ETSI GR NFV-EVE 018 V5.1.1 (2024-05)

Network Functions Virtualisation (NFV) Release 5; Evolution and Ecosystem; Report on Multi-tenancy in NFV

Disclaimer

The present document has been produced and approved by the Network Functions Virtualisation (NFV) ETSI Industry Specification Group (ISG) and represents the views of those members who participated in this ISG.
It does not necessarily represent the views of the entire ETSI membership.

Reference
DGR/NFV-EVE018

Keywords
functional, isolation, management, MANO, NFV, orchestration, tenancy, virtualisation

ETSI

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

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

Siret N° 348 623 562 00017 - APE 7112B
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° w061004871

Contents

Intellectual Property Rights 7
Foreword 7
Modal verbs terminology 7
1 Scope 8
2 References 8
2.1 Normative references 8
2.2 Informative references 8
3 Definition of terms, symbols and abbreviations 10
3.1 Terms 10
3.2 Symbols 10
3.3 Abbreviations 10
4 Overview 11
5 Use Cases and Scenarios 12
5.1 Introduction 12
5.2 Use Case #1: Two users with own NFVO on shared NFVI 12
5.2.1 Motivation 12
5.2.2 Detailed User Story 13
5.2.2.1 Summary 13
5.2.2.2 Actor(s) 13
5.2.2.3 Pre-Conditions 14
5.2.2.4 Description 14
5.2.2.5 Post-Conditions 15
5.2.3 Variants 15
5.2.4 Analysis 17
5.3 Use Case #2: Two users share the same NFV environment 17
5.3.1 Motivation 17
5.3.2 Detailed User Story 18
5.3.2.1 Summary 18
5.3.2.2 Actor(s) 19
5.3.2.3 Pre-Conditions 19
5.3.2.4 Description 19
5.3.2.5 Post-Conditions 20
5.3.3 Variants 21
5.3.4 Analysis 21
5.4 Use Case #3: Network slicing by a single user 22
5.4.1 Motivation 22
5.4.2 Detailed User Story 23
5.4.2.1 Summary 23
5.4.2.2 Actor(s) 23
5.4.2.3 Pre-Conditions 23
5.4.2.4 Description 24
5.4.2.5 Post-Conditions 25
5.4.3 Variants 25
5.4.3.1 Variant: Network Slice Subnets use instances of the same NS 25
5.4.3.2 Variant: Multiple NS instances in the same network slice subnet 25
5.4.4 Analysis 26
5.5 Use Case #4: Nested network services 26
5.5.1 Motivation 26
5.5.2 Detailed User Story 27
5.5.2.1 Summary 27
5.5.2.2 Actor(s) 28
5.5.2.3 Pre-Conditions 28
5.5.2.4 Description 28
5.5.2.5 Post-Conditions 31

5.5.3 Variants ... 31
5.5.4 Analysis ... 31
5.6 Use Case #5: Tenants of a service provider ... 32
5.6.1 Motivation ... 32
5.6.2 Detailed User Story ... 33
5.6.3 Variants ... 34
5.6.4 Analysis ... 34
5.7 Use Case #6: Two users with their own MANO stack managed by provider MANO ... 34
5.7.1 Motivation ... 34
5.7.2 Detailed User Story ... 35
5.7.2.1 Summary ... 35
5.7.2.2 Example flow instantiating MANO-T instance for an NMT ... 36
5.7.2.2.1 Actor(s) ... 36
5.7.2.2.2 Pre-Conditions ... 36
5.7.2.2.3 Description ... 37
5.7.2.2.4 Post-Conditions ... 38
5.7.2.3 Example flow of MANO-T instance performing NS LCM operation ... 38
5.7.2.3.1 Actor(s) ... 38
5.7.2.3.2 Pre-Conditions ... 39
5.7.2.3.3 Description ... 39
5.7.2.3.4 Post-Conditions ... 39
5.7.2.4 Example flow of LCM operation exceeding MLA bounds ... 40
5.7.2.4.1 Actor(s) ... 40
5.7.2.4.2 Pre-Conditions ... 40
5.7.2.4.3 Description ... 40
5.7.2.4.4 Post-Conditions ... 41
5.7.3 Variants ... 42
5.7.4 Analysis ... 42
5.8 Use Case #7: Provide Isolation on different levels ... 43
5.8.1 Motivation ... 43
5.8.2 Detailed User Story ... 44
5.8.2.1 Summary ... 44
5.8.2.2 Usage of anti-affinity groups for isolation ... 45
5.8.2.3 Example of flow instantiating network services with isolation ... 46
5.8.2.3.1 Actors ... 46
5.8.2.3.2 Pre-Conditions ... 47
5.8.2.3.3 Description ... 47
5.8.2.3.4 Post-Conditions ... 48
5.8.3 Variants ... 48
5.8.4 Analysis ... 49
5.9 Use Case #8: Isolation of containerized VNF instances ... 49
5.9.1 Motivation ... 49
5.9.2 Detailed User Story ... 51
5.9.2.1 Summary ... 51
5.9.2.2 Actors ... 51
5.9.2.3 Pre-Conditions ... 52
5.9.2.4 Description ... 52
5.9.2.5 Post-Conditions ... 53
5.9.3 Variants ... 54
5.9.4 Analysis ... 54
5.10 Use Case #9: Multiple NMTs use the same entity ... 55
5.10.1 Introduction ... 55
5.10.2 Sharing of VNF packages and descriptors ... 56
5.10.2.1 Motivation ... 56
5.10.2.2 Detailed User Story ... 58
5.10.2.2.1 Summary ... 58
5.10.2.2.2 Actor(s) ... 58
5.10.2.2.3 Pre-Conditions ... 58
5.10.2.2.4 Description ... 58
5.10.2.2.5 Post-Conditions ... 59
5.10.3 Sharing of NS or VNF instances ... 59
5.10.3.1 Motivation ... 59

5.10.3.2 Isolation aspects of shared entities 61
5.10.4 Special case: Shared storage 62
5.10.5 Special case: Common Services 62
5.10.6 Analysis with regards to License management 62
5.10.7 Conclusions of Use Case #9 63

6 Key Issues 63
6.1 Key Issue #1: Specifying Resource Isolation 63
6.1.1 Description 63
6.1.2 Solution Proposal #1.1: Affinity-or-antiaffinity Groups 64
6.1.3 Solution Proposal #1.2: Affinity-or-anti-affinity constraints group identification 66
6.1.4 Solution Proposal #1.3: Infrastructure resource groups 67
6.1.5 Solution Proposal #1.4: Use nested NSs to express tenant isolation 67
6.1.6 Recommendations 67
6.2 Key Issue #2: Tenant Identification 68
6.2.1 Description 68
6.2.2 Solution Proposal #2.1: Tenant management 69
6.2.3 Solution Proposal #2.2: Tenant authorization 70
6.2.4 Solution Proposal #2.3: Ownership 70
6.2.5 Solution Proposal #2.4: Management isolation 71
6.2.6 Solution Proposal #2.5: Levels of permission 71
6.2.7 Recommendations 71
6.3 Key issue #3: Sharing of artifacts 73
6.3.1 Description 73
6.3.2 Solution Proposal #3.1: Multiple onboarding of a VNF package 73
6.3.3 Solution Proposal #3.2: Multiple tenants using the same onboarded VNF package 74
6.3.4 Solution Proposal #3.3: Multiple tenants onboarding the same VNF package using different vnfdId 74
6.3.5 Solution Proposal #3.4: Multiple onboarding of an NSD 74
6.3.6 Solution Proposal #3.5: Catalogue for NFV artifacts 75
6.3.7 Solution Proposal #3.6: External locations of VNF artifacts 75
6.3.8 Solution Proposal #3.7: Multi-tenancy of the CIR 75
6.3.9 Solution Proposal #3.8: License management in case of shared artifacts 75
6.3.10 Recommendations 75
6.4 Key issue #4: Management of Privileges 76
6.4.1 Description 76
6.4.2 Recommendations 76
6.5 Key issue #5: Sharing virtual storage and PaaS services 76
6.5.1 Description 76
6.5.2 Solution Proposal #5.1: Sharing virtual storage 76
6.5.3 Solution Proposal #5.2: Sharing PaaS services 76
6.5.4 Recommendations 77
6.6 Key issue #6: Quota management for tenants 77
6.6.1 Description 77
6.6.2 Solution Proposal #6.1: Tenant quota management 77
6.6.3 Recommendations 77
6.7 Key Issue # 7 - Management of MLA 78
6.7.1 Description 78
6.7.2 Solution Proposal #7.1: Specifying MLA Parameters 78
6.7.3 Solution Proposal #7.2: MLA Compliance 78
6.7.4 Recommendations 79

7 Recommendations 80

8 Conclusions 80

Annex A: Multi-Tenancy in Open Source 81

A.1 Multi-Tenancy in OpenStack® 81
A.1.1 General 81
A.1.2 Feedback from Tacker 82

A.2 Multi-Tenancy in Kubernetes® 85
A.2.1 Introduction 85

A.2.2 Isolation considerations for tenants 85
A.2.2.1 Same cluster 85
A.2.2.1.1 General 85
A.2.2.1.2 Control plane isolation 85
A.2.2.1.3 Data plane isolation 86
A.2.2.2 Multiple clusters 86
A.2.3 Relation with multi-tenancy in NFV 86
A.3 Multi-Tenancy in Anuket 87
Annex B: Change History 88
History 91

Intellectual Property Rights

Essential patents

IPRs essential or potentially essential to normative deliverables may have been declared to ETSI. The declarations pertaining to these essential IPRs, if any, are publicly available for **ETSI members and non-members**, and can be found in ETSI SR 000 314: *"Intellectual Property Rights (IPRs); Essential, or potentially Essential, IPRs notified to ETSI in respect of ETSI standards"*, which is available from the ETSI Secretariat. Latest updates are available on the ETSI Web server (https://ipr.etsi.org/).

Pursuant to the ETSI Directives including the ETSI IPR Policy, no investigation regarding the essentiality of IPRs, including IPR searches, has been carried out by ETSI. No guarantee can be given as to the existence of other IPRs not referenced in ETSI SR 000 314 (or the updates on the ETSI Web server) which are, or may be, or may become, essential to the present document.

Trademarks

The present document may include trademarks and/or tradenames which are asserted and/or registered by their owners. ETSI claims no ownership of these except for any which are indicated as being the property of ETSI, and conveys no right to use or reproduce any trademark and/or tradename. Mention of those trademarks in the present document does not constitute an endorsement by ETSI of products, services or organizations associated with those trademarks.

DECT™, **PLUGTESTS™**, **UMTS™** and the ETSI logo are trademarks of ETSI registered for the benefit of its Members. **3GPP™** and **LTE™** are trademarks of ETSI registered for the benefit of its Members and of the 3GPP Organizational Partners. **oneM2M™** logo is a trademark of ETSI registered for the benefit of its Members and of the oneM2M Partners. **GSM**® and the GSM logo are trademarks registered and owned by the GSM Association.

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).

"**must**" and "**must not**" are **NOT** allowed in ETSI deliverables except when used in direct citation.

1 Scope

The present document studies multi-tenancy related Use Cases and concepts for NFV, with the goal to remove the gap between the existing general functional requirements on multi-tenancy as described in ETSI GS NFV-IFA 010 [i.10] and the missing requirement details regarding NFV elements consumed by different tenants. Key issues on multi-tenancy in NFV (e.g. tenant-dependent LCM, tenant-dependent resource management, traffic separation, management isolation, etc.) are identified and analysed as well as recommendations for further work are provided.

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.

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

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

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

[i.1] ETSI GR NFV 001: "Network Functions Virtualisation (NFV); Use Cases".

[i.2] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

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

[i.4] ETSI GS NFV 004: "Network Functions Virtualisation (NFV); Virtualisation Requirements".

[i.5] ETSI GS NFV-IFA 005: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".

[i.6] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[i.7] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[i.8] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[i.9] ETSI GS NFV-SOL 001: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; NFV descriptors based on TOSCA specification".

[i.10] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Functional requirements specification".

[i.11] ETSI GS NFV-IFA 011: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; VNF Descriptor and Packaging Specification".

[i.12] ETSI GR NFV-EVE 012: "Network Functions Virtualisation (NFV) Release 3; Evolution and Ecosystem; Report on Network Slicing Support with ETSI NFV Architecture Framework".

[i.13] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Os-Ma-nfvo reference point - Interface and Information Model Specification".

[i.14] ETSI GS NFV-IFA 014: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Network Service Templates Specification".

[i.15] ETSI GR NFV-IFA 028: "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on architecture options to support multiple administrative domains".

[i.16] ETSI GS NFV-IFA 030: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Multiple Administrative Domain Aspect Interfaces Specification".

[i.17] ETSI GR NFV-IFA 034: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Report on Architectural enhancement for VNF License Management support and use of VNF licenses".

[i.18] ETSI GS NFV-IFA 036: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for container cluster management and orchestration specification".

[i.19] ETSI GS NFV-IFA 040: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".

[i.20] ETSI GS NFV-SOL 014: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; YAML data model specification for descriptor-based virtualised resource management".

[i.21] ETSI GS NFV-SEC 023 (V0.0.7): "Network Functions Virtualisation (NFV) Release 5; Security; Container Security Specification".

[i.22] ETSI GR ZSM 010: "Zero Touch Network and Service Management (ZSM); General Security Aspects".

[i.23] 3GPP TR 28.804: "3rd Generation Partnership Project; Technical Specification Group Services and System Aspects; Telecommunication management; Study on tenancy concept in 5G networks and network slicing management (Release 16)".

[i.24] OpenStack® documentation: "OpenStack® Operations Guide".

[i.25] ETSI GS NFV-SEC 025 (V0.0.15): "Network Functions Virtualisation (NFV); Security; Secure End-to-End VNF and NS management specification".

[i.26] ETSI GS NFV-SEC 026 (V0.0.10): "Network Functions Virtualisation (NFV); Security; Isolation and trust domain specification".

[i.27] ENISA NFV 5G security report: "NFV Security in 5G - Challenges and Best Practices".

[i.28] Kata Containers project page.

[i.29] ETSI GS NFV-SOL 003: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Or-Vnfm Reference Point".

[i.30] ETSI GS NFV-IFA 048: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Policy Information Model Specification".

[i.31] ETSI GS NFV-SOL 013: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; Specification of common aspects for RESTful NFV MANO APIs".

[i.32] ETSI GS NFV-SOL 005: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Os-Ma-nfvo Reference Point".

[i.33] ETSI GS NFV-SOL 002: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; RESTful protocols specification for the Ve-Vnfm Reference Point".

[i.34] ETSI GS NFV-SEC 022: "Network Functions Virtualisation (NFV) Release 4; Security; Access Token Specification for API Access".

[i.35] ETSI GS NFV-SOL 004: "Network Functions Virtualisation (NFV) Release 4; Protocols and Data Models; VNF Package and PNFD Archive specification".

[i.36] ETSI GS NFV-SEC 021: "Network Functions Virtualisation (NFV) Release 4; Security; VNF Package Security Specification".

[i.37] Anuket project web site.

[i.38] Anuket: "Reference Model for Cloud Infrastructure (RM)".

[i.39] Anuket: "Reference Architecture for OpenStack based cloud infrastructure (RA1)".

[i.40] Anuket: "Reference Architecture for Kubernetes based cloud infrastructure (RA2)".

[i.41] Kubernetes® reference documentation: "Multi-tenancy".

[i.42] Official Kubernetes® reference documentation.

[i.43] Kubernetes® Cluster API.

[i.44] vCluster Documentation (provided by Loft Labs, Inc.).

[i.45] The Kubernetes® API documentation.

[i.46] ETSI GR NFV-IFA 037: "Network Functions Virtualisation (NFV) Release 4; Architectural Framework; Report on further NFV support for 5G".

[i.47] ETSI GS NFV-SOL 016: "Network Functions Virtualisation (NFV) Release 3; Protocols and Data Models; NFV-MANO procedures specification".

[i.48] ETSI GR NFV-EVE 022 (V5.1.1): "Network Functions Virtualisation (NFV) Release 5; Architectural Framework; Report on VNF configuration".

[i.49] ETSI GS NFV-IFA 049 (V5.1.1): "Network Functions Virtualisation (NFV) Release 5; Architectural Framework; VNF generic OAM functions specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GS NFV 003 [i.3] apply.

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 003 [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 ETSI GS NFV 003 [i.3].

MANO-P	Provider MANO
MANO-T	Tenant MANO
MLA	Management Level Agreement
NFVO-P	Provider NFVO
NFVO-T	Tenant NFVO
NMT	NFV-MANO Tenant
VIM-P	Provider VIM

VIM-T	Tenant VIM
VNFM-P	Provider VNFM
VNFM-T	Tenant VNFM

4 Overview

According to ETSI GR ZSM 010 [i.22], "*multi-tenancy refers to an architecture in which a single instance of software runs on a server and serves multiple tenants*". In NFV deployments this refers not only to VNF instances but also to NFV-MANO components (NFVO, VNFM, VIM as specified in ETSI GS NFV 002 [i.2]) and to entities like CISM (see ETSI GS NFV-IFA 040 [i.19]) and CCM (see ETSI GS NFV-IFA 036 [i.18]).

The present document focuses on Use Cases where multiple users consume services from the same NFV-MANO environment that are offered via the Os-Ma-nfvo reference point (see ETSI GS NFV-IFA 013 [i.13]). It is analysed e.g. how the NFV-MANO can be enabled to protect a consumer (NFV-MANO Tenant, NMT) against another consumer.

The Use Cases in clause 5 show example configurations where such isolation or protection is provided.

The ways of protection and isolation can be grouped in two groups:

- The first group is related to management actions. This type of protection can use some access control and ownership of entities. This is sometimes called management isolation:
  - Resources created by NMT-A cannot be managed by NMT-B (see note 1).
  - Resources created by NMT-A cannot be used by NMT-B (e.g. bandwidth on a VL of NMT-A cannot be consumed by NMT-B).
  - NMT-B is not able to access information about resources created by NMT-A.
  - NMT-B is not able to monitor usage of resources created by NMT-A.
  - NMT-B is not able to access traffic on resources created by NMT-A.
- The second group is related to normal operation of the workloads. This is sometimes called resource isolation and can be achieved in a strict way or by more light-weight but less powerful means:
  - Traffic on resources serving NMT-A is not able to access resources serving NMT-B.
  - Failures of resources serving NMT-A are not affecting resources serving NMT-B.
  - Load situations of resources serving NMT-A are not affecting resources serving NMT-B.
  - Vulnerabilities of resources serving NMT-A are not affecting resources serving NMT-B.

NOTE 1: In case of shared resources NMT-B could be provided with limited management permissions.

Nevertheless, there can be cases where NMTs A and B share resources.

Different types of resources can be protected in different ways. Therefore in some cases, compute resources, storage resource or network resources are discussed separately.

In many cases resources to isolate are not directly visible on the Os-Ma-nfvo reference point. Therefore the information about isolation expectations is communicated between the entities of the NFV-MANO.

The present document analyses the interworking within NFV-MANO to understand potential enhancements of NFV-MANO that can be used to allow protection and isolation of physical or virtual resources of the NFVI.

This is done by analysing several key issues which are derived from the Use Cases. For each key issue, solutions are provided and evaluated.

Clause 6 describes several key issues and related solutions. From these solutions, recommendations for the further work are derived.

NOTE 2: The present document does not consider multi-tenancy aspects related to security management, certificate management, analytics, automation and intent management as defined in ETSI GS NFV-IFA 010 [i.10].

The present document provides input to the security analysis in ETSI GS NFV-SEC 025 [i.25] the Secure End-to-End VNF and NS management specification and ETSI GS NFV-SEC 026 [i.26] the Isolation and trust domain specification.

5 Use Cases and Scenarios

5.1 Introduction

The first five Use Cases (Use Cases #1 to #5) illustrate in a set of scenarios how an NFV environment can be shared between multiple tenants. Then, in Use Case #6, it is shown how a service provider can offer NFV to tenants. All Use Cases can only be realized if there is established isolation. The next two Use Cases (Use Cases #7 and #8) then demonstrate how different levels of isolation can be achieved, and the last Use Case specifically discusses how NFV entities can be shared between tenants. Finally, Use Case #9 showcases how multiple NMTs can use the same entity.

ETSI GS NFV-SEC 026 [i.26] analyses the Use Cases from a security point of view. Security isolation deals with the protection of entities (e.g. VNFs) in situations when another entity is attacked. Without proper isolation, vulnerabilities of one entity could lead to vulnerability of other entities. Therefore, it is important to understand the different levels of isolation that can be defined in an NFV system.

ETSI GS NFV-SEC 025 [i.25] analyses vulnerabilities and attacks per LCM operation and therefore provides some more details on the use of isolation for protection.

The security considerations will lead to additional aspects in isolation, e.g. more fine-grained affinity definitions or the use of hardware enclaves. These aspects are not discussed in the present document.

5.2 Use Case #1: Two users with own NFVO on shared NFVI

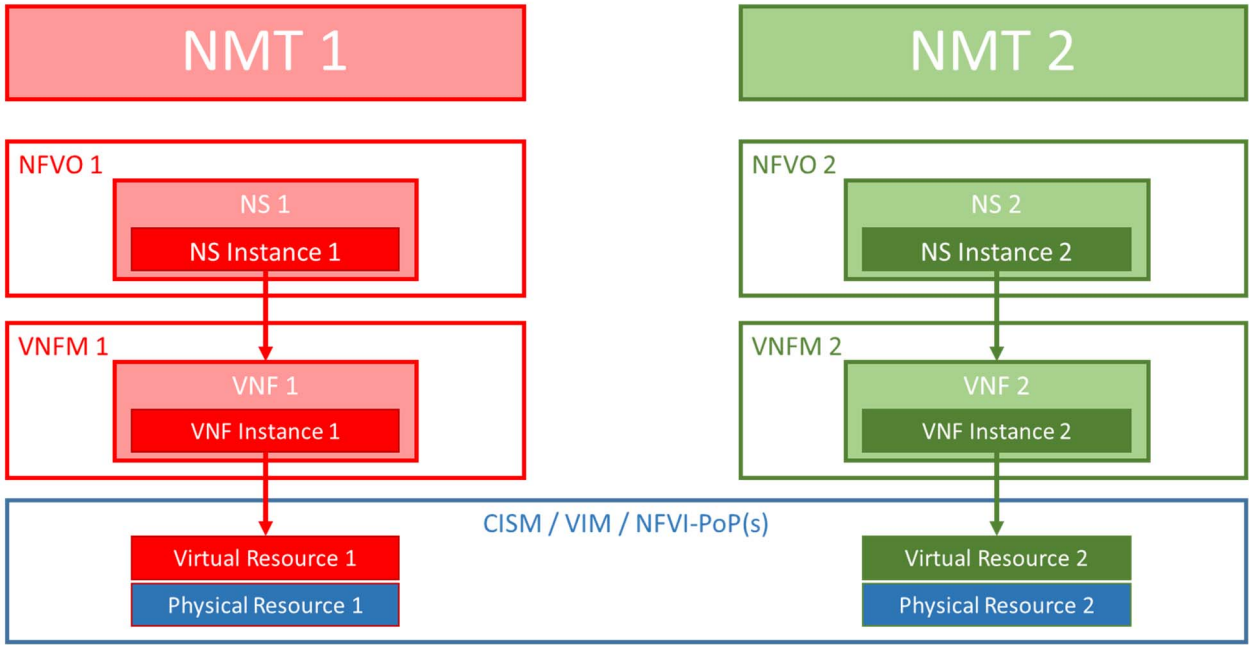
5.2.1 Motivation

This Use Case describes two users using their own NFVO and VNFM but allocate resources from the same NFVI-PoP(s) to build their NSs. It is assumed that an NFVI-PoP is managed by a single VIM

NOTE: The NFV-MANO implementations of the two users can be from different vendors.

In this Use Case the term NFV-MANO tenant (NMT) is used for a user managing NSs via the Os-Ma-nfvo reference point. This reduces ambiguity between NFVO users, VNFM users, VIM users, etc.

Figure 5.2.1-1 illustrates the relation of the NMTs and NFV-MANO FB instances, including the NSs and resources.



NOTE: "Virtual Resources" refers to different virtualization technologies, e.g. VMs and containers.

Figure 5.2.1-1: Two users with own NFVO on shared NFVI

In this Use Case it is expected that NFV-MANO FBs are aware that they are expected to provide the appropriate isolation between the resources allocated to the different users (NMTs) as required in ETSI GS NFV 004 [i.4].

In this Use Case it is assumed that the NSs of the different NMTs can be deployed on different resources within the NFVI. For sharing physical resources see other Use Cases.

This Use Case is derived from Use Case #1 in ETSI GR NFV 001 [i.1], Network Function Virtualisation Infrastructure as a Service (NFVIaaS).

5.2.2 Detailed User Story

5.2.2.1 Summary

In this Use Case, each NMT has its own NFVO and VNFM(s) to instantiate their NSs via the Os-Ma-nfvo reference point, see ETSI GS NFV-IFA 013 [i.13]. Therefore NFVO and VNFM(s) do not know about different users/consumers. Only the VIM is aware whether resources are allocated to the same or a different user/consumer.

As specified in ETSI GS NFV-IFA 005 [i.5] and ETSI GS NFV-IFA 006 [i.6], the VIM uses resource groups to identify the expected isolation.

5.2.2.2 Actor(s)

Table 5.2.2.2-1 describes the Use Case actors and roles. It is assumed that NMT1 and NMT2 have no business relationship and their network services are expected to be isolated.

Table 5.2.2.2-1: Use case #1, actors and roles

#	Actor	Description
1	NMT1	OSS or other management system of service provider 1. NMT1 expects isolation from NMT2.
2	NMT2	OSS or other management system of service provider 2. NMT2 expects isolation from NMT1.
3	NFVO1	NFV Orchestrator used by NMT1
4	NFVO2	NFV Orchestrator used by NMT2
5	VNFM1	VNF Manager used by NMT1
6	VNFM2	VNF Manager used by NMT2
7	VIM	VIM managing the NFVI hosting all resources involved
8	VNFs	VNFs of the NS

5.2.2.3 Pre-Conditions

Table 5.2.2.3-1 describes the pre-conditions.

Table 5.2.2.3-1: Use case #1, pre-conditions

#	Pre-condition	Description
1	NFV-MANO of both NMTs (VIM, NFVOs and VNFMs) is running.	
2	NMT1 and NMT2 have established their business relationship with the provider(s) of the NFV-MANO environments and NFVI allowing them to deploy their services.	
3	NMT1 and NMT2 have prepared their NFV packages and templates (e.g. NSD, VNFD) for the onboarding	

5.2.2.4 Description

Table 5.2.2.4-1 describes the flow for onboarding an NS for NMT1. There is no difference to the standard flow. In this Use Case the NFVOs do not consider different tenants during the onboarding, since each NFVO works for a single NMT only.

Table 5.2.2.4-1: Use case #1, base flow for onboarding an NS for NMT1

#	Flow	Description
1	NMT1 -> NFVO1	NMT1 requests NFVO1 to onboard the NS, providing the NSD.
2	NFVO1	NFVO1 executes the onboarding
3	NFVO1 -> NMT1	NFVO acknowledges the onboarding
4	NMT1 -> NFVO1	NMT1 subscribes for notifications. See note.
5	NMT1 -> NFVO1	NMT1 requests NFVO1 to onboard the VNFs, providing the VNF packages and VNFDs.
6	NFVO1	NFVO1 executes the onboarding.
7	NFVO1 -> NMT1	NFVO1 acknowledges the onboarding.
NOTE: Subscription can also be done earlier.		

Table 5.2.2.4-2 describes the flow for instantiating an NS for NMT1. There is no difference to the standard flow. The description only highlights some aspects related to tenants, which is mainly during steps 9 and 10.