



Network Functions Virtualisation (NFV) Release 3; Licensing Management; Report on License Management for NFV

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Foreword

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

Modal verbs terminology

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

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Introduction

Today there is huge diversity of license management mechanisms across VNF Providers which makes service provisioning and license renewing operations more complex, error prone and time consuming. It also makes it difficult to deal with VNF license usage information for settlement between the Service Provider and the VNF Provider.

These issues can be resolved by establishing a standard NFV license management architecture which will have the following benefits:

- Speed up provision of VNF service without customizing the license management procedure for each VNF-type or VNF Provider.
- Simplifying acquisition of VNF license usage information.
- Reduce licensing errors.
- Simplified license management operations independent of the underlying VNF solution.

A guiding principle is to minimize the impact on the existing NFV specifications by identifying the minimum features needed to implement any commercial license management framework typically residing in a separate or higher layer system (e.g. OSS/BSS).

In order to provide a standardized licensing mechanism, it is necessary to identify the functional blocks, interfaces, and flows impacted by the requirement to implement any commercial license management framework.

1 Scope

The present document studies the features needed within the NFV-MANO framework to support license management for NFV. In this version of the document, a focus is made on the software licenses for VNFs. A set of use cases related to VNF licenses in the NFV environment are described, analyzed and used to understand the issues and produce recommendations regarding support for license management within the NFV architectural and NFV-MANO frameworks.

2 References

2.1 Normative references

Normative references are not applicable in the present document.

2.2 Informative references

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

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

The following referenced documents are not necessary for the application of the present document but they assist the user with regard to a particular subject area.

[i.1] TM Forum IG1143 Release 16.5.1: "Framework Exploratory Report - License Management".

[i.2] ISO/IEC 19770-5:2015: "Information technology - IT asset management - Part 5: Overview and vocabulary".

NOTE: Available at <https://www.iso.org/standard/68291.html>.

[i.3] ETSI GS NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

3 Definitions and abbreviations

3.1 Definitions

For the purposes of the present document, the terms and definitions given in [i.3] and the following apply:

NOTE: A term defined in the present document takes precedence over the definition of the same term, if any, in [i.3].

license key: identifier key or activation code associated with VNF, made available by VNF Provider to Service Provider for operating a VNF instance

license pool: pool of licenses containing licenses to be processed on-demand without need for real-time interaction with the VNF Provider

NOTE: The Service Provider could maintain a real-time view of all licenses available in the license pools.

VNF license: legal rights to use a VNF in accordance with terms and conditions specified by the VNF licensor

NOTE 1: "Using a VNF" can include: accessing, copying, distributing, installing and executing the VNF software, depending on the license's terms and conditions.

NOTE 2: Specified license terms and conditions can include VNF components' license information if different than the one of the VNF.

NOTE 3: This definition has been specialized from the term "software license" as defined in International Standard ISO/IEC 19770-5 [i.2].

VNF license entitlement: VNF license use rights as defined through agreements between a VNF licensor and a VNF licensee

NOTE 1: Effective use rights take into account any contracts and all applicable licenses, including full licenses, upgrade licenses and maintenance agreements.

NOTE 2: A commonly used synonym for this term is "VNF license terms".

NOTE 3: This definition has been specialized from the term "software entitlement" as defined in International Standard ISO/IEC 19770-5 [i.2].

VNF licensee: person or organization granted a license to use a specific VNF

NOTE: This definition has been specialized from the term "software licensee" as defined in International Standard ISO/IEC 19770-5 [i.2].

VNF licensor: person or organization who owns or holds the rights to issue a VNF license for a specific VNF package

NOTE 1: This entity might or might not create the VNF software.

NOTE 2: This definition has been specialized from the term "software licensor" as defined in International Standard ISO/IEC 19770-5 [i.2].

VNF usage: consumption against a VNF license entitlement measured as defined by the terms and conditions of that entitlement

NOTE 1: Depending on the specific terms and conditions, usage can include accessing, copying, distributing, installing and executing the VNF software.

NOTE 2: This definition has been specialized from the term "software usage" as defined in International Standard ISO/IEC 19770-5 [i.2].

3.2 Abbreviations

For the purposes of the present document, the abbreviations given in [i.3] and the following apply:

NOTE: An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any in [i.3].

BSD	Berkeley Software Distribution
BSS	Business Support System
CAPEX	Capital Expenditures
CI/CD	Continuous Integration / Continuous Development
EM	(Network) Element Manager
EPC	Evolved Packet Core
EULA	End-User License Agreement
FOSS	Free and Open Source Software
GPL	General Public License
IMS	IP Multimedia Subsystem
LGPL	Lesser General Public License
LM	License Management
MIT	Massachusetts Institute of Technology
MPL	Mozilla Public License

NFVI	Network Functions Virtualisation Infrastructure
NFVO	NFV Orchestrator
OPEX	Operational Expenditure
OSS	Operation Support System
PAYG	Pay As You Go/Grow
RGW	Residential GateWay
SAM	Software Asset Management
SAU	Simultaneous Active Users
VNF	Virtual Network Function
VNFC	Virtualised Network Function Component

4 NFV licenses

4.1 NFV licenses scope

Generally speaking (see note) the software licenses differ according to the rights that are actually granted to the licensee by the licensor. The scope of those rights covers all what the licensee could do with the licensed software in his business processes and which may be subject to authorization by the licensor. Usually, the licensee might **copy** the software, possibly **modify** for internal development purpose, resell the derived software and by the way **sublicense** the acquired licensed software, **distribute** it as such or simply deploy and **use** it to provide services to his customers.

The rights can be granted for a delimited period, i.e. **subscription-based** license or without time limit, i.e. **perpetual** license.

NOTE: This is not limited to NFV software.

4.2 NFV licenses categorization

4.2.1 Introduction

Different types of software licenses exist today and many of them can be reused in the context of NFV. A classification is generally made according to the **entitlement** regarding the reproduction (i.e. copy), distribution and use of the software, which can be different depending on the process of software production and motivations of the **licensor**, which can be, for example a software editor or an open source community.

Table 1 gives a high level classification of software licenses.

Table 1: Overall classification of software licenses

Rights	Public domain	Free and Open Source Software (FOSS)				Proprietary	Trade secret
		Open Source (Without copyleft)	Open Source (Weak copyleft)	Open Source (Strong copyleft)	Freeware, Shareware, Freemium		
Examples	SQLite, ImageJ	Apache, BSD, MIT	GNU LGPL, MPL	GNU GPL, GNU Affero	Irfanview, Winamp	Windows	World of Warcraft
Copyright retained	No	Yes	Yes	Yes	Yes	Yes	Yes
Right to use	Yes	Yes	Yes	Yes	Yes	Yes	No
Right to copy	Yes	Yes	Yes	Yes	Often	No	No
Right to modify	Yes	Yes	Yes	Yes	No	No	No
Right to distribute	Yes	Yes, under same license	Yes, under same license	Yes, under same license	Often	No	No
Right to sublicense	Yes	Yes	No	No	No	No	No

The present document focuses on two "families" of software license:

- Open Source software licenses.
- Proprietary software licenses, used for commercial software products.

4.2.2 Open Source software licenses

There are several subtypes of Open Source software but they all assume that the source code is available according to the terms of a license that allows the licensee to use but also modify and distribute this code.

Open Source software is also characterized by a charter on rights and duties based on a community model organizing the use of the software for the benefit of all licensees.

Three subtypes are distinguished in particular by a criterion called **copyleft** which diverts the principle of copyright to preserve the freedom of any user to use, modify and distribute the software and its derived versions.

Three degrees of copyleft are identified which specify the obligations with regard to the distribution of modified software:

- *Strong copyleft* implies that the whole modified software is subject to the same type of license as the original copyleft software.
- *Weak copyleft* allows to compose the copyleft software components with any other software (open source or proprietary), and in the modified software, only the copyleft software components keep the original copyleft license.
- *Without copyleft*, where the choice of the software license for the modified software is free (open source or proprietary).

4.2.3 Proprietary software licenses

For commercial proprietary software the licensor grants the use of one or more copies of software under the End-User License Agreement (EULA), but ownership of those copies remains with the licensor, therefore also called proprietary software.

This characteristic of proprietary software means that, on one hand certain rights relating to the software (see Table 1), in particular those regarding modification and distribution are reserved by the licensor and on the other side the use are allowed but subject to entitlements, i.e. the terms and conditions specified in the license.

Business Models

For commercial software products, the licensor monetizes use and distribution rights to finance the development costs and make profits. Examples of business models for proprietary licenses are:

- **FLAT:** A perpetual right to use the software is purchased at a fixed price. The price depends on the features of the software, but is bought entirely from the beginning.
- **PAY-AS-YOU-GROW:** A perpetual right to use the software is purchased progressively according to the growth of the service it is deployed for. A metric is used to measure the growth.
- **SUBSCRIPTION:** A temporary right to use the software (term base) is acquired for a given period of time. The renewal of this right is decided at the end of each period.

NOTE: License restrictions can be applied to the above business models.

Metrics

Business models of proprietary software licenses are all based on a manner to measure the use of the software. Any measuring technique relies on well-defined metrics. Metrics differ according to several criteria as for instance, the network domain and market considered. For instance, for software dedicated to a user (e.g. vRGW), counting the number of instances actually deployed is probably sufficient. In the case of the Virtualisation of mobile core network and IMS network functions (e.g. vIMS, vEPC), other metrics are usually used such as the Simultaneous Active Users (SAU).

4.2.4 Declarative software licenses

In this approach, software use is left to the software license and enforcement to license terms and condition is done offline as per the business agreement. One of possible way is to implement it through audit.

Reconciliations between the software licensor and the software licensee can be carried out (off-line) on the basis of:

- 1) Software usage measurements and reporting based upon the license defined metrics.
- 2) Explicit business agreements between the software licensor (e.g. VNF Provider) and the software licensee (e.g. Service Provider).

4.3 VNF licenses

Software licenses are applicable in the different functional domains of network architectures based on NFV (e.g. OSS / BSS, NFV-MANO, VNF, NFVI). However, it is in the VNF domain that the ruptures are the most important. Indeed, the promise of time-to-market reduction relies on CI/CD concepts and automated processes (e.g. on-boarding) are essential across all the domains. In the present document a focus is made on the software licenses for VNFs.

Service providers will be deploying VNFs from many VNF Providers with various terms and agreement for use. Runtime VNFs instances will be managed and orchestrated by NFV-MANO based on agreed licensing policies and business models. Streamlining/automating the management and operational aspects of VNF licenses will be very important to realize the cost saving benefits for NFV. On the other side, it is expected that the management of licenses does not have impact on service continuity:

- NFV-MANO will use the license for the VNF instantiation and operation.
- Enforcement of the contract between the VNF Provider and the Service Provider should be enabled by a mechanism trusted by both the parties.
- Usage of VNF licenses needs to be handled proactively to meet the requirements for continuity of the service.
- Service providers adhere to the license policies as per agreed business model and metrics.
- Auto scaling may not work if desired licenses are not in place and even a well-defined automated process for obtaining licenses on demand cannot guarantee to have the license installed on-time.
- To get the desired business benefit, especially for long term planning it is important to monitor the usage of VNFs based on the VNF license agreements in place.
- Ability to implement a flexible and extensible model for VNF licenses is essential for cost efficiency.
- There is need to standardize the acquisition of VNF licenses information's to ensure it is VNF and VNF Provider agnostic.

It is important to note that in the B2B market, and especially with important customers as telecommunication operators, a **declarative license** approach is commonly used (in place of a license management module) which consists in entrusting the software licensee with the task of controlling by himself that the use of the software is made in accordance with the license terms defining the rights of use and associated limits. Telecommunication operators are used to managing their software licenses and have a dedicated business process called Software Asset Management (SAM). The SAM needs to be adapted to fit with automation processes orchestrated by NFV-MANO.

Telecommunication operators have always collected **usage data** from their network resources for scaling and business planning and this will not change with the Virtualisation of network functions. Obviously, these usage data are considered as sensitive and Virtualisation will not change this.

The management of VNF licenses in the Service Provider and VNF Provider environment is outside the scope of the present document. The TM Forum IG1143 [i.1] has studied the implications for OSS/BSS of license management and it is a useful reference to gain a complete picture of VNF license management requirements.

4.4 Enforcement of VNF licenses

Different approaches are used today for the enforcement of software licenses. Following are the two examples:

- The first approach is based on an automated enforcement of VNF licenses during VNF operations, especially during instantiation and scaling of VNFs. In this case, an operation (e.g. instantiation) will not be carried out if it contravenes the terms of the acquired license(s).
- The second approach is based on the declarative VNF license concept (see clause 4.3). In this case the operations on the VNF will be carried out as per the license agreement. A regularization is carried out on the basis of VNF usage measurements and reporting as well as explicit business agreements between the VNF Provider (i.e. the VNF licensor) and the Service Provider (i.e. the VNF licensee) regarding this situation. Business agreements might refer to the possibility of audits performed by the VNF licensor in order to strengthen the confidence on the well follow-up of the terms of the business agreements.

The use cases presented in clause 5 cover both approaches:

- Use cases 1 to 6 assume the existence of an on-line license enforcement (using a licenses management function).
- Use case 7 assumes a declarative license, the possibility of audits and an off-line regularization (using a centralized SAM function).

NOTE: Enforcement of license is to be looked into from both Service Provider and VNF Provider perspective.

5 NFV Licenses use cases

5.1 Use Case 1: On-demand instantiation and termination of Virtual Firewall (vFirewall)

5.1.1 Introduction

This use case highlights the use of license for vFirewall VNF, instantiation and termination based on End User order journey. A vFirewall VNF is composed of a single VNFC which is packaged as a VNF sourced from a VNF Provider.

For the purpose of describing the license management lifecycle, it is assumed that the Service Provider has already on-boarded the vFirewall VNF Package from the VNF Provider. It is further assumed that:

- For each End User there will be separate instances of vFirewall that will be created to fulfil the End User order.
- The on-boarded vFirewall VNF Package will be used to create new instances.
- The Service Provider will procure a new license for each new instance of vFirewall.

5.1.2 Business Value

Efficient management of VNF licenses will enable realization of the expected OPEX and CAPEX cost savings for NFV deployment through automation of the VNF lifecycle, including automation of VNF licensing:

- Service Provider only pays for the number of active instances of vFirewall.
- Once the End User disconnects the vFirewall service offering, the Service Provider will release the license key back to the VNF Provider or release it to the license pool for reuse.
- Automation of on-boarding and release of licenses without manual intervention.
- Enforcement of the contract between the VNF Provider and the Service Provider should be enabled by a mechanism trusted by both the parties.

- VNF license enforcement is performed according to the terms of the contract between VNF Provider and Service Provider through the use of licenses.

5.1.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** This actor provides vFirewall VNF Packages and associated licenses for use.
- **Service Provider:** This actor uses the vFirewall VNF Package to create services for its End Users and pays the VNF Provider based on the number of active vFirewall instances.
- **End User:** This actor subscribes for services from Service Provider.
- **License Manager:** This actor provides the following:
 - Maintaining a license pool for the VNFs.
 - Answering to NFV-MANO's license need and providing the license keys.
 - Metering and reporting on "VNF usage" for a "pay as you grow" model.

NOTE: License Manager should be trusted by both Service Provider and VNF Provider.

5.1.4 Pre-conditions

The use case pre-conditions are as follows:

- The Service Provider has already on-boarded the vFirewall VNF Package from the VNF Provider.
- Each End User specific service will have its own instance(s) of vFirewall.
- An agreement with the VNF Provider in place to pay for each instance of the vFirewall.
- The Service Provider will acquire or release licenses for each vFirewall instances back to VNF Provider, or to the license pool for re-use as and when required.

5.1.5 Post-conditions

The use case post-conditions are as follows:

- As part of End User order fulfilment, the Service Provider will acquire the licenses for instantiation of vFirewall.
- The acquired license will be associated with the vFirewall instance which in turn will be associated with the End User service.
- Once the End User discontinues the service, the Service Provider will release the license key back to the VNF Provider or to the license pool for re-use.

5.1.6 Flow description

The following steps detail the flow description between the actors regarding the order fulfilment for the End User:

- The End User places an order with the Service Provider. The End User order fulfilment requires at least one instance of vFirewall.
- The Service Provider order fulfilment process will check for license availability from the license pool.
- If no license is available from the license pool, the order fulfilment process at the Service Provider will acquire an additional license from the VNF Provider via the License Manager.

- The Service Provider uses the acquired additional license to instantiate the vFirewall to fulfil the End User order.
- The enforcement of the license is done in the vFirewall domain by checking the validity of the license during instantiation. If the license is invalid, the instantiation will be denied.
- The License Manager logs and/or reports (in a signed report) the usage of the vFirewall associated licenses as per the commercial agreement with the VNF Provider.
- The Service Provider will pay the VNF Provider for the use of the additional license as per the commercial agreement between the Service Provider and the VNF Provider.

The following steps detail the flow description between the actors for cease of services by the End User:

- The End User places an order for cancellation of services with the Service Provider.
- As part of the service cancellation request the vFirewall services for the End User will be stopped. This will include termination of all the instances of vFirewall used to build the End User services.
- The Service Provider service cancellation process will release the license back to the VNF Provider or to the license pool for future re-use.
- If the license is no longer required, the Service Provider returns the license to the VNF Provider according to the commercial agreement between the Service Provider and VNF Provider.

5.2 Use Case 2: VNF licenses implications for sharing of vFirewall VNFs instances across NFVI-PoPs

5.2.1 Introduction

This use case highlights the use of VNF licenses for vFirewalls instantiated in more than one NFVI-PoP through sharing the license information.

A vFirewall VNF is composed of single VNFC which is packaged as VNF sourced from VNF Provider. For the purpose of describing the license management lifecycle, it is assumed that the Service Provider has already on-boarded the vFirewall VNF Package from the VNF Provider. It is further assumed that:

- The focus of this use case is on license management hence the process of moving the vFirewall instance from one NFVI-PoP to another is out of scope.
- The on-boarded vFirewall VNF Package will be used to create vFirewall instances.
- Each vFirewall instance will have its own license. The VNF license required for instantiating vFirewall instances is already made available to the Service Provider (via the license pool), hence there is no need to approach the VNF Provider for the required licenses.
- One or more End Users will share the same instance of vFirewall.

The following describes the agreement between the Service Provider and the VNF Provider for use of the VNF, along with other aspects of sharing the vFirewall instance:

- The Service Provider has procured licenses to create X (number of) instances of vFirewall which can be instantiated across one or more NFVI-PoPs.
- Geolocation restriction:
 - A vFirewall instance can only be created in NFVI-PoPs within geographically defined areas as agreed between Service Provider and VNF Provider.
 - Instances of the vFirewall can only be used by an End User located in the defined geographical areas.

- End User usage restriction:
 - The vFirewall instance can only be used by maximum X number of End Users.
- A single NFVO can manage one or more NFVI-PoPs.
- To respond to load changes the NFVO can move the vFirewall instance from one NFVI-PoP to another one under NFVO control. This can be done by the NFVO alone since the license has already been acquired.
- If the NFVO needs to create a new vFirewall instances then it will retrieve a license from the license pool.
- If instances of vFirewall are no longer required the NFVO can shutdown surplus instances of the vFirewall and release the license(s) back to the license pool.

5.2.2 Business Value

Efficient management of VNF licenses will enable realization of the expected OPEX and CAPEX cost savings for NFV deployment through automation of the VNF lifecycle, including automation of VNF licensing:

- Once the End User disconnects the vFirewall service offering, the Service Provider will release the license key back to the VNF Provider or release it to the license pool for reuse.
- Automation of on-boarding and release of licenses without manual intervention.

5.2.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** This actor provides vFirewall packages and associated licenses for use.
- **Service Provider:** This actor uses the vFirewall package to create services for its End Users and pays the VNF Provider based on the commercial agreement, for example number of active vFirewall instances.
- **End User:** This actor subscribes for services from Service Provider.
- **License Manager:** This actor provides the following:
 - Maintaining a license pool for the VNFs.
 - Answering to NFV-MANO's license need and providing the license keys.
 - Metering and reporting on "VNF usage" for a "pay as you grow" model.

NOTE: License Manager should be trusted by both Service Provider and VNF Provider.

5.2.4 Pre-conditions

The use case pre-conditions are as follows:

- The Service Provider has already on-boarded the vFirewall VNF Package from the VNF Provider.
- A fixed number of licenses to create multiple instances for the vFirewall is available to the Service Provider via the license pool.

5.2.5 Post-conditions

The use case post-conditions are as follows:

- The VNF license of vFirewall will be shared across the NFVI-PoPs for optimum utilization.
- The Service Provider network support team will get automated notifications on usage of VNF resources.

- The Service Provider procurement team will get involved for on boarding of new licenses as per demand if the available number of licenses is not sufficient to meet the vFirewall demand.

5.2.6 Flow description

- The flow description includes the following steps: Multiple vFirewall instances will be instantiated or moved between NFVI-PoPs. This implies release of licenses to the license pool and retrieval of licenses from the license pool based on demand.
 - When a need for additional vFirewall instances is detected for a NFVI-PoP to serve the increased load, the NFVO will request additional licenses.

NOTE 1: This will require tracking the number of End Users connected to the vFirewall instance to avoid exceeding the limit on End Users.

- Release of license
 - NFVO (managing the NFVI-PoPs) having surplus vFirewall instance will shut down the instance and release the license back to the license pool.
- The NFVO managing multiple NFVI-PoPs can decide to move the vFirewall instance from one NFVI-PoP to another without consulting the License Manager.
 - Here the assumption is made that NFVI-PoP managed by the NFVO can operate the vFirewall instance as per its geolocation license restrictions.

NOTE 2: If this assumption is not correct then this part of the flow description will not be applicable then the flow should follow the description provided in the next bullet.

- Moving vFirewall instances across NFVI-PoPs managed by more than one NFVO requires license information to be available from the License Manager.
 - An NFVO with surplus vFirewall instances should release the license back to the license pool for re-use.
 - An NFVO which needs additional instances of vFirewall should request a license compliant with the geolocation where the vFirewall instance needs to be instantiated.

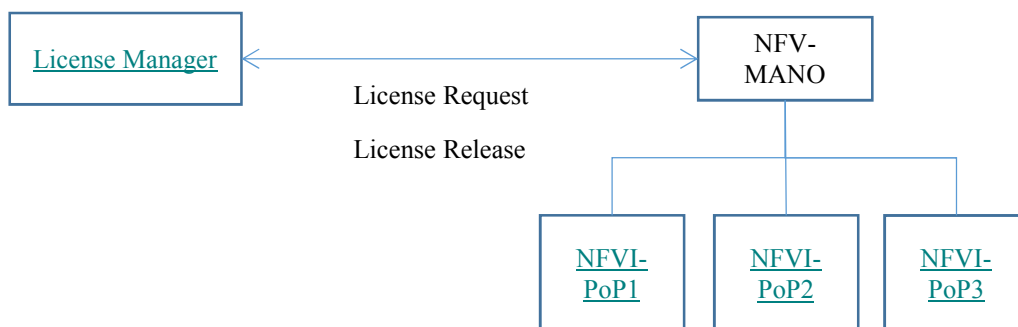


Figure 1: High level information flow between NFV-MANO and License Manager

5.3 Use Case 3: Applying revised license terms to an on-boarded VNF Package

5.3.1 Introduction

This use case highlights the need for allowing VNF Package to be used under more than one license terms without re-on-boarding the VNF Package.

NOTE: While the VNF Package remains the same, the license terms can change according to the commercial agreement between the VNF licensor and VNF licensee.

It is assumed that the Service Provider has already on-boarded the VNF Package from the VNF Provider. It is further assumed that:

- The focus of this use case is to highlight the requirement for allowing the VNF Package to be used under more than one license terms. The process of on boarding the VNF Package, VNF license, etc. are out of scope of this use case.
- The on-boarded VNF Package will be used to create VNF instances. Each VNF instance will use the VNF license with associated agreed license terms.

5.3.2 Business Value

Efficient management of VNF licenses will enable realization of the expected OPEX and CAPEX cost savings for NFV deployment through automation of the VNF lifecycle, including automation of VNF licensing:

- This eliminates the need to on board the already on boarded VNF Package when license terms are changed.
- The Service Provider can use VNF Packages under different license terms according to service configuration.

5.3.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** This actor provides vFirewall packages and associated licenses for use.
- **Service Provider:** This actor uses the vFirewall package to create services for its End Users and pays the VNF Provider based on the commercial agreement, for example number of active vFirewall instances.
- **End User:** This actor subscribes for services from Service Provider.
- **License Manager:** This actor provides the following:
 - Maintaining a license pool for the VNFs.
 - Answering to NFV-MANO's license need and providing the license keys.
 - Metering and reporting on "VNF usage" for a "pay as you grow" model.

NOTE: License Manager should be trusted by both Service Provider and VNF Provider.

5.3.4 Pre-conditions

The use case pre-conditions are as follows:

- The Service Provider has already on-boarded the VNF Package and associated licenses from the VNF Provider.
- As per the commercial agreement between the Service Provider and VNF Provider, the Service Provider can use VNF Package under more than one license terms.

5.3.5 Post-conditions

The use case post-conditions are as follows:

- VNF instances are operated according to the VNF license terms and the Service Provider has fulfilled their obligations to the VNF Provider based on the commercial agreement.

NOTE: Usage collection and payment is out of scope of this use case.

5.3.6 Flow description

The flow description includes the following steps:

- The Service Provider on-boards the VNF Package from the VNF Provider.
- VNF instances are operated as per the entitlements and restrictions defined by the license terms.
- Based on the VNF Package usage, the Service Provider identifies the need for operating the VNF under different license terms for the same VNF Package.
- The Service Provider obtains the revised license for the VNF from VNF Provider or license pool.
- The Service Provider uses the new VNF license to instantiate the VNF using the same VNF Package as previously.

5.4 Use Case 4: Applying VNF license to enable or disable VNF functionalities

5.4.1 Introduction

This use case highlights how a VNF license can be applied for enabling and disabling VNF functionalities.

Typically, a VNF will consist of one or more than one functionalities. However it may well be the case that not all functionalities are required by the Service Provider. Further to this, the Service Provider would like to use the VNF functionality based on their network demands.

License driven enablement or disablement of VNF functionalities will simplify the process for both Service Provider and VNF Provider. The VNF Provider will be able to restrict the use of functionality through VNF licenses whereas Service Provider can use the VNF license to unlock VNF functionalities for instantiation.

NOTE: To support this use case there is a need to take care of the VNF integrity check that is done on all VNF during on-boarding and/or run time to avoid modification on the VNF instance by malicious software. It is recommended that this VNF functionality enablement/disablement will not imperil this integrity check.

It is assumed that Service Provider has already on boarded the VNF Package along with license from the VNF Provider. It is further assumed that:

- The focus of this use case is to highlight how VNF licenses could be used to enable or disable VNF Functionality without the need to on-board a different version of the VNF Package.
- The process of on boarding the VNF Package, VNF license, etc. are out of scope of this use case.
- The on-boarded VNF package will be used to create VNF instances.

5.4.2 Business Value

Efficient management of VNF licenses will enable realization of the expected OPEX and CAPEX cost savings for NFV deployment through automation of the VNF lifecycle, including automation of VNF licensing:

- This eliminates the need to re-package the VNF if certain functionality is to be enabled or disabled.
- Using different licenses the Service Provider can lock/unlock VNF functionalities without the need to on-board a new VNF Package.

5.4.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** This actor provides vFirewall packages and associated licenses for use.

- **Service Provider:** This actor uses the vFirewall package to create services for its End Users and pays the VNF Provider based on the commercial agreement for example number of active vFirewall instances.
- **End User:** This actor subscribes for services from Service Provider.
- **License Manager:** This actor provides the following:
 - Maintaining a license pool for the VNFs.
 - Answering to NFV-MANO's license need and providing the license keys.
 - Metering and reporting on "VNF usage" for a "pay as you grow" model.

NOTE: License Manager should be trusted by both Service Provider and VNF Provider.

5.4.4 Pre-conditions

The use case pre-conditions are as follows:

- The Service Provider has already on boarded the VNF Packages and associated license from the VNF Provider.
- The Service Provider uses the VNF license for creating the VNF instances.
- The VNF was fully tested during the on-boarding procedure including functionalities which might not need to be enabled by the initial license.

5.4.5 Post-conditions

The use case post-conditions are as follows:

- The VNF instances are operated using the VNF licenses obtained by the Service Provider.
- The Service Provider would receive new VNF licenses from the License Manager or the VNF Provider if there is a need to use features which were earlier restricted by VNF Provider or not required for the initial service deployment.

5.4.6 Flow description

The flow description includes the following steps:

- The Service Provider on-boards the VNF Package from the VNF Provider.
- VNF instances are operated using the VNF license entitlements and restrictions.
- The Service Provider decides to use functionalities supported by the VNF Package but restricted by the initial VNF license.
- The Service Provider requests new VNF licenses from the VNF Provider or License Manager license pool.
- The acquired new VNF licenses are used to operate the existing instances of the VNF.
- License enforcement ensures that VNF functionality gets enabled / disabled according to the provided VNF license.

5.5 Use Case 5: License event reporting

5.5.1 Introduction

This use case highlights license event reporting in order to examine and ascertain the accuracy of license use. The reporting of license events could also be used by other business function such as it could be shared with VNF Provider for billing in a post-paid licensing model.

License event itself could be just an information of licenses embedded within the existing events or could be derived based on co-relation of existing event with license information.

It is assumed that Service Provider has already on boarded the VNF Package from the VNF Provider, and the VNF instance is granted with a specific license.

This use case highlights the events to be generated by for example VNF instance, EM, NFV-MANO, etc. The license management system uses the events to track VNF usage against the VNF license terms and for analysis, auditing, reporting, etc. Following are the list of events that can be generated during the lifecycle of VNF Instances:

- VNF license information corresponding to VNF Lifecycle events with time stamps:
 - VNF instantiation
 - VNF scaling
 - VNF termination
 - VNF healing
 - VNF deployment flavour change
- Other events related to VNF licenses with timestamps:
 - VNF license availability check
 - VNF usage
 - VNF license reservation event and license reservation release event
- VNF license information's corresponding to the VNF assurance:
 - VNF failure event
 - VNF performance degradation
 - VNF threshold breach

NOTE: The shared events should be trusted by both Service Provider and VNF Provider.

5.5.2 Business Value

Both the Service Provider and the VNF Provider need to ascertain the license usage, in order to protect their business interests.

5.5.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** Provides VNF Packages and associated licenses for use.
- **Service Provider:** Uses the VNF Package and associated licenses to operate the VNFs.

5.5.4 Pre-conditions

The use case pre-conditions are as follows:

- Service Provider has already on boarded the VNFs Package and associated license for use from VNF Provider.
- The granted license is stored in the license management system.
- Service Provider uses the VNF license for operating the VNF instances.

5.5.5 Post-conditions

The use case post-conditions are as follows:

- License events are reported by the VNF instance, EM, NFV-MANO, etc. to the license management system.

5.5.6 Flow description

The following steps details the flow description between the actors for tracking the license events:

- VNF instances are operated as per agreed business model.
- The VNF Instance, EM, NFV-MANO, etc. generates the events which are made available to the license management system.
- The license management system will then aggregate the events and ensures the VNF usage complies with the license terms.
- In addition, it can also sign the usage data and sent it to the VNF Provider for billing in a post-paid licensing model.

5.6 Use Case 6: Identifying the need of additional license

5.6.1 Introduction

This use case highlights the ability for Service Provider to identify the need for additional VNF licenses on-demand.

5.6.2 Business Value

- Overall OPEX and CAPEX cost saving as described below:
 - Service Provider can use it to purchase VNF licenses on-demand.

5.6.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** Provides VNF Packages and associated licenses for use.
- **Service Provider:** Uses the VNF Package and associated licenses to operate the VNFs.

5.6.4 Pre-conditions

The use case pre-conditions are as follows:

- Service Provider on-boards the VNF Package along with the license terms from VNF Provider.
- VNF instances are operated using VNF license.

5.6.5 Post-conditions

The use case post-conditions are as follows:

- Identifies additional licenses needs to the management system.

5.6.6 Flow description

The flow description includes the following steps:

- During the operation of VNFs instances, the VNF lifecycle management events (e.g. VNF instantiation, VNF scaling out, etc.), the VNF license events and VNF failure events are generated.
- The license management system uses the information in these events to identify that the granted VNF license is insufficient to support the current network demands or to meet the future network demands and therefore there is need for additional licenses.
- The management system reports the need for additional license to the procurement team.

5.7 Use Case 7: Use of declarative licenses for vEPC-VNF

5.7.1 Introduction

This use case highlights the use of VNF declarative licensing for virtualised evolved packet core (vEPC). A vEPC can be split into a few smaller VNFs, each of them with their own licensing requirement but for the sake of simplicity, the use case will only refer to one vEPC VNF (referred to as vEPC-VNF in the description).

For the purpose of this use case, the following assumptions apply:

- In the context of a telco service (e.g. specialized telephony) the Service Provider needs to deploy a vEPC-VNF (among other VNFs).
- A business agreement has been established between the VNF Provider and the Service Provider concerning vEPC-VNF including license entitlements and payment terms.
- This business agreement foresees on-site audits by the VNF licensor in order to control the correct usage of the vEPC-VNF.
- For each vEPC-VNF deployed the usage data is collected to verify the correct use of the vEPC-VNF with regard to the license terms. The collected information is trusted by both parties, i.e. Service Provider and VNF Provider.
- The collected usage data can be used to build an audit report.

5.7.2 Business value

The proposed business model will enable OPEX and CAPEX cost savings for NFV deployment through automation of the vEPC-VNF lifecycle, ensuring high availability of vEPC-VNF.

- The VNF Provider will charge/bill the Service Provider according to the measured usage of the vEPC-VNF (e.g. number of Simultaneous Active Users).

NOTE: The number of Simultaneous Active Users is smaller than the total number of end users as end users are not active all the time.

- Automated operations (e.g. re-deployment on cloud infrastructure, scaling, etc.) are not conditioned to on-time availability of required license. Service continuity is optimized as license enforcement in this use case will not lead to cancellation of a VNF automated operation.
- The possibility to perform an audit reinforces the level of trust between the VNF Provider and the Service Provider and contributes to strengthen their relationships.

5.7.3 Actors and roles

The use case actors and roles are as follows:

- **VNF Provider:** It provides vEPC-VNF packages and associated license for use. The VNF Provider is acting as a VNF licensor.
- **Service Provider:** It uses the vEPC-VNF packages, instantiates the vEPC-VNF in order to build a service. The Service Provider is acting as a VNF Licensee. The VNF Provider charge/bill the Service Provider according to the measured number of Simultaneous Active Users.
- **Service Customer:** It subscribes to services from the Service Provider. In this use case, the considered service is provided thanks to (but not limited to) a vEPC-VNF.

NOTE: Software Asset Management (SAM) can be used in this use case.

5.7.4 Pre-conditions

The use case pre-conditions are as follows:

- The business agreement between the VNF Provider (i.e. VNF licensor) and the Service Provider (i.e. VNF licensee) has been established.
- A vEPC-VNF license is marked as "not used" e.g. in the Software Asset Management.
- The licence terms for the vEPC-VNF foresees:
 - A price per Simultaneous Active Users measured for live usage (service charged).
 - A measurement of Simultaneous Active Users for all usages: live, testing, back-up, redundancy, etc.
 - An automated way of reporting all measurements on a periodic basis (e.g. every month).
 - An exhaustive listing of usage (including limits exceeding).
- In order to provide a telco service (e.g. specialized telephony) the Service Provider performs the on-boarding of a vEPC-VNF package (among other VNFs).
- The Service Provider, e.g. thanks to the SAM, extracts the license metadata from the vEPC-VNF package.
- The license metadata allows to identify the events which are significant with regard to the license policy management, typically:
 - VNF life-cycle events (e.g. instantiation, scaling...).
 - VNF usage data (e.g. thresholds on the number of Simultaneous Active Users).

5.7.5 Post-conditions

The use case post-conditions are as follows:

- The telco service provided thanks to the vEPC has been decommissioned.
- The Service Provider has paid the VNF Provider in accordance with the terms of the business agreement and the license (e.g. PAYG) and the measured usages of vEPC-VNF.
- Audits have been carried out thus reinforcing the level of trust between the VNF Provider and the Service Provider and contributing to strengthen their business relationships.
- The vEPC-VNF license is marked as "not used" e.g. in the Software Asset Management (SAM).

5.7.6 Flow description

The flow description includes the following steps:

- The Service Provider decides to instantiate (for example to fulfil end customer order) the vEPC-VNF (and other required VNFs), with the required flavours.
- The resources are allocated by NFV-MANO accordingly and as a result the vEPC-VNF is instantiated (as well as the other VNFs).
- The Usage collection function e.g. SAM registers itself to events of the license policy management:
 - VNF life-cycle events (generated by NFV-MANO).
 - VNF usage data (potentially generated by an EM).
- The vEPC-VNF license is marked as "used" e.g. in the SAM.
- Depending on the need of the Service Provider network operation a new instance of vEPC-VNF can be operated by Service Provider.
- During telco service utilization, it might also arise that the vEPC-VNF usage is about to reach threshold related to a license pricing agreement.
- If a scaling of the vEPC-VNF is necessary in order to preserve the service continuity and/or quality, it will be performed in accordance with business agreement (which takes these situations into account).
- The Service Provider logs and/or reports the vEPC-VNF related life-cycle events and usage as per the agreed license agreement with the VNF Provider.
- If required by the license agreement, an audit is realized in the Service Provider premises and the collected logs and reports are used in support of this audit.

The Service Provider will pay the VNF Provider for the VNF usage as per the license agreement between the Service Provider and the VNF Provider.

6 Use case analysis

6.1 VNF license recommendations

Table 2 provides the VNF license recommendations derived from the analysis of use cases described in clause 5.

Table 2: Recommendation

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.001	It is recommended that a requirement be specified so that a VNF Package be associated with one or more license terms, if the VNF requires one or more licenses.	On boarding	Use Case 3: Applying revised license terms to an on-boarded VNF Package.	The intent is to avoid the need to on-board a different variant of the VNF Package when it is required to change the license terms under which the VNF will operate. For example, to enable/disable licensed features after the VNF Package has been on-boarded.
VNF_LICENSE.002	It is recommended that a requirement be specified that addition or modifications of VNF licenses or VNF license terms do not impact the on-boarded VNF Package.	On boarding	Use Case 3: Applying revised license terms to an on-boarded VNF Package.	The intent is to avoid the need to on-board a different variant of the VNF Package when it is required to change the license terms under which the VNF will operate. For example, to enable/disable licensed features after the VNF Package has been on-boarded.

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.003	It is recommended that a requirement be specified that if the VNF Package is changed (New version or modification of existing software image) the existing VNF license remains valid until the new VNF license terms come into effect.	On boarding	Use Case 3: Applying revised license terms to an on-boarded VNF Package.	The intent is to ensure service continuity according to the existing license terms, to enable a controlled transition to the new VNF and license configuration.
VNF_LICENSE.004	It is recommended that a requirement be specified that a consistent view of VNF license information is available across all involved components and instances.	Management	Use Case 2: VNF licenses implications for sharing of vFirewall VNFs instances across NFVI-PoPs Use Case 7: Use of declarative licenses for vEPC-VNF.	The intent is to avoid conflicting decisions about valid licenses leading to dissimilar operation of the same VNFs across a distributed infrastructure. Use Case 7: assumes a centralized management of VNF licenses.
VNF_LICENSE.005	It is recommended that a requirement be specified that the NFVO should be able to share the licenses across the NFVI-PoP if the NFVI-PoP complies with geolocation or any other restriction policies defined by the licenses.	Operations	Use Case 2.	
VNF_LICENSE.006	It is recommended that a requirement be specified that VNF licensing is decoupled from the platform where it runs.	Management, On boarding	All the use cases.	The intent is to enable any commercial model to be applied to VNFs independently of implementation of the NFVI and NFV-MANO framework.
VNF_LICENSE.007	It is recommended that a requirement be specified that the business agreement allows VNF licensing allows for testing, validation of features even if it not used in production.	On boarding	Use Case 4: Applying VNF licenses To enable-disable VNF functionalities.	Enables network operators to thoroughly test VNF lifecycle operation, including performance and interoperability, and scaling. Though this requirement is only indirectly mentioned in Use Case 4, it is a very important requirement and is applicable for all the on-boarding scenarios.
VNF_LICENSE.008	It is recommended that a requirement be specified that VNF licensing allows usage based charging.	Operations	All the use cases.	Usage base metrics are required for most core network functions (e.g. vEPC-VNF).
VNF_LICENSE.009	It is recommended that a requirement be specified that VNF licensing describes entitlements and restrictions in a format which is understandable and interpretable across implementations for example orchestration function.	Management, On boarding, Operations	Use Case 2: VNF licenses implications for sharing of vFirewall VNFs Instances across NFVI-PoPs.	The format should be specified as part of the solution definition.

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.010	It is recommended that a requirement be specified that makes possible to enable dormant VNF functionality or disable existing VNF functionalities as per VNF license terms without interrupting operations on running VNFs.	Management, On boarding, Operations	Use Case 4: Applying VNF licenses To enable-disable VNF functionalities.	The intent is to on-board fully-featured VNFs that will only execute functionality that has been allowed by the current license terms. If new license terms are purchased from the VNF manufacturer, the VNF features should be able to be changed without neither on-boarding a new version of the VNF nor interrupting operations on running VNFs.
VNF_LICENSE.011	It is recommended that a requirement be specified that VNF license key(s) supports creation of one or more instances.	Management, On boarding, Operations	All the use cases, except Use Case 7.	Although it is not mentioned directly in any of the use cases. It is a generic licensing key requirement that one license key can support creation of one VNF instance; alternatively one license key can support creation of multiple VNF instances. This is to avoid multiple license keys needing to be acquired when deploying multiple VNFs with the same licensed functionality.
VNF_LICENSE.012	It is recommended that a requirement be specified that on-boarding of VNF licenses might be decoupled from on-boarding of VNF Packages.	On boarding	Implicit for all the use cases except for Use Case 7 where it is explicitly needed.	Use Case 7 assumes that a modification or replacement of the license metadata associated to a VNF Package is possible after the on boarding of VNF Package.
VNF_LICENSE.013	It is recommended that a requirement be specified that in order to manage the VNF instances, NFV-MANO and OSS/BSS are able to acquire/release/reserve the VNF licenses.	Management, Operations	Use Case 1 : On demand instantiation and termination of Virtual Firewall (vFirewall) Use Case 2 : VNF licenses implications for sharing of vFirewall VNFs Instances across NFVI-PoPs Use Case 7: Use of declarative licenses for vEPC-VNF.	Reserve is not explicitly mentioned in the use case.

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.014	It is recommended that a requirement be specified that in order to manage the VNF instances NFV-MANO and OSS/BSS are able to query the available VNF licenses anytime.	Management, Operations	Use Case 1 : On demand instantiation and termination of Virtual Firewall (vFirewall) Use Case 2 : VNF licenses implications for sharing of vFirewall VNFs Instances across NFVI-PoPs Use Case 7: Use of declarative licenses for vEPC-VNF.	Not explicitly mentioned in the use case.
VNF_LICENSE.015	It is recommended that a requirement be specified that scaling out of VNF instances is supported in VNF license terms.	Operations	Generic requirement for VNF licenses.	A basic requirement for NFV systems to adapt to demand.
VNF_LICENSE.016	It is recommended that a recommendation be specified that when a running VNF instance is terminated, the VNF licenses associated with it are released.	Operations	Use Case 1 : On demand instantiation and termination of Virtual Firewall (vFirewall) Use Case 2 : VNF licenses implications for sharing of vFirewall VNFs Instances across NFVI-PoPs Use Case 7: Use of declarative licenses for vEPC-VNF.	A basic requirement to conserve VNF licenses by enabling re-use if no longer needed by the current service chain configuration. Use Case 7 : Assumes that NFV-MANO informs the function managing the licenses (e.g. SAM) that the VNF license is no longer used.
VNF_LICENSE.017	It is recommended that a requirement be specified that if lack of VNF license occurs, continuity of services may be guaranteed in accordance with license agreement for example continuity for specified time period.	Operations	Generic requirement to meet service continuity.	The intent is to allow a VNF to continue to operate, even if the VNF license server is down or otherwise not available. The actual operation will be subject to the commercial agreement between the VNF Provider and the Service Provider. NOTE: The loss of availability of a VNF license is not the same as the lack of a VNF license.
VNF_LICENSE.018	It is recommended that a requirement is specified to define advance notifications of VNF license expiration.	Management	Generic requirement.	Both, LM and license enforcement need to consider expected expirations. The advance notifications will allow for timely adjustment of license agreements. For perpetual license there will be no notification.
VNF_LICENSE.019	It is recommended that a requirement be specified that it is possible to query the license information under which the VNF is currently operating.	Management, Operations	Generic requirement.	This will enable audit and to validate correct configuration at any time during the VNF lifecycle.

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.020	It is recommended that a requirement be specified that Service Providers are able to allocate and manage licenses for different types of VNFs and VNFs supplied by different VNF Providers, in the same way during provisioning processes.	Management, Operations	Generic requirement.	Requirement for standardization of the license management capabilities.
VNF_LICENSE.021	It is recommended that a requirement be specified that makes possible to collect events related to VNFs licenses which could be used by functions of Service Provider outside NFV-MANO for planning, charging, and proactive monitoring to avoid failures, etc.	Management, Operations	For charging and billing for license usage, etc.	Facilitates audit of running VNF licenses and enable other functions to monitor license management events.
VNF_LICENSE.022	It is recommended that a recommendation be specified that higher layer systems e.g. SAM (outside of the NFV-MANO scope) manages the VNF licenses, including their lifecycle.	Management, Operations	For unified view of licenses information across NFV-MANO instances. Use Case 7 : Use of declarative licenses for vEPC-VNF.	Intent to minimize license-management specific functionality in NFV-MANO. Use Case 7 (Use of declarative licenses for vEPC-VNF): assumes a centralized license management function e.g. SAM.
VNF_LICENSE.023	It is recommended that a requirement be specified the same methods, mechanisms and protocols are used for communication with the license management systems whatever the VNF.	Management, Operations	All use cases for standardizing the interfaces.	Requirement for standardization of the license management capabilities irrespective of VNF origin. Use Case 7 (Use of declarative licenses for vEPC-VNF): assumes a centralized license management function, e.g. SAM.
VNF_LICENSE.024	It is recommended that a recommendation be specified that license management operations be automated, i.e. requiring no manual intervention.	Management, Operations	To achieve the maximum automation.	Enables high speed reconfiguration of the service chain according to pre-defined policies.
VNF_LICENSE.025	It is recommended that a recommendation be specified that license management be able to handle very large numbers of VNFs.	Management, Operations	Requirement needed for use cases with potentially a huge numbers of VNFs.	Where it is needed to minimize License Management telemetry by efficient mechanisms for license replication.
VNF_LICENSE.026	It is recommended that a recommendation be specified that VNF "usage" accounting for license management purposes should be independent of "charging & billing", i.e. it should be possible to turn "usage" data into a license management "bill" using a third party application.	Management, Operations	Generic recommendation.	Billing and charging parameters and license management parameters should be decoupled.

Recommendation Number	Recommendation Description	Recommendation Category	Reference Use case	Remarks (In lieu of supporting text)
VNF_LICENSE.027	It is recommended that a recommendation be specified that VNF "usage" data can be authenticated & auditable.	Security	Generic recommendation.	Appropriate security mechanisms for accounting purposes.
VNF_LICENSE.028	It is recommended that a recommendation be specified that in a High Availability configuration, for active primary VNF and multiple secondary VNFs, the VNF license enables switchover without impacting the failure recovery process.	Management, Operations	Generic recommendation.	Hitless failover mechanisms should be pre-enabled by the license terms.
VNF_LICENSE.029	It is recommended that a recommendation be specified that licenses can support various High Availability configurations, where hitless failovers are always covered by the licenses.	Management, Operations	Generic recommendation.	Hitless failover mechanisms should be pre-enabled by the license terms.
VNF_LICENSE.030	It is recommended that a requirement be specified that VNF functionality enablement/disablement will not imperil the on-boarding and run-time integrity check of the VNF Instance.	Security	Use Case 4: Applying VNF licenses to enable-disable VNF functionalities.	Need to ensure that the enabling/disabling of a functionality will not imperil the integrity checks that are made on the VNF Package and VNF Instance.
VNF_LICENSE.031	It is recommended that a requirement be specified that enforcement of the contract between the VNF provider and the Service Provider should be enabled by a mechanism trusted by both the parties.	Management, Operations	Generic recommendation.	
VNF_LICENSE.032	It is recommended that a requirement is specified that the VNF license enforcement is able to securely verify and authenticate the origin of license.	Security	Generic recommendation.	The entity that enforces the license is able to determine if the license is valid and signed by an authentic License Manager, that the license provided by the NFV-MANO was really a license for this NFV-MANO of the Service Provider and not another one.
VNF_LICENSE.033	It is recommended that a requirement is specified that the use of supplied licenses is not repudiable.	Security	Generic recommendation.	NFV-MANO is not able to repudiate the use of this license.
VNF_LICENSE.034	It is recommended that a requirement be specified that VNF license terms can specify VNF metrics limits for VNF instances, where the exceedance of the limit results in an additional consumption of a VNF license.	Management, Operations	All the use cases, except Use Case 7.	Enables to the VNF licensor to define and enforce VNF license terms based on VNF instance metrics, i.e. to define capacity licenses.

7 NFV license final report

7.1 Management and operational aspects

Recommendations made in clause 6.1 "VNF license recommendations" cover both management and operational aspects of the VNF licenses. This final report presents a consolidated outcome of the study to set the direction for further work within the ETSI ISG NFV so that it takes into account the following aspects:

- While actual management of VNF licenses is not within the scope of standardization of the NFV-MANO framework, the expression of the license terms and the translation of those terms into runtime policies should be able to accommodate a wide range of licensing models. This implies that the NFV-MANO framework should be able to use the information provided by VNF license management functional components to enable the lifecycle of a particular VNF instance to be executed according to the license management policies applicable to the particular VNF instance.
- VNF licenses will impact the on boarding and management of VNF Packages.
- The impact of VNF licenses needs to be considered in VNF instance related operations, such like lifecycle management.
- VNF licenses information will translate into runtime policies for operations of VNF instances and will have an impact on the runtime of VNF instances.
- Though not covered directly in the use cases described in this report, there may be impacts on security, reliability and testing of VNF Packages to accommodate the Licenses requirements.

In summary, the present document has identified a set of recommendations which will enable licensing of VNF in an NFV architectural framework. The impact on the NFV architectural framework and NFV-MANO should be studied in the context of the NFV-MANO interfaces, to identify which interfaces are impacted by the requirement to support VNF license management, and what new features, if any are required. It is recommended to further study the impact of licensing on the NFV architectural framework, in particular NFV-MANO, to identify the interfaces and features impacted by licensing, and specify the necessary normative requirements.

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