ETSI GS NFV-TST 002 V1.1.1 (2016-10)

Network Functions Virtualisation (NFV);
Testing Methodology;
Report on NFV Interoperability Testing Methodology

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

DGS/NFV-TST002

Keywords

interoperability, NFV, testing, methodology

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 - NAF 742 C
Association à but non lucratif enregistrée à la
Sous-Préfecture de Grasse (06) N° 7803/88

Important notice

The present document can be downloaded from:
http://www.etsi.org/standards-search

The present document may be made available in electronic versions and/or in print. The content of any electronic and/or print versions of the present document shall not be modified without the prior written authorization of ETSI. In case of any existing or perceived difference in contents between such versions and/or in print, the only prevailing document is the print of the Portable Document Format (PDF) version kept on a specific network drive within ETSI Secretariat.

Users of the present document should be aware that the document may be subject to revision or change of status. Information on the current status of this and other ETSI documents is available at
https://portal.etsi.org/TB/ETSIDeliverableStatus.aspx

If you find errors in the present document, please send your comment to one of the following services:
https://portal.etsi.org/People/CommiteeSupportStaff.aspx

Contents

Intellectual Property Rights

IPRs essential or potentially essential to the present document may have been declared to ETSI. The information pertaining to these essential IPRs, if any, is 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 IPR Policy, no investigation, 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.

Foreword

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

Modal verbs terminology

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

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

Executive summary

The present document studies how interoperability test methodology can be applied to NFV by analysing some of the core NFV capabilities and the interactions between the functional blocks defined within the NFV architectural framework required to enable them.

Introduction

The present document provides methodology guidelines for interoperability testing of NFV features, starting from a review of some basic concepts for interoperability testing and their fit in an NFV environment and a methodology for the development of interoperability test specifications illustrated with examples of basic NFV operations. A high level analysis of some core NFV capabilities allows to identify a generic architecture for the associated System Under Test configurations, and to classify some initial Interoperability Feature areas.

The present document is organized as follows:

- Clause 4 provides an overview of common interoperability concepts and testing methodology guidelines.
- Clause 5 identifies a generic system under test (SUT) architecture and some initial SUT configurations for interoperability testing of basic NFV capabilities.
- Clause 6 identifies and analyses some initial NFV interoperability feature areas and outlines for each of them the impacted functional blocks and interfaces, as well as the applicable SUT configurations described in clause 5.

1 Scope

The present document provides some guidelines for NFV interoperability testing and identifies a generic System Under Test (SUT) architecture for NFV, some initial SUT configurations, and some interoperability feature areas derived from core NFV capabilities.

2 References

2.1 Normative references

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

Referenced documents which are not found to be publicly available in the expected location might be found 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.

Not applicable.

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] ISO/IEC 9646 (parts 1 to 7): "Information technology - Open Systems Interconnection - Conformance testing methodology and framework".

[i.2] ETSI EG 202 237: "Methods for Testing and Specification (MTS); Internet Protocol Testing (IPT); Generic approach to interoperability testing".

[i.3] ETSI EG 202 568: "Methods for Testing and Specification (MTS); Internet Protocol Testing (IPT); Testing: Methodology and Framework". .

[i.5] ETSI GS NFV 002: "Network Functions Virtualisation (NFV); Architectural Framework".

[i.6] ETSI GS NFV-MAN 001: "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.7] ETSI GS NFV-IFA 010 (V2.1.1): "Network Functions Virtualisation (NFV); Management and Orchestration; Functional requirements specification".

[i.8] ETSI GS NFV-IFA 005 (V2.1.1): "Network Functions Virtualisation (NFV); Management and Orchestration; Or-Vi reference point - Interface and Information Model Specification".

[i.9] ETSI GS NFV-IFA 006: "Network Functions Virtualisation (NFV); Management and Orchestration; Vi-Vnfm reference point - Interface and Information Model Specification".

[i.10] ETSI GS NFV-IFA 007: "Network Functions Virtualisation (NFV); Management and Orchestration; Or-Vnfm reference point - Interface and Information Model Specification".

[i.11] ETSI GS NFV-IFA 008: "Network Functions Virtualisation (NFV); Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[i.12] ETSI GS NFV-IFA 013: "Network Functions Virtualisation (NFV); Management and Orchestration; Os-Ma-Nfvo reference point - Interface and Information Model Specification".

[i.13] 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 ETSI GS NFV 003 [i.13] apply.

3.2 Abbreviations

For the purposes of the present document, the terms and definitions given in ETSI GS NFV 003 [i.13] and the following apply:

API	Application Programming Interface
CON	CONformance
DUT	Device Under Test
FUT	Function Under Test
IFS	Interoperable Features Statement
IOP	InterOPerability
IUT	Implementation Under Test
LCM	Life Cycle Management
MMI	Man-Machine Interface
NSD	Network Service Descriptor
OSS	Operation System Support
PICS	Protocol Implementation Conformance Statement
QE	Qualified Equipment
QF	Qualified Function
SUT	System Under Test
TD	Test Description
TSS	Test Suite Structure
VNFFG	Virtual Network Function Forwarding Graph

4 Interoperability Testing Methodology Guidelines for NFV

4.1 Introduction

Well established test methodology like ETSI EG 202 237 [i.2] and ETSI EG 202 568 [i.3] describe two main and complementary ways of testing devices implementing standardized services, which each have benefits and limitations:

- **Conformance Testing** can show that a product correctly implements a particular standard, that is, it establishes whether or not the Implementation Under Test (IUT) meets the requirements specified by the standard. For example, it will test protocol message contents and format as well as the permitted sequences of messages. In this context:
    - There is only one Implementation Under Test, which is part of the System Under Test.
    - Tests are performed at open standardized interfaces which might not be accessible to an end user, and executed by a dedicated test system that has full control of the System Under Test and the ability to observe all incoming and out coming communications.
    - The high degree of control of the test system over the sequence and contents of the protocol messages allows to test both valid and invalid behaviour.

Figure 1: Conformance testing

- **Interoperability Testing** can demonstrate that a product will work with other like products: it proves that **end-to-end functionality** between (at least) two functions is as required by the standard(s) on which those functions are based. In this context:
    - The System Under Test (SUT) is made of the combination of different Functions Under Test (FUT) coming from different suppliers.
    - Interoperability tests are based on functionality as experienced by a user, where the user may be human or a software application.
    - Tests are performed and observed at functional interfaces such as Man-Machine Interfaces (MMIs), protocol service interfaces and Application Programming Interfaces (APIs).
    - Testing at functional interfaces implies that interoperability tests can only describe functional behaviour and sometimes it might not be possible to trigger or test protocol error behaviour on the interface(s) among the FUTs.

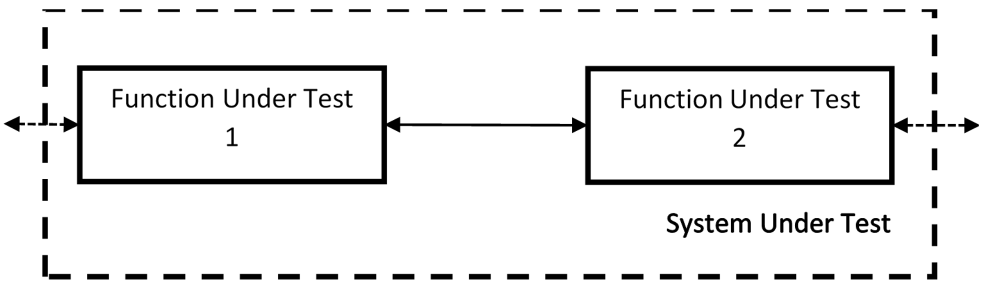

Figure 2: Interoperability testing

NOTE: The concept of Function Under Test used in the present document corresponds to the concept of Device Under Test (DUT) introduced in ETSI EG 202 568 [i.3].

Conformance testing in conjunction with interoperability testing provides both the proof of conformance and the guarantee of interoperation. ETSI EG 202 237 [i.2] and ETSI EG 202 568 [i.3] describe several approaches on how to combine the two methods, the most common one being **Interoperability Testing with Conformance Checks**, where reference points between the FUTs are monitored to verify the appropriate sequence and contents of protocol messages, API calls, interface operations, etc.

Clauses 4.2 to 4.4 provide an overview of the main concepts and practices associated with interoperability testing. The intention is to develop simple and pragmatic guidelines that can be used as a "cook-book", rather than a rigid prescription of how to perform NFV interoperability testing.

The main areas of these guidelines are as follows:

- Definition of basic concepts.
- Instructions for the development of interoperability test specifications, including:
  - Definition of a generic System Under Test (SUT) architecture.
  - Identification of interoperability features.
  - Specification of SUT configurations and Test Descriptions.
- Description of the interoperability testing process.

As their name implies, guidelines are only for guidance and the actual process followed should use and adapt whichever of these guidelines are most applicable in each particular situation. In some cases this may mean the application of all aspects.

4.2 Basic concepts for interoperability testing

4.2.1 Overview

There are a number of different terms and concepts that can be used when describing a test methodology. Clauses 4.2 to 4.4 describe the most important concepts used by these guidelines, which can been categorized either as part of the System Under Test (SUT) or as part of the Test Environment.

Figure 3 provides an overview of these basic concepts, which are described in detail in clauses 4.2.2 to 4.2.7.

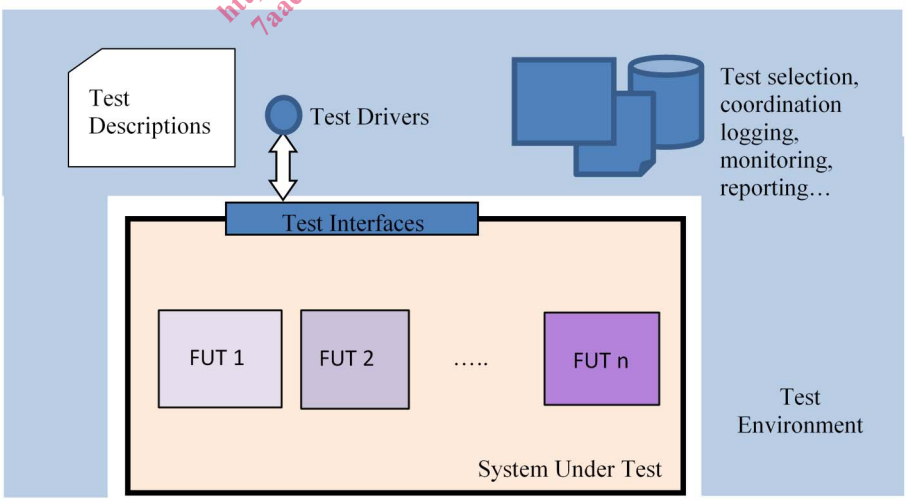

Figure 3: Illustration of basic concepts

4.2.2 System Under Test (SUT)

In the context of interoperability testing, the System Under Test (SUT) is made of a number of interacting Functions Under Test (FUTs) coming from different suppliers.

Depending on the complexity of the end-to-end system, the overall number of FUTs comprising the SUT, and the interactions among them, it might be advisable to define different SUT configuration addressing specific functional areas or groups of tests.

The first steps towards defining an Interoperability Tests Specification are identifying the Functions Under Test and describing a generic architecture where all the required SUT configurations will fit.

4.2.3 Function Under Test (FUT)

In the context of NFV, a Function Under Test is a combination of software and/or hardware items which implement the functionality of one or several NFV functional blocks and interact with other FUTs via one or more reference points, as described in ETSI GS NFV 002 [i.5].

NOTE: When using Interoperability Test Specifications in a certification scheme, the notion of Qualified Equipment (QE) or Qualified Function (QF) applies. A QF is a FUT that has successfully been tested with other QFs. The usage of interoperability Test Specifications in a certification scheme is out of the scope of the present document. Further details on this topic can be found at ETSI EG 202 237 [i.2].

4.2.4 Test interfaces

The interfaces that are made available by the SUT to enable the testing are usually known as the test interfaces. These interfaces are accessed by the test drivers to trigger and verify the test behaviour, as described in clause 4.2.7. Other (non-test) interfaces offered by the SUT can be used for monitoring, log analysis, etc.

In the simplest case, the test interfaces will be the normal user interfaces offered by some of the FUTs (command line, GUI, web interface, etc.). FUTs may also offer APIs over which interoperability testing can be performed either manually using a dedicated application, or automatically using a programmable test function.

In some cases, observing and verifying the functional behaviour or responses of one FUT may require analysing its logs or records. In that case, it is recommended to pre-define those log messages or records to avoid ambiguity in their interpretation.

Additionally, while in the context of interoperability testing interfaces between the FUTs are not considered to be test interfaces, combining interoperability testing with conformance checks may require to monitor those interfaces to assess the conformance of the exchanged information or messages.

4.2.5 Test Environment

Interoperability testing involves control and observation at the functional (rather than protocol) level. The Test Environment is the combination of equipment, functions and procedures which allow testing the interoperability of the FUTs. Entities in the test environment access the different Functions Under Test via the Test Interfaces offered by the SUT. These entities ensure the selection, interpretation and execution of the test descriptions, coordination and synchronization of the actions on the test interfaces, and provide mechanisms for logging, reporting, monitoring and observing the interactions among the FUTs, etc.

4.2.6 Test Descriptions

A test description provides the detailed set of instructions (or steps) that need to be followed in order to perform a test. Most often, interoperability tests are described in terms of actions that can be performed by the user(s) of the endpoint device(s).

In the case where the test is executed by a human operator, test will be described in natural language. In the case where the tests are automated, a programming or test language will be used to implement the test descriptions.

The steps in the test description can be of different nature, depending on the kind of action required: trigger a behaviour on one FUT, verify the functional response on another FUT, configure the SUT (add/remove a FUT), check a log, etc. Each step identifies the FUT and/or the interface targeted by the action.

4.2.7 Test drivers

The test driver realizes the steps specified in a test description at one specific test interface. Testing efficiency and consistency can be improved by implementing the role of the test driver via an automatic device programmed to carry out the specified test steps. This approach may require standardized test interfaces in the FUTs, or at least well-documented, open interfaces providing the needed functionality.

In any given instance of testing, there may be more than one test interface over which the tests will be executed. In that case, coordination among the different test drivers and synchronization of the actions performed by them will be required. This test coordination role can be played by one of the test drivers, or by and additional entity in the test environment.

4.3 Interoperability Test Specifications

4.3.1 Overview

The main steps involved in the process of developing an interoperability test specification are as follows:

- describing a generic architecture for the System Under Test;
- collecting interoperable (IOP) features and requirements in the Interoperable Features Statement (IFS);
- identifying the SUT Configurations;
- defining a structure for the Test Specification (TSS);
- writing Test Descriptions (TDs) for each item in the IFS.

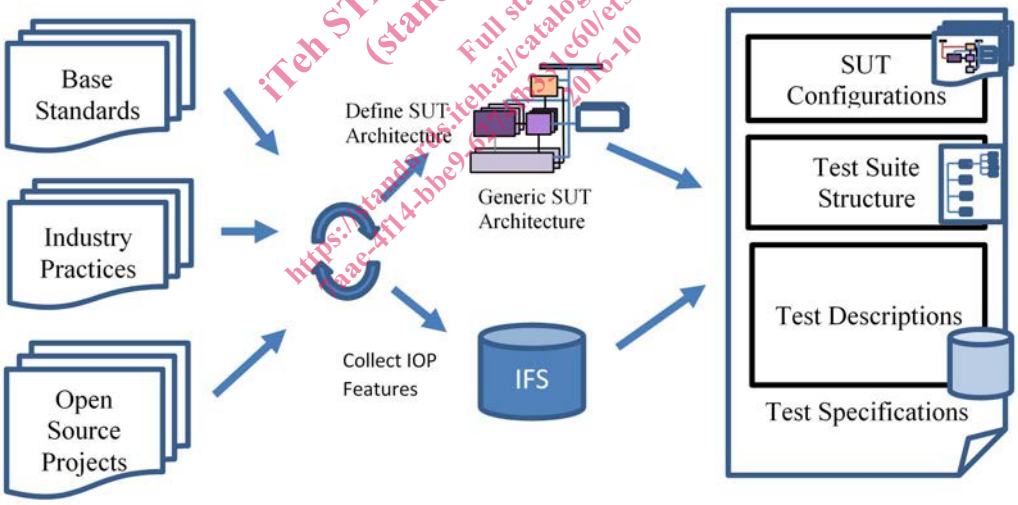

Figure 4: Interoperability Test Specification Development process

4.3.2 Generic SUT Architecture

A generic SUT architecture provides an abstract framework within which any specific SUT configuration can fit in. The starting point for defining a generic SUT architecture is most often the functional architecture described in the base standards, in combination with pragmatic input on how the industry and open source projects are actually implementing these functional blocks (grouping, bundling, etc.).

In a complex system, it may be required to define several SUT configurations to cover all the specified groups of tests. Defining the generic architecture and identifying the SUT configurations at an early stage helps to provide a structure for the test descriptions later. The generic test architecture is usually specified as a diagram and identifies:

- the Functions Under Test, and the functional blocks implemented by them;

- the interfaces and communications paths between the FUTs;
- if required, the protocols, APIs and/or data models to be used for communication between the FUTs.

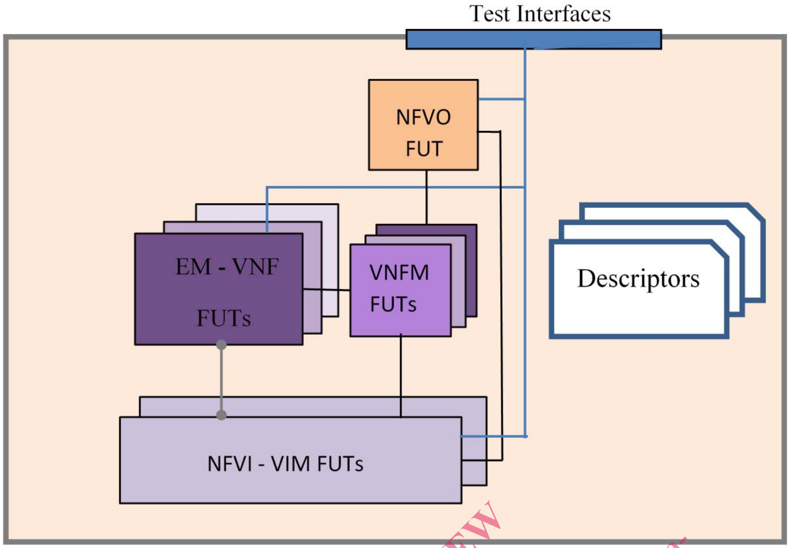

Figure 5: Example of Generic SUT Architecture

4.3.3 Interoperable Features Statement (IFS)

The purpose of the Interoperable Features Statement (IFS) is to identify those standardized functions which a FUT supports, including those which are optional and those which are conditional on the support of other functions. Although not strictly part of the interoperability test specification, the IFS also helps to provide a structure to the tests descriptions which will subsequently be developed. In the context of interoperability testing, the IFS provides a similar functionality than the one provided by the Protocol Implementation Conformance Statement (PICS) for conformance testing.

The IFS can also be used as a pro-forma for each FUT to identify which standardized functions it will support when interoperating with peering FUTs from other suppliers.

Standardized functions and IOP Features are compiled by analysing the base standards, use cases, flows, etc.

The IFS provides the means to compile and organize all the following information:

- FUT Identification.
- Supported Functional Blocks: i.e. VNF, VNFM, NFVO, etc.
- Supported Role (when/if applicable): i.e. producer/consumer, source/sink, etc.
- Supported Functional Groups and subgroups (optional): i.e. VNF Life Cycle Management, NS Life Cycle Management, etc.
- Supported IOP Features: i.e. VNF on-board, VNF update, etc.
- Supported options: i.e. Resource Commitment Model.
- Applicable reference point.
- Supported test interfaces.
- For each identified IOP Feature the following information is provided:
    - A unique **identifier** - the usage of a naming convention allowing to put the Feature into context (Functional Block, (Role), Functional Group, etc.) is recommended.