EM indicating the start of VNF instantiation procedure (see clause 7.3.3 [8]).	
Step 6 (M)	VNFM sends the VNF lifecycle change notification to EM indicating the success or failure of the VNF instantiation, when the VNF instantiation procedure is completed (see clause 7.3.3 [8]).	
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	A new VNF instance is instantiated but not associated to any NS (.see NOTE in clause 7.2.3.4 in [8]).	
Traceability	REQ-NFV_LCM_Ve-Vnfm-em-FUN-1, REQ-NFV_LCM_Ve-Vnfm-em-FUN-2.	

## 6.4.1.2.2 VNF instantiation initiated through Os-Ma-nfvo

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	Enable NM to add a VNF instance to a NS via Os-Ma-nfvo reference point.	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	N/A	
Pre-conditions	The VNF Package for the VNF instantiation is enabled.	
Begins when	NM decides to instantiate a VNF instance that is part of an NS.	
Step 1 (M)	NM sends a request to NFVO to instantiate a VNF instance as part of the update of a NS (see clause 7.3.3 in ETSI GS NFV-IFA 013 [6]) and the VNF parameters/values, including those captured in vendor specific name value pairs, carried by such request are only related to VNF virtualization aspects and are not VNF application specific..	
Step 2 (M)	NFVO sends the NS Lifecycle Change notification to NM indicating the addition of the VNF instance (see clause 5.3.3 [6]), when the VNF instantiation procedure is completed.	
Ends when	Ends when NM receives the notification from NFVO indicating the VNF instance has been successfully instantiated.	
Exceptions	One of the steps identified above fails.	
Post-conditions	A new VNF instance is instantiated.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-16, REQ-NFV_LCM_Os-Ma-nfvo-FUN-18	

## 6.4.1.3 VNF scaling

## 6.4.1.3.1 VNF instance scaling through operation request to VNFM by EM

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To expand/contract a VNF instance by scaling the VNF instance through operation request to VNFM by EM, and notify about the execution of the VNF instance scaling through reference point Ve-Vnfm-em.	
Actors and Roles	EM detects whether a scaling execution is needed and requests the VNFM to execute the VNF scaling.	
Telecom resources	EM. VNFM. VNF	
Assumptions	EM is subscribed to VNF lifecycle change notifications from the VNFM. See note 1.	
Pre-conditions	The subject VNF instance is not being scaled at the moment. VNFM does not have any auto-scaling scripts or the policy for auto-scaling is not in used or active (see note 2).	
Begins when	EM detected the need (e.g., triggered by MO attribute value modification from NM) to scale and have determined the scaling action (expand/contract).	
Step 1 (M)	EM sends the VNFM a request to scale a VNF with an indication of the type of VNF Components to scale, and value of scaling.	
Step 2 (M)	VNFM sends to EM a notification about the start of the VNF scaling execution.	
Step 3 (M)	The VNFM executes the procedure to scale the VNF instance.	
Step 4 (M)	VNFM sends to EM a notification 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_Ve-Vnfm-em-FUN-3, REQ-NFV_LCM_Ve-Vnfm-em-FUN-4	
NOTE 1: In the case where VNF scaling is triggered by MOI attribute value changes, the IRPManager (Operator) is aware of the MO attributes whose value changes can trigger VNF scaling actions. How the IRPManager (Operator) knows the names of the MO attributes whose value change can trigger VNF scaling is out of scope of this specification (e.g. could be stated in NRM attribute definitions or in product documentation).		
NOTE 2: How 3GPP management system can determine if Pre-conditions are true is FFS.		

## 6.4.1.4 VNF instance termination

## 6.4.1.4.1 VNF instance termination initiated through Ve-Vnfm-em

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	Enable EM to terminate a VNF instance which is no longer needed for testing and integration purpose.	
Actors and Roles	EM	
Telecom resources	VNFM	
Assumptions	The VNF instance being terminated does not participate in any NS (see note 1).	
Pre-conditions	The VNF instance to be terminated is no longer needed. The VNF instance has been instantiated (see NOTE in clause 7.2.3.4 in [8]) by the EM.	
Begins when	EM decides to terminate a VNF instance.	
Step 1 (M)	EM sends the request (see clause 5.2.1.1 [8]), to VNFM via Ve-Vnfm-em reference point to terminate the identified VNF instance.	
Step 2 (M)	VNFM sends the VNF lifecycle change notification to EM indicating the start of VNF termination procedure (see clause 5.2.1.2 [8]).	
Step 3 (M)	VNFM sends the VNF lifecycle change notification to EM indicating the result (e.g. success or failure) of VNF termination, when the VNF termination procedure is completed (see clause 5.2.1.2 [8]).	
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 instance is terminated.	
Traceability	REQ-NFV_LCM_Ve-Vnfm-em-FUN-6, REQ-NFV_LCM_Ve-Vnfm-em-FUN-7	

NOTE 1: Participation of the VNF instance in a NS is not known to the EM/VNFM and could only be determined by the NFVO (e.g. during granting operation). Potential negative impact to the NS instance can be prevented by the granting operation.

## 6.4.1.4.2 Remove VNF instance from NS through Os-Ma-nfvo

Use Case Stage	Evolution / Specification	<<Uses>> Related use
Goal	Enable NM to delete a VNF instance from a NS via Os-Ma-nfvo reference point.	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	N/A	
Pre-conditions	The VNF instance to be terminated is no longer needed,	
Begins when	NM decides that VNF instance is no longer needed as part of the NS.	
Step 1 (M)	NM sends a request to NFVO to remove a VNF instance from a NS instance (see clauses 5.3.2 [6]).	
Step 2 (M)	NFVO sends the NS Lifecycle Change notification to NM indicating the removal of the VNF instance (see clauses 5.3.3 [6]).	
Ends when	Ends when the VNF instance is removed from NS.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The VNF is removed from NS.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-17, REQ-NFV_LCM_Os-Ma-nfvo-FUN-18	

## 6.4.1.5 Notifications about VNF lifecycle changes

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To monitor by EM the lifecycle changes of one or more VNF instance(s).	
Actors and Roles	EM subscribes to and receives VNF lifecycle change notifications.	
Telecom resources	EM. VNFM. VNF.	
Assumptions		
Pre-conditions	VNFM is running.	
Begins when	EM determines to monitor VNF lifecycle changes on one or more managed VNF instance(s).	
Step 1 (M)	EM requests a subscription to VNFM to receive VNF lifecycle change notifications regarding one or more managed VNF instance(s).	
Step 2 (M)	VNFM creates a subscription and acknowledges the creation of the subscription to EM.	
Step 3 (M)	VNFM monitors the lifecycles of the identified managed VNF instance(s).	
Step 4 (M)	VNFM creates a VNF lifecycle change notification including information: identity the managed VNF instance, the type of lifecycle change including the beginning or the end of the procedure affecting the lifecycle changes.	
Step 5 (M)	VNFM sends to EM the VNF lifecycle change notification(s).	
Ends when	EM unsubscribes to VNF lifecycle change notification regarding the managed VNF instance(s).	
Exceptions		
Post-conditions	EM has information about VNF lifecycle changes of the one or more managed VNF instance(s).	
Traceability	REQ-NFV_LCM_Ve-Vnfm-em-FUN-4, REQ-NFV_LCM_Ve-Vnfm-em-FUN-5	

Note: VNF lifecycle change notifications are supported by NFV-MANO system [5].

## 6.4.1.6 Enabling/disabling the auto-scaling of a VNF instance

Use Case	Evolution/Specification	<<Uses>> Related use
Goal	Enable/Disable the auto-scaling of a VNF instance (e.g.needed for testing and integration purposes).	
Actors and Roles	EM	
Telecom resources	VNFM	
Assumptions	The auto-scaling is supported. In cases where NM is aware of the VNF instance (e.g. it was instantiated by NM request), it is expected that NM is made aware of the of auto-scaling enable/disable flag value change resulting from this Use Case.	
Pre-conditions		
Begins when	EM decides to enable/disable the auto-scaling of a VNF instance.	
Step 1 (M)	EM requests VNFM to enable/disable the auto-scaling of a VNF instance.	
Step 2 (M)	VNFM notifies EM of the completion result of enabling/disabling the auto-scaling of 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 auto-scaling of the VNF instance is enabled/disabled.	
Traceability	REQ-NFV_LCM_Ve-Vnfm-em-FUN-8	



## 6.4.1.7 Retrieve VNF instance information from VNFM by EM

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To retrieve by EM from VNFM, information of a subject VNF instance.	
Actors and Roles	EM queries the VNF instance information.	
Telecom resources	EM. VNFM. VNF.	
Assumptions	N/A	
Pre-conditions	N/A	
Begins when	EM determines to retrieve certain information about the subject VNF instance.	
Step 1 (M)	EM sends a request to VNFM over the Ve-Vnfm-em reference point querying certain information about the subject VNF instance.	
Step 2 (M)	VNFM sends to EM over the Ve-Vnfm-em reference point 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	EM has the information about the subject VNF instance.	
Traceability	REQ-NFV_LCM-CON-16, REQ-NFV_LCM_Ve-Vnfm-em-FUN-10	

## 6.4.1.8 Retrieve VNF instance information by NM through NFVO as part of the NS query

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To retrieve by NM through NFVO information about a subject VNF instance as part of the query of a NS. Such information about a subject VNF instance is maintained by NFV-MANO (see clause 9.4.2 in ETSI GS NFV-IFA 008 [5]).	
Actors and Roles	NM queries the information about a subject VNF instance which is part of NS instance.	
Telecom resources	NM. NFVO. VNFM.	
Assumptions	N/A	
Pre-conditions	The subject VNF instance is part of the NS instance.	
Begins when	NM determines to retrieve certain information about the subject VNF instance.	
Step 1 (M)	As part of query of a NS, NM sends a request to NFVO over the Os-Ma-nfvo reference point querying certain information about the subject VNF instance (see clause 7.3.6 in ETSI GS NFV-IFA 013 [7]).	
Step 2 (M)	NFVO sends to NM over the Os-Ma-nfvo reference point 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	NM has the information about the subject VNF instance.	
Traceability	REQ-NFV_LCM-CON-17, REQ-NFV_LCM_Os-Ma-nfvo-FUN-36	

### 6.4.1.9 Modify non-application information and non-application configuration attributes of a VNF instance by NM through NFVO as part of NS update

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	To request by NM the modification of non-application information and non-application configuration attribute(s) of a subject VNF instance. Such information about a subject VNF instance is managed by NFV-MANO (see clause 9.4.2 in ETSI GS NFV-IFA 008 [5]), for which certain attributes are writable/modifiable (see clauses 7.2.11 and 7.4.2 in ETSI GS NFV-IFA 008 [5]), e.g. VNF instance name, VNF external connectivity.	
<b>Actors and Roles</b>	NM requests modifying the non-application information and non-application configuration attributes of the VNF instance which is part of the NS instance.	
<b>Telecom resources</b>	NM. NFVO. VNFM.	
<b>Assumptions</b>	N/A	
<b>Pre-conditions</b>	The subject VNF instance is part of the NS instance.	
<b>Begins when</b>	NM determines to modify certain non-application information and/or non-application configuration attribute(s) managed by NFV-MANO about the subject VNF instance that is part of an identified NS instance.	
<b>Step 1 (M)</b>	NM sends a request to NFVO over the Os-Ma-nfvo reference point to modify the needed non-application attribute(s) about the subject VNF instance as part of the NS update operation (see clause 7.3.5 in ETSI GS NFV-IFA 013 [7]).	
<b>Step 2 (M)</b>	NFVO sends an acknowledgement of the NS update request to the NM.	
<b>Step 3 (M)</b>	NFVO sends to NM an NS Lifecycle Change notification about the start of the NS update execution (see clause 7.4.3 in ETSI GS NFV-IFA 013 [7]).	
<b>Step 4 (M)</b>	NFVO executes the procedure to update the NS instance.	
<b>Step 5 (M)</b>	NFVO sends to NM the NS Lifecycle Change notification to indicate the completion of the modification of requested attributes of the VNF instance as part of NS update (see clause 7.4.3 in ETSI GS NFV-IFA 013 [7]).	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The non-application information and/or non-application configuration attribute(s) managed by NFV-MANO of the subject VNF instance has been modified.	
<b>Traceability</b>	REQ-NFV_LCM-CON-18, REQ-NFV_LCM-CON-19, REQ-NFV_LCM_Os-Ma-nfvo-FUN-37, REQ-NFV_LCM_Os-Ma-nfvo-FUN-38	

## 6.4.2 VNF Package use cases

### 6.4.2.1 VNF Package on-boarding

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	VNF Package on-boarding	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NM.NFVO	
<b>Assumptions</b>	- The VNF Package is supplied by the NM - On-boarding is triggered by the NM	
<b>Pre-conditions</b>	NFVO is running. NM is operational. The NM possesses a VNF Package which is not on-boarded yet	
<b>Begins when</b>	NM layer determines the need for on-boarding of the VNF Package	
<b>Step 1 (M)</b>	NM sends a request to the NFVO on the VNF package on-boarding as specified in [6]	
<b>Step 2 (M)</b>	NFVO processes the VNF Package and on-boarding proceeds	
<b>Step 3 (M)</b>	NFVO acknowledges to the NM successful package on-boarding.	
<b>Exceptions</b>		
<b>Post-conditions</b>	The VNF Package is on-boarded.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-3	

## 6.4.2.2 VNF Package enabling

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable a previously disabled VNF Package instance, allowing again its use for instantiation of new VNF with this package.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Enablement is triggered by the NM.	
Pre-conditions	A VNF Package is in the "Disabled, Not in use" or "Disabled, In use" state.	
Begins when	NM determines the need for enabling of the VNF Package.	
Step 1 (M)	NM sends a request to the NFVO to enable the VNF package.	
Step 2 (M)	NFVO processes the request and enables the VNF Package.	
Step 3 (M)	NFVO acknowledges to the NM successful enablement of the VNF package.	
Exceptions		
Post-conditions	The VNF Package is enabled and available for use for instantiation of new VNF(s) with this package.	
Traceability		

## 6.4.2.3 VNF Package disabling

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	VNF Package disabling.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Disabling is triggered by the NM.	
Pre-conditions	A VNF Package is on-boarded, available for use for instantiation of new VNF instance(s) and is not marked as deletion pending	
Begins when	NM layer determines the need for disabling of the VNF Package.	
Step 1 (M)	NM sends a request to the NFVO to disable the VNF package	
Step 2 (M)	NFVO processes the request and disables the VNF Package.	
Step 3 (M)	NFVO acknowledges to the NM successful operation of disabling the VNF package.	
Exceptions		
Post-conditions	The VNF Package is on-boarded, disabled and cannot be used for instantiation of new VNF instance(s) with this package.	
Traceability		

## 6.4.2.4 VNF Package deleting

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	VNF Package deleting.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Deletion is triggered by the NM.	
Pre-conditions	The VNF Package is in "Disabled, Not in use" state defined in [6], clause D1.2	
Begins when	NM layer determines the need for deletion of the VNF Package.	
Step 1 (M)	NM sends a request to the NFVO to delete the VNF package as specified in [6], clause 7.7.5.	
Step 2 (M)	NFVO processes the request and deletes the VNF Package.	
Step 3 (M)	NFVO indicates to the NM the result of the operation.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The VNF Package is deleted.	
Traceability		

## 6.4.2.5 Delete VNF Package operation, when in use

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Delete VNF Package	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	NM has an active subscription at the NFVO for notifications on deletion of the VNF Package. Deletion of the VNF Package is triggered by the NM.	
Pre-conditions	A VNF Package is in "Disabled, In use" state as defined in [6], Annex D.	
Begins when	NM layer determines the need for deletion of the VNF Package.	
Step 1 (M)	NM sends a request to the NFVO to delete the VNF package as specified in [6], clause 7.7.5.	
Step 2 (M)	NFVO processes the request and moves the VNF Package to the "Deletion Pending" state.	
Step 3 (M)	NFVO responds to the NM with notification of the result of the Delete VNF Package operation indicating that the VNF Package is now marked as delete pending.	
Step 4 (M)	After the last VNF terminated, the NFVO deletes the VNF Package and sends VNF Package change notification that indicates deletion of the VNF Package.	
Step 5 (M)	NM receives the notification on deletion.	
Exceptions		
Post-conditions	The VNF Package is deleted and no further operations with the package are possible.	
Traceability		

## 6.4.2.6 Abort VNF Package deletion operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Abort VNF Package deletion.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Deletion of the VNF Package was earlier triggered by the NM when the VNF Package was in use.	
Pre-conditions	A VNF Package is in "Deletion Pending" state defined in [6], Annex D.	
Begins when	When the VNF Package is in use, the NM layer determines the need for abort of the deletion of the VNF Package e.g. because of expected further use of the package.	
Step 1 (M)	NM sends a request to the NFVO to abort deletion of the VNF package as specified in [6], clause 7.7.12.	
Step 2 (M)	NFVO processes the request and moves the VNF Package to the "Disabled, In use" state.	
Step 3 (M)	NFVO sends a response message to the NM.	
Exceptions		
Post-conditions	The VNF Package deletion is aborted and the VNF Package is in the "Disabled, In use" state.	
Traceability		

## 6.4.2.7 VNF Package querying

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Obtain properties of the VNF Package.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	VNF Package querying is triggered by the NM.	
Pre-conditions	A VNF Package is on-boarded	
Begins when	NM layer determines the need for querying of the VNF Package.	
Step 1 (M)	NM layer sends a request to the NFVO to query the VNF package as specified in [6], clause 7.7.6	
Step 2 (M)	NFVO processes the request.	
Step 3 (M)	NFVO acknowledges to the NM layer successful operation and returns the result of the operation.	
Exceptions		
Post-conditions	The NM layer possesses up-to-date information of the VNF Package,	
Traceability		

## 6.4.2.8 Fetch VNF Package operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	In case when the VNF Package has been on-boarded by another NM layer entity, fetch a whole VNF Package.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Fetch operation is triggered by the NM layer entity.	
Pre-conditions		
Begins when	NM layer entity determines the need for fetching a whole VNF Package.	
Step 1 (M)	NM sends a fetch request to the NFVO to obtain the whole VNF Package using the VNFD identifier assigned by the VNF provider, as specified in [6], clause 7.7.9 or the identifier of information held by the NFVO about the VNF Package as specified in [6], clause 7.7.10.	
Step 2 (M)	NFVO sends to the NM the fetch response that contains information requested by the NM.	
Exceptions		
Post-conditions	The NM possesses the requested information.	
Traceability		

## 6.4.2.9 Fetch On-boarded VNF Package Artefacts operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Fetch selected artefacts of the VNF Package.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Fetch operation is triggered by the NM layer entity.	
Pre-conditions	The VNF Package is on-boarded.	
Begins when	NM layer entity determines the need for fetching selected artefacts contained in the VNF package.	
Step 1 (M)	The NM queries the NFVO for the VNF Package Information	Clause 6.4.2.7: Use case for VNF Package querying
Step 2 (M)	The NFVO responds to the NM with the result of the query that contains the VNF Package information	Clause 6.4.2.7: Use case for VNF Package querying
Step 3 (M)	NM sends a fetch request to the NFVO to obtain the selected artefacts contained in the VNF package as specified in [6], clause 7.7.11. The artefacts are addressed using access information obtained in response to the Query On-boarded VNF Package Information operation.	
Step 4 (M)	NFVO sends to the NM the fetch response that contains copy of the artefacts requested by the NM.	
Exceptions		
Post-conditions	The NM possesses the requested information.	
Traceability		

## 6.4.2.10 Notify operation on VNF package management interface

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	NM to receive notifications related to changes of VNF Packages sent by the NFVO.	
Actors and Roles	NFVO.	
Telecom resources	NM, NFVO.	
Assumptions	NM has an active subscription at the NFVO for certain notifications related to changes of VNF Packages such as VNF Package on-boarding and VNF Package Change notifications. The subscription includes a filter for selecting the VNF Package(s) and related change notifications.	
Pre-conditions		
Begins when	There is a change in the VNF Package that triggers a notification matching the filter in the subscription, see [6], clause 7.7.8.	
Step 1 (M)	NFVO sends the notification on the change, to the NM.	
Step 2 (M)	The NM receives the notification.	
Exceptions		
Post-conditions	The NM possesses information carried by the received notification.	
Traceability		

## 6.4.2.11 Subscribe operation at the VNF Package management interface

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To subscribe with a filter for the notifications related to changes of VNF Packages sent by the NFVO.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	Subscription is triggered by the NM layer.	
Pre-conditions		
Begins when	NM layer determines the need to subscribe with a filter for the notifications related to changes of VNF Packages sent by the NFVO.	
Step 1 (M)	NM sends to the NFVO request for subscription to certain notifications related to changes of certain VNF Package(s) as specified in [6], clause 7.7.7.	
Step 2 (M)	NFVO responds to the NM with the result of the operation indicating if the subscription has been successful or not, and, in the case of success, identification of the subscription realized.	
Exceptions		
Post-conditions	In the case of successful subscription, the NM is registered to receive notifications related to changes of VNF Packages sent by the NFVO and matching the filter	
Traceability		

## 6.4.3 NS Instance use cases

### 6.4.3.1 NS instantiation

#### 6.4.3.1.1 Instantiation of a new NS

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To instantiate a NS with necessary input parameterization through operation request from NM on the Os-Ma-nfvo reference point in order to honour specific NS usage, e.g. geographical location, capacity, etc.	
Actors and Roles	NM requests the NS instantiation	
Telecom resources	NM. NFVO	
Assumptions	NS may contain VNFs, PNFs and nested NSs.	
Pre-conditions	The VNF Package(s) of the VNF(s) to be instantiated as part of the NS are on-boarded. The NSD for the NS instantiation is on-boarded. A NS instance identifier and an associated instance of a NsInfo information element have been created. PNFDs for PNF constituents of NS have been on-boarded.	Clause 6.4.2.1: Use case for VNF Package on-boarding Clause 6.4.4.1: Use case for Network Service Descriptor (NSD) On-boarding. Clause 6.4.3.12: Create NS Identifier
Begins when	NM determines (e.g., by operator request) that a new NS needs to be instantiated honouring certain usage and input requirements.	
Step 1 (M)	NM sends to NFVO a request to instantiate the new NS indicating in the request information about the target NSD and additional parameterization for the specific NS to instantiate (see clause 7.3.3 in ETSI GS NFV-IFA013 [6]).  In case the NS instantiation request required VNF(s) instantiation or configuration, the VNFs' parameters/values, including those captured in vendor specific name value pairs, carried by such request are only related to VNF virtualization aspects and are not VNF application specific.	
Step 2 (M)	NFVO sends to NM a notification about the start of the NS instantiation (see clause 7.4.3 in ETSI GS NFV-IFA 013 [6]).	
Step 3 (M)	NFVO executes with rest of NFV-MANO system the instantiation of the NS.	
Step 4 (M)	NFVO sends to NM a notification about the results of the NS instantiation execution (see clause 7.4.3 in ETSI GS NFV-IFA 013 [6]).	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	A new NS is instantiated.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-1	



## 6.4.3.1.2 Instantiation of a new NS with existing VNF instances and new VL instances

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Interconnect specific external CPs of specific VNF instances by adding them to a new NS.	
Actors and Roles	NM	
Telecom resources	NFVO	
Assumptions	NM is subscribed for NS LCM notifications	
Pre-conditions	The VNF instances being interconnected already exist (have been instantiated) and do not belong to the same NS instance. A NS instance identifier and an associated instance of a NsInfo information element have been created.	Clause 6.4.3.12: Create NS Identifier
Begins when	NM determines (e.g. by operator's request) the need for interconnecting the VNF instances that do not belong to the same NS.	
Step 1 (M)	NM sends a request to the NFVO to instantiate a new NS instance by adding existing VNF instances to it and creating new instances of VL connecting specific external CPs of specific VNF instances belonging to this NS instance.	
Step 2 (M)	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request.	
Step 3 (M)	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
Step 4 (M)	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
Step 5 (M)	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The new NS instance has been created with identified VNF instances interconnected according to the operator's needs	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-26	

## 6.4.3.1.3 Instantiation of a new NS with existing NS instances and new VL instances

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Interconnect specific SAPs of specific NS instances by adding them to a new NS.	
Actors and Roles	NM	
Telecom resources	NFVO	
Assumptions	NM is subscribed for NS LCM notifications	
Pre-conditions	The NS instances with SAPs being interconnected already exist (have been instantiated) and do not belong to the same NS instance. A NS instance identifier and an associated instance of a NsInfo information element have been created.	Clause 6.4.3.12: Create NS Identifier
Begins when	NM determines (e.g. by operator's request) the need for interconnecting the NS instances that do not belong to the same NS.	
Step 1 (M)	NM sends a request to the NFVO to instantiate a new NS instance by adding existing NS instances to it and creating new instances of VL connecting specific SAPs of specific nested NS instances belonging to this NS instance.	
Step 2 (M)	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request.	
Step 3 (M)	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
Step 4 (M)	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
Step 5 (M)	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The new NS instance has been created with identified nested NS instances interconnected according to the operator's needs	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-27	

## 6.4.3.2 NS instance termination

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to terminate a NS instance	
Actors and Roles	NM.	
Telecom resources	NFVO.	
Assumptions	NS termination is triggered by the NM.	
Pre-conditions	NS instance(s) exist.. NFVO is running. NM is operational	
Begins when	NM determines to terminate a NS instance.	
Step 1 (M)	NM sends a request to the NFVO to terminate a NS instance.	
Step 2 (M)	NFVO terminates the NS instance and all those VNF instances associated only with the NS instance	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	In case of success, the NS instance has been terminated and all those VNF instances associated only with this NS instance have been terminated.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-6	

## 6.4.3.3 NS instance querying

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to obtain information on one or more NS instance(s)	
Actors and Roles	NM.	
Telecom resources	NFVO.	
Assumptions	NS querying is triggered by the NM.	
Pre-conditions	One or more NS instance(s) exist. NFVO is running. NM is operational	
Begins when	NM determines to query one or more NS instance(s).	
Step 1 (M)	NM sends a request to the NFVO to query one or more NS instance(s) with queryFilter specifying identifiers and attributeSelector providing a list of attribute names of NS.	
Step 2 (M)	NFVO processes the request.	
Step 3 (M)	NFVO send to the NM the result of the operation.	
Exceptions		
Post-conditions	The NM possesses up-to-date information of the NS instance(s)	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-7	

#### 6.4.3.4 NS scaling using VNF scaling operation initiated through Os-Ma-nfvo reference point

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To scale a VNF instance by scaling the NS instance through operation request to NFVO by NM, and notify about the execution of the NS instance scaling through reference point Os-Ma-nfvo.	
Actors and Roles	NM detects whether a scaling execution is needed and requests the NFVO to execute the NS scaling.	
Telecom resources	NM, NFVO	
Assumptions		
Pre-conditions	The subject NS instance is not being scaled at the moment.	
Begins when	NM detected the need to scale and have determined the scaling target VNF instance(s) and action (i.e. addition, expansion, contraction or removal).	
Step 1 (M)	NM sends the NFVO a request to scale a NS with an indication of the target VNF instance to scale, type of scaling and value of scaling as necessary.	
Step 2 (M)	The NFVO sends to NM a notification about the start of the NS scaling execution.	
Step 3 (M)	The NFVO executes the procedure to scale the NS instance.	
Step 4 (M)	NFVO sends to NM a notification about the end of the NS scaling execution.	
Ends when	All the steps identified above are successfully completed.	
Exceptions		
Post-conditions	The NS instance has been scaled.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-8, REQ-NFV_LCM_Os-Ma-nfvo-FUN-11	

## 6.4.3.5 Updating an NS instance to correspond to a different NSD version

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	The network operator through 3GPP management system can decide the time when and has the capacity to update the NS instance to correspond to a different NSD version when such update synchronization has not automatically been performed by the NFVO.	
<b>Actors and Roles</b>	NM.	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	The NM is subscribed to NS lifecycle change notifications from the NFVO.	
<b>Pre-conditions</b>	The NS to update is instantiated. The new NSD version is available to the NM.	Clause 6.4.3.1.1: Use case of NS instantiation
<b>Begins when</b>	NM determines to update the existing NS instance, e.g., due to changes in its VNF instances.	
<b>Step 1 (M)</b>	The NSD instance is updated with the new NSD version (see clause 7.2.5 in ETSI GS NFV-IFA 013 [6]).	Clause 6.4.4.7: Use case for updating NSD instance
<b>Step 2 (M)</b>	The NS instance is associated to the newly on-boarded NSD version.  NOTE: The automatic update synchronization by NFVO is set to false (see clause 8.3.4.19 in ETSI GS NFV-IFA 013 [6]).	Clause 6.4.3.6: Use case for associating a new NSD version to an NS instance as part of NS update
<b>Step 3 (M)</b>	NM sends a request to NFVO to update the NS instance with the necessary update information, e.g., addition, removal or modification of existing VNF instances part of the NS instance (see clause 7.3.5 in ETSI GS NFV-IFA 013 [6]).	
<b>Step 4 (M)</b>	NFVO acknowledges the NS instance update request providing information to identify the lifecycle operation occurrence (see clause 7.3.5 in ETSI GS NFV-IFA 013 [6]).	
<b>Step 5 (M)</b>	NFVO sends to NM a notification indicating the start of the NS update lifecycle changes. The notification identifies the NS instance affected for the lifecycle change, the lifecycle operation occurrence and the type of lifecycle operation (see clause 8.3.2.2 in ETSI GS NFV-IFA 013 [6]).	
<b>Step 6 (M)</b>	NFVO sends to NM a notification indicating the end result of the NS update lifecycle changes. The notification identifies the NS instance affected for the lifecycle change, the lifecycle operation occurrence, the type of lifecycle operation and information about the entities part of the NS instance affected by the lifecycle change (see clause 8.3.2.2 in ETSI GS NFV-IFA 013 [6]).	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The NS instance has been updated to correspond to the different NSD version.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-9, REQ-NFV_LCM_Os-Ma-nfvo-FUN-17, REQ-NFV_LCM_Os-Ma-nfvo-FUN-20	

## 6.4.3.6 Associating a different NSD version to an NS instance as part of NS update

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	The network operator through 3GPP management system has the capacity to associate an existing NS instance to a different NSD version as part of NS update, so that the NS instance lifecycle management and NS instance updates can be performed according to the different NSD version.	
<b>Actors and Roles</b>	NM.	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	N/A	
<b>Pre-conditions</b>	The different NSD version to associate the NS instance to is already on-boarded.	Clause 6.4.4.7: Use case for updating NSD instance.
<b>Begins when</b>	NM determines to associate the different NSD version to the existing NS instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO as part of NS update to associate the different NSD version to the NS instance by providing the identifier of the on-boarded different version and indication of whether the NS instance will be automatically synchronized to the new NSD by the NFVO (see clause 8.3.4.15 in ETSI GS NFV-IFA 013 [6]). NOTE: The present use case does not elaborate in the additional steps that can occur when automatic synchronization is performed.	
<b>Step 2 (M)</b>	NFVO acknowledges to the NM the successful NS update operation (see clause 7.3.5 in ETSI GS NFV-IFA 013 [6]).	
<b>Ends when</b>	Ends when all steps identified above are completed or when an exception occurs.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The NS instance is associated to the different NSD version.	
<b>Traceability</b>	REQ- NFV_LCM_Os-Ma-nfvo-FUN-22	

## 6.4.3.7 Addition of a new VL to an existing NS instance

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Interconnect specific external CPs of specific VNF instances.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed for NS LCM notifications	
<b>Pre-conditions</b>	The VNF instances being interconnected already exist (have been instantiated) and belong to the same NS instance.	
<b>Begins when</b>	NM determines (e.g. by operator's request) the need for interconnecting the VNF instances.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance by creating a new instance of VL with specific external CPs of specific VNF instances belonging to this NS instance.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request.	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The identified VNF instances are interconnected according to the operator's needs	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-23	

## 6.4.3.8 Addition of an existing VNF instance to an existing NS instance

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Add an existing VNF instances to the existing NS instance.	
Actors and Roles	NM	
Telecom resources	NFVO	
Assumptions	NM is subscribed for NS LCM notifications	
Pre-conditions	The VNF instance being added already exist (has been instantiated) and does not belong to this NS instance. The VNFD (VNF type) of the VNF instance being added is already known to the NSD of the NS where the VNF instance is being added to. The DF of the VNF instance being added matches one of the VNF profiles in the NSD of the NS where the VNF instance is being added to.	
Begins when	NM determines (e.g. by operator's request) the need for adding an existing VNF instance to an existing NS instance.	
Step 1 (M)	NM sends a request to the NFVO to update the NS instance by adding the existing instance of VNF and if needed, with VNF profile to be used for this VNF instance (see [6] clauses 7.3.5 and 8.3.4.3).	
Step 2 (M)	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request.	
Step 3 (M)	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
Step 4 (M)	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
Step 5 (M)	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The identified VNF instances have been added to the NS instance according to the operator's needs	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-24	

## 6.4.3.9 Addition of a new SAP to an existing NS instance

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Add new Service Access Point exposing specific external CP of a specific VNF instance.	
Actors and Roles	NM	
Telecom resources	NFVO	
Assumptions	NM is subscribed for NS LCM notifications	
Pre-conditions	The VNF instance who's external CP is being exposed as SAP already exists (has been instantiated) and belongs to the same NS instance where the new SAP is being added.	
Begins when	NM determines (e.g. by operator's request) the need for exposing a specific VNF external CP as a new SAP.	
Step 1 (M)	NM sends a request to the NFVO to update the NS instance by creating a new instance of SAP exposing specific external CP of a specific VNF instance belonging to this NS instance.	
Step 2 (M)	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request.	
Step 3 (M)	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
Step 4 (M)	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
Step 5 (M)	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The identified external CP of the identified VNF instance is exposed as a new SAP according to the operator's needs	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-25	

## 6.4.3.10 Notification regarding NS instance lifecycle changes

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to obtain the lifecycle change notifications on one or more NS instance(s).	
Actors and Roles	NM receives NS lifecycle change notifications.	
Telecom resources	NFVO	
Assumptions		
Pre-conditions	NFVO is running. NM subscribed for the notifications related to NS lifecycle changes.	
Begins when	NFVO monitors the lifecycles of the identified NS instance and the NS lifecycle is changed	
Step 1 (M)	NFVO creates NS lifecycle change notification including information: identity of the NS instance, the type of lifecycle change including the beginning or the end of the procedure affecting the lifecycle changes.	
Step 2 (M)	NFVO sends to NM the NS lifecycle change notifications.	
Ends when	NM unsubscribes to NS lifecycle change notification.	
Exceptions		
Post-conditions	NM has information about the lifecycle changes of the one or more managed NS instance(s).	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-20	

## 6.4.3.11 Subscription regarding NS instance lifecycle changes

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To subscribe by NM the lifecycle changes on one or more NS instance(s).	
Actors and Roles	NM subscribes NS instance lifecycle change notifications.	
Telecom resources	NFVO	
Assumptions		
Pre-conditions	NFVO is running. NM is operational	
Begins when	NM determines to subscribe lifecycle changes on one or more NS instance(s).	
Step 1 (M)	NM requests a subscription to NFVO to receive the lifecycle change notifications regarding one or more NS instance(s).	
Step 2 (M)	NFVO creates a subscription and acknowledges the creation of the subscription to NM.	
Ends when	All the steps identified above are successfully completed.	
Exceptions		
Post-conditions	NM is subscribed to lifecycle changes of the one or more managed NS instance(s).	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-19	

## 6.4.3.12 Create NS Identifier

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To create a NS instance identifier and associated instance of a NsInfo information element to enable further NS instantiation.	
Actors and Roles	NM requests creation of the NS Identifier	
Telecom resources	NM, NFVO	
Assumptions		
Pre-conditions	The NSD is on-boarded.	
Begins when	NM determines (e.g., by operator request) that a new NS instance identifier, and an associated instance of a NsInfo information element are needed to enable NS instantiation based on the NSD.	
Step 1 (M)	NM sends to NFVO a Create NS Identifier request with reference to the NSD and additional information like NS name (see clause 7.3.2 in ETSI GS NFV-IFA013 [6]).	
Step 2 (M)	NFVO creates the NS Identifier and the associated instance of NsInfo information element and sends the response to the NM	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	A new NS instance identifier and an associated instance of a NsInfo information element are created and can be used in further NS instantiation.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-29	

## 6.4.3.13 Delete NS instance identifier

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	To delete the NS instance identifier and the associated instance of a NsInfo information element after the NS instance termination.	
Actors and Roles	NM requests deletion of the NS instance identifier.	
Telecom resources	NM, NFVO	
Assumptions		
Pre-conditions	NS instance is terminated.	
Begins when	NM determines (e.g., by operator request) that the NS instance identifier and the associated instance of NsInfo information element of the terminated NS instance are needed to be deleted.	
Step 1 (M)	NM sends to NFVO a Delete NS Identifier request (see clause 7.3.8 in ETSI GS NFV-IFA013 [6]).	
Step 2 (M)	NFVO deletes the NS Identifier and sends the response to the NM.	
Ends when	All the steps identified above are successfully completed.	
Exceptions	One of the steps identified above fails.	
Post-conditions	The NS instance identifier are deleted.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-35	



## 6.4.3.14 Addition of PNF to the NS instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Add an existing PNF to the existing NS instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	The PNF being added already exist and does not belong to this NS instance. The PNFD of the PNF being added is already known to the NSD of the NS where the PNF is being added to.	
<b>Begins when</b>	NM determines (e.g. by operator's request) the need for adding an existing PNF to an existing NS instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance by adding the existing PNF (see [6] clauses 7.3.5).	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The identified PNF has been added to the NS instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.3.15 Add an existing VNF instance with connectivity

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Add an existing VNF instance to a NS with connectivity to other VNF instance or PNF.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	A VNF instance has been instantiated.	
<b>Begins when</b>	NM determines (e.g. by operator's request) to add an existing VNF instance to a NS with connectivity to other VNF instance or PNF.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to add an existing VNF instance to a NS (see clause 7.3.5 in [6]) with VNF instance identifier and connectivity information for the external CP instances.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The existing VNF instance has been added with connectivity to other VND instance or PNF in the NS.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.3.16 Add external connectivity to a PNF or VNF instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Add external connectivity to a PNF or VNF instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	A PNF or VNF instance has been added or instantiated in an NS instance without the external connectivity, or a new external connectivity is needed due to PNF or VNF upgrade.	
<b>Begins when</b>	NM determines (e.g. by operator's request) that it is necessary to add the external connectivity to an existing PNF or VNF instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance (see clause 7.3.5 in [6]) to add the external connectivity to an existing PNF or VNF instance.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The external connectivity has been added to the PNF or VNF instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

#### 6.4.3.17 Add a virtual link to a NS instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Add a virtual link to a NS instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	The NS where the virtual link is to be added has been instantiated. The virtual link descriptor and virtual link profile for the virtual link to be added are available in the NSD either on-boarded previously or updated.	
<b>Begins when</b>	NM determines (e.g. by operator's request) that it is necessary to add a virtual link to an existing NS instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance (see clause 7.3.5 in [6]) to add a virtual link.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	A virtual link has been added to the NS instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.3.18 Change external connectivity to a PNF or VNF instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Change external connectivity to a PNF or VNF instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	A PNF or VNF instance has been added or instantiated in an NS instance.	
<b>Begins when</b>	NM determines (e.g. by operator's request) that it is necessary to change the external connectivity to an existing PNF or VNF instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance (see clause 7.3.5 in [6]) to change the external connectivity to an existing PNF or VNF instance.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The external connectivity has been changed to the PNF or VNF instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.3.19 Add VNF forwarding graph to a NS instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Add VNF forwarding graph to a NS instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	An NS instance, containing the VNF instances and all necessary components (e.g. VLs, CPs, SAPs, ...) to form a VNFFG, has been instantiated, VNFFGD for the VNFFG to be added already exists.	
<b>Begins when</b>	NM determines (e.g. by operator's request) that it is necessary to add a VNFFG to a NS instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the NS instance (see clause 7.3.5 in [6]) by adding a VNFFG to a NS instance.	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId and processes the request	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The VNFFG has been added to the NS instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.3.20 Update VNF forwarding graph in a NS instance

Use Case	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	Update VNF forwarding graph in a NS instance.	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NFVO	
<b>Assumptions</b>	NM is subscribed to receive the NS LCM notifications.	
<b>Pre-conditions</b>	An NS instance with VNFFG already exists, VNFFGD for the VNFFG to be updated already exists.	
<b>Begins when</b>	NM determines (e.g. by operator's request) that it is necessary to update the VNFFG in a NS instance.	
<b>Step 1 (M)</b>	NM sends a request to the NFVO to update the VNFFG (e.g. addition, deletion, and modification of NFP) in a NS instance via the NS update operation (see clause 7.3.5 in [6]).	
<b>Step 2 (M)</b>	NFVO returns to the NM lifecycleOperationOccurrenceId, and the identifier of new NFP if the update is to add a NFP to the existing VNFFG, and processes the request.	
<b>Step 3 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating start of the operation.	
<b>Step 4 (M)</b>	NFVO sends to NM Lifecycle Change Notifications indicating progress of the operation.	
<b>Step 5 (M)</b>	NFVO sends to NM Lifecycle Change Notification indicating result of the operation.	
<b>Ends when</b>	All the steps identified above are successfully completed.	
<b>Exceptions</b>	One of the steps identified above fails.	
<b>Post-conditions</b>	The VNFFG has been updated to the NS instance according to the operator's needs.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.4 NS Descriptor use cases

### 6.4.4.1 NS Descriptor (NSD) On-boarding

Use case stage	Evolution/Specification	<<Uses>> Related use
<b>Goal</b>	NSD On-boarding	
<b>Actors and Roles</b>	NM	
<b>Telecom resources</b>	NM, NFVO	
<b>Assumptions</b>	NSD on-boarding is triggered by the NM layer	
<b>Pre-conditions</b>	NFVO is running. NM layer is operational. The NM layer possesses the NSD	
<b>Begins when</b>	NM layer determines the need for on-boarding of the NSD	
<b>Step 1 (M)</b>	NM layer sends a request to the NFVO on the NSD on-boarding as specified in [6], clause 7.2.2.	
<b>Step 2 (M)</b>	NFVO processes the request and on-boarding proceeds.	
<b>Step 3 (M)</b>	NFVO acknowledges to the NM layer successful NSD on-boarding.	
<b>Exceptions</b>		
<b>Post-conditions</b>	The NSD is on-boarded.	
<b>Traceability</b>	REQ-NFV_LCM_Os-Ma-nfvo-FUN-14, REQ-NFV_LCM_Os-Ma-nfvo-FUN-15	

## 6.4.4.2 Enabling NS Descriptor instance

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	NS Descriptor instance enabling	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	NS Descriptor instance enabling is triggered by the NM layer	
Pre-conditions	NFVO is running. NM layer is operational. There is a NS Descriptor instance in one of the following states: "Disabled, In use" or "Disabled, Not in use" defined in [6], clause D2.2	
Begins when	NM layer determines the need for enabling the NS Descriptor instance	
Step 1 (M)	NM layer sends a request to the NFVO on enabling the NS Descriptor instance as specified in [6], clause 7.2.3.	
Step 2 (M)	NFVO processes the request and enables the NS Descriptor instance	
Step 3 (M)	NFVO acknowledges to the NM layer successful enablement of the NS Descriptor instance.	
Exceptions		
Post-conditions	The NS Descriptor instance is enabled.	
Traceability		

## 6.4.4.3 Disabling NS Descriptor instance

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	NS Descriptor instance disabling	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	NS Descriptor instance disabling is triggered by the NM layer	
Pre-conditions	NFVO is running. NM layer is operational. There is a NS Descriptor instance in one of the states "Enabled, In use" or "Enabled, Not in use" defined in [6], clause D2.2	
Begins when	NM layer determines the need for disabling the NS Descriptor instance	
Step 1 (M)	NM layer sends a request to the NFVO on disabling the NS Descriptor instance as specified in [6], clause 7.2.4.	
Step 2 (M)	NFVO processes the request and disables the NS Descriptor instance	
Step 3 (M)	NFVO acknowledges to the NM layer successful disabling of the NS Descriptor instance	
Exceptions		
Post-conditions	The NS Descriptor instance is disabled	
Traceability		

## 6.4.4.4 Query NSD operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to obtain information on one or more NS Descriptors (NSDs)	
Actors and Roles	NM.	
Telecom resources	NFVO.	
Assumptions	NSD querying is triggered by the NM.	
Pre-conditions	One or more NSDs are on-boarded. NFVO is running. NM is operational	
Begins when	NM determines to query one or more NSD(s).	
Step 1 (M)	NM sends a request to the NFVO to query one or more NSD(s), with the filter defining the NSDs on which the query applies, and the attribute selector providing a list of attribute names of the NSD(s), according to [6], clause 7.2.7	
Step 2 (M)	NFVO processes the request.	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The NM possesses the requested information on the NSD(s)	
Traceability		

## 6.4.4.5 Delete NS Descriptor operation, when in use

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Delete one or more NS Descriptor(s) that are in use.	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	Deletion of the NS Descriptor (NSD) is triggered by the NM layer	
Pre-conditions	NFVO is running. NM layer is operational. There are one or several NSD(s) in the state "Disabled, In use" defined in [6], clause D2.2	
Begins when	NM layer determines the need for deletion of the NSDs	
Step 1 (M)	NM layer sends a request to the NFVO on deletion of the NSDs as specified in [6], clause 7.2.6.	
Step 2 (M)	NFVO processes the request and transfers the NSDs into the Deletion Pending state.	
Step 3 (M)	NFVO responds to the NM layer with the result of the operation including indication that the NSDs are marked as delete pending.	
Step 4 (M)	After the last NS associated with certain NSD is terminated, the NFVO deletes the NSD.	
Exceptions		
Post-conditions	The NSDs are deleted	
Traceability		

## 6.4.4.6 Delete NS Descriptor operation, when not in use

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Delete one or more NS Descriptor(s), a single version of an NSD or all versions.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO	
Assumptions	Deletion of the NS Descriptor (NSD) is triggered by the NM layer	
Pre-conditions	NFVO is running. NM layer is operational. There is a group of NSD(s) to be deleted that are all in the state "Disabled, Not in use" as defined in [6], clause D2.2	
Begins when	NM layer determines the need for deletion of the group of the NSD(s).	
Step 1 (M)	NM layer sends a request to the NFVO on deletion of the NSD(s) as specified in [6], clause 7.2.6.	
Step 2 (M)	NFVO processes the request and deletes the NSD(s).	
Step 3 (M)	NFVO responds to the NM layer with the result of the operation.	
Exceptions		
Post-conditions	The NSD(s) are deleted	
Traceability		

## 6.4.4.7 Updating NSD instance

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	The network operator through 3GPP management system has the capacity to update an on-boarded NSD instance on the NFVO. An NSD update creates a new NSD version and the previous on-boarded versions of the NSD are not modified (see clause 7.2.5.1 in ETSI GS NFV-IFA 013 [6]).	
Actors and Roles	NM.	
Telecom resources	NFVO	
Assumptions	N/A	
Pre-conditions	The NSD to update has been on-boarded.	Clause 6.4.4.1: Use case for NS Descriptor (NSD) On-boarding
Begins when	NM determines to update the existing on-boarded NSD.	
Step 1 (M)	NM sends a request to the NFVO to update the NSD by providing the identifier of the existing on-boarded version of the NSD to update, the new NSD version, and optionally additional user defined data (see clause 7.2.5 in ETSI GS NFV-IFA 013 [6]).	
Step 2 (M)	NFVO acknowledges to the NM the successful NSD update providing the identifier of the newly on-boarded NSD version (see clause 7.2.5 in ETSI GS NFV-IFA 013 [6]).	
Ends when	Ends when all steps identified above are completed or when an exception occurs.	
Exceptions	One of the steps identified above fails. The NSD to update is in deletion pending state. The new NSD version does not correspond to be a different version of the existing on-boarded NSD to update.	
Post-conditions	The newly NSD version is on-boarded.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-21	

## 6.4.4.8 Updating NSD user defined data

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Update the user defined data in the NS Descriptor	
Actors and Roles	NM	
Telecom resources	NM, NFVO	
Assumptions	NS Descriptor update is triggered by the NM layer	
Pre-conditions	NFVO is running. NM layer is operational. There is an onboarded NS Descriptor (NSD).	
Begins when	NM layer determines the need for update of the user defined data in the NSD.	
Step 1 (M)	NM layer sends a request to the NFVO on update of the user defined data in the NSD as specified in [6], clause 7.2.5.	
Step 2 (M)	NFVO processes the request and updates the NSD resulting in update of the user defined data of the NSD.	
Step 3 (M)	NFVO sends response message to the NM layer, indicating successful NSD update.	
Exceptions		
Post-conditions	The NSD is updated.	
Traceability		

## 6.4.4.9 Subscribe to NSD change notifications

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable the NM to subscribe with a filter for the notifications related to changes of one or several NSDs, sent by the NFVO	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational.	
Begins when	NM determines a need in subscription to notifications on changes of certain NSD(s).	
Step 1 (M)	NM sends a request to the NFVO, according to [6], clause 7.2.12. The request contains the input filter for selecting the NSD(s) and the related change notifications to subscribe to. This filter can contain information about specific types of changes to subscribe to, or attributes of the NsdInfo.	
Step 2 (M)	NFVO processes the request and registers the NM to receive notifications about changes of NSD(s).	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The NM is registered to receive notifications about changes of the NSD(s).	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-33	



#### 6.4.4.10 Notify operation on management changes in NSDs

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable the NM to receive notifications related to NSD management changes, sent by the NFVO.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational. The NM is subscribed to notifications related to management changes of NSD instances matching the filter defined at the time of the subscription.	
Begins when	NFVO monitors the NSD instances matching the filter and detects the management change in one of the NSD instances.	
Step 1 (M)	NFVO sends to the NM the notification according to [6], clause 7.2.13.	
Exceptions		
Post-conditions	The NM received the notification.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-34	

### 6.4.5 PNFDF Use Cases

#### 6.4.5.1 Introduction

PNFDF lifecycle operations are considered exclusively in the context of definitions of the PNF connection points where the PNF may connect to a VL and PNF connection points exposure as service access points, see clause 6.6 [10], particularly the Table 6.6.2.2-1: Attributes of the Pnfd information element.

#### 6.4.5.2 On-board PNFDF operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to perform On-board PNFDF operation.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions	PNFDF on-boarding is triggered by the NM.	
Pre-conditions	NFVO is running. NM is operational.	
Begins when	NM determines a need in on-boarding a PNFDF to make it available for use by NS Descriptors (NSDs).	
Step 1 (M)	NM sends a PNFDF on-board request to the NFVO, according to [6], clause 7.2.8. The request contains the PNFDF to be on-boarded.	
Step 2 (M)	NFVO processes the request and on-boards the PNFDF.	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The PNFDF is on-boarded and available for use by NS Descriptors.	
Traceability	REQ-NFV_LCM_Os-Ma-nfvo-FUN-x	

## 6.4.5.3 Create a new version of already on-boarded PNFD

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to create a new version of already on-boarded PNFD using Update PNFD operation.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational. The old version of the PNFD is on-boarded.	
Begins when	NM determines a need in creation of a new version of already on-boarded PNFD using Update PNFD operation.	
Step 1 (M)	NM sends a Update PNFD request to the NFVO, according to [6], clause 7.2.9. The request contains the PNFD to be created as a new version of the existing PNFD.	
Step 2 (M)	NFVO processes the request and creates a new version of the PNFD	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The new version of the PNFD is created and available for use by NS Descriptors.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-28	

## 6.4.5.4 Update of the user defined data on PNFD

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to update the user defined data on PNFD using Update PNFD operation.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational. PNFD is on-boarded.	
Begins when	NM determines a need in updating the user defined data on PNFD using Update PNFD operation.	
Step 1 (M)	NM sends a Update PNFD request to the NFVO, according to [6], clause 7.2.9. The request contains the user defined data to be updated and does not contain new PNFD to be created.	
Step 2 (M)	NFVO processes the request and updates the user defined data on the PNFD.	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The user defined data on the PNFD is updated.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-30	

## 6.4.5.5 Delete PNFD operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to delete the PNFDs.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational. The PNFD(s) are on-boarded and not in use in any of the NSs that are in the active or NOT_INSTANTIATED state.	
Begins when	NM determines a need in deletion of the PNFD(s).	
Step 1 (M)	NM sends a Delete PNFD request to the NFVO, according to [6], clause 7.2.10. The request contains - identification of the on-boarded instance(s) of the PNFD(s) to be deleted. - indication if the delete operation is to be applied on all versions of these PNFD instances.	
Step 2 (M)	NFVO processes the request and deletes the PNFD(s) as requested.	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The PNFD(s) are deleted as requested.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-31	

## 6.4.5.6 Query PNFD operation

Use case stage	Evolution/Specification	<<Uses>> Related use
Goal	Enable NM to query the NFVO concerning details of one or more PNFDs.	
Actors and Roles	NM.	
Telecom resources	NM, NFVO.	
Assumptions		
Pre-conditions	NFVO is operational. NM is operational. The PNFD(s) are on-boarded.	
Begins when	NM determines a need in querying of the PNFD(s).	
Step 1 (M)	NM sends a Query PNFD request to the NFVO, according to [6], clause 7.2.11. The request contains - Filter conditions to select the PNFDs on which the query applies, based on attributes of the PNFDs - A list of attribute names of the PNFD. If present, only these attributes are returned for the instances of PNFD matching the filter. If absent, the complete PNFD instances are returned.	
Step 2 (M)	NFVO processes the request and provides the requested information.	
Step 3 (M)	NFVO sends to the NM the result of the operation.	
Exceptions		
Post-conditions	The information on the PNFDs provided to the NM as requested.	
Traceability	REQ- NFV_LCM_Os-Ma-nfvo-FUN-32	

## Annex A (informative): Change history

Change history							
Date	Meeting	TDoc	CR	Rev	Cat	Subject/Comment	New version
2017-06	SA#76	SP-170504	0001	1	F	Moving LCM supported use cases and requirements from TS 28.510	14.1.0
2017-06	SA#76	SP-170504	0002	2	F	VNF application software update	14.1.0
2018-03	SA#79	SP-180059	0004	1	F	Scope extension	14.2.0
2018-03	SA#79	SP-180059	0005	1	F	Use case of NS instantiation	14.2.0
2018-03	SA#79	SP-180059	0006	1	F	Use cases of PNF addition, removal, and modification	14.2.0
2018-06	SA#80	SP-180417	0009	2	B	Add use case of adding VNF instance to a NS with connectivity	15.0.0
2018-06	SA#80	SP-180417	0010	2	B	Add use case of adding external connectivity to a PNF or VNF instance	15.0.0
2018-06	SA#80	SP-180417	0011	2	B	Add use case of adding NS virtual link to a NS instance	15.0.0
2018-06	SA#80	SP-180417	0013	2	B	Add use case of changing external connectivity to a PNF or VNF instance	15.0.0
2018-06	SA#80	SP-180417	0014	2	B	Adding requirement for PNFD on-boarding use case	15.0.0
2018-06	SA#80	SP-180417	0016	1	B	Use case and requirement of adding VNFFG to a NS instance	15.0.0
2018-06	SA#80	SP-180417	0017	1	B	Use case and requirement of updating VNFFG in a NS instance	15.0.0

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# History

<b>Document history</b>		
V15.0.0	June 2018	Publication