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Network Functions Virtualisation (NFV); Pre-deployment Testing; Report on Validation of NFV Environments and Services

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Foreword

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

Modal verbs terminology

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1 Scope

The present document is an informative report on methods for pre-deployment testing of the functional components of an NFV environment. The NFV components addressed in the present document include Virtual Network Functions (VNFs), the NFV Infrastructure (NFVI) and the NFV Management and Orchestration (NFV MANO). The recommendations focus on lab testing and the following aspects of pre-deployment testing:

1) Assessing the performance of the NFVI and its ability to fulfil the performance and reliability requirements of the VNFs executing on the NFVI.

2) Data and control plane testing of VNFs and their interactions with the NFV Infrastructure and the NFV MANO.

3) Validating the performance, reliability and scaling capabilities of Network Services.

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 http://docbox.etsi.org/Reference.

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

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

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2.2 Informative references

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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] ETSI GS NFV-SWA 001: "Network Functions Virtualisation (NFV); Virtual Network Functions Architecture".

[i.2] IETF RFC 2544: "Benchmarking Methodology for Network Interconnect Devices".

[i.3] IETF RFC 2889: "Benchmarking Methodology for LAN Switching Devices".

[i.4] IETF RFC 5180: "IPv6 Benchmarking Methodology for Network Interconnect Devices".

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

[i.6] ETSI GS NFV-INF 010: "Network Functions Virtualisation (NFV); Service Quality Metrics".

[i.7] ETSI GS NFV 001: "Network Functions Virtualisation (NFV); Use Cases".

[i.8] ETSI GS NFV-MAN 001: "Network Functions Virtualisation (NFV); Management and Orchestration".

[i.9] ETSI GS NFV-PER 001: "Network Functions Virtualisation (NFV); NFV Performance & Portability Best Practises".

[i.10] IETF draft-vsperf-bmwg-vswitch-opnfv-01: "Benchmarking virtual switches in OPNFV".

[i.11] IETF RFC 4656: "One Way Active Measurement Protocol".

[i.12] IETF RFC 5357: "Two Way Active Measurement Protocol".

[i.13] One-Way Active Measurement Protocol (OWAMP).

NOTE: Available at http://software.internet2.edu/owamp/.

[i.14] IETF draft-ietf-bmwg-virtual-net-01: "Considerations for Benchmarking Virtual Network Functions and Their Infrastructure".

[i.15] IETF draft-huang-bmwg-virtual-network-performance-01: "Benchmarking methodology for Virtualisation Network Performance".

[i.16] ETSI GS NFV-INF 004: "Network Functions Virtualisation (NFV); Infrastructure; Hypervisor Domain".

[i.17] ETSI TS 123 002: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Network architecture (3GPP TS 23.002)".

[i.18] ETSI TR 121 905: "Digital cellular telecommunications system (Phase 2+) (GSM); Universal Mobile Telecommunications System (UMTS); LTE; Vocabulary for 3GPP Specifications (3GPP TR 21.905)".

[i.19] ETSI TS 122 278: "Universal Mobile Telecommunications System (UMTS); LTE; Service requirements for the Evolved Packet System (EPS) (3GPP TS 22.278)".

[i.20] IETF RFC 5481: "Packet Delay Variation Applicability Statement".

[i.21] IETF RFC 6985: "IMIX Genome".

[i.22] IETF RFC 2647: "Vocabulary for 3GPP Specifications".

[i.23] IETF RFC 3511: "Service Requirements for the Evolved Packet System (EPS)".

[i.24] IETF RFC 6349: "Packet Delay Variation Applicability Statement".

[i.25] IETF RFC 7230 to IETF RFC 7239: The family of IETF RFCs that specify HTTP/1.1.

[i.26] IETF RFC 4271: "A Border Gateway Protocol 4 (BGP-4)".

[i.27] IETF RFC 2328: "OSPF Version 2".

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3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GS NFV 003 [1] and the following apply:

BFD	Bidirectional Forwarding Detection
BGP	Border Gateway Protocol
DoA	Dead on Arrival
DUT	Device Under Test
FUT	Function Under Test
IMIX	Internet MIX

NOTE: Some benchmarking methodologies use constant packet sizes, others use a mixture of packet sizes, or "IMIX" ("Internet Mix").

ISIS	Intermediate System to Intermediate System
LDP	Label Distribution Protocol
NSUT	Network Service Under Test

OSPF	Open Shortest Path First
OWAMP	One Way Active Measurement Protocol
RSVP	Resource ReserVation Protocol
SUT	System Under Test
TWAMP	Two Way Active Measurement Protocol
VNFUT	Virtual Network Function Under Test
WG	Working Group

4 Definition of SUTs

4.1 Overview

All the recommended test methods (e.g. functional testing, performance testing etc.) address a certain target to be validated and a test environment enabling the test execution. A test target in the context of the present document is considered to be the System Under Test (SUT) which comprises one or more Functions Under Test (FUT).

The following clauses describe the general definitions of SUTs, the test environment, the test function and the NFV components considered as SUTs for pre-deployment validation.

All descriptions provide a functional view; connections between elements in the figures 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6 illustrate functional interaction.

4.2 System Under Test (SUT)

In the context of pre-deployment validation, the System Under Test (SUT) consists of one or more functions under test.

NOTE: The functions under test (FUT) are entities which are also commonly known as Devices Under Test (DUT) in the testing community. The term Device Under Test is not used in the present document in order to avoid ambiguities; devices are often considered to be physical entities which does not apply here.

In order to illustrate this concept, the functions under test could for example be implementations of functional blocks from the NFV architecture such as virtualisation layer or VNF. However, other physical or virtual components could as well be functions under test (FUT), like a virtual switch for example.

Each test specification validates one SUT where the SUT is one or more functional components of the NFV architecture. The SUTs considered for pre-deployment validation are the NFV Infrastructure (NFVI), a Virtualised Network Function (VNF), a Network Service (NS) or the Management and Orchestration (MANO).

It has to be noted that even though the MANO or parts of it are listed as potential SUTs, no direct pre-deployment validation methodologies of them are in the scope of this report. However they are required as supporting functional blocks for the validation of other entities and are listed for completeness and might be considered for further study.

4.3 Test environment

The test environment for pre-deployment validation consists of reference implementations of those functional NFV components from the NFV architecture which do not represent the particular SUT. Additionally the test environment contains test functions and entities to enable controlling the test execution and collecting the test measurements.

4.4 Test function

The test functions for pre-deployment validation are entities that communicate with the SUT via standardized interfaces. The test functions are controlled from the test environment for test execution and are monitored from the test environment to obtain measurements for test results.

4.5 NFV Infrastructure Under Test

For pre-deployment validation of the NFV Infrastructure (NFVI), the NFVI represents the SUT.

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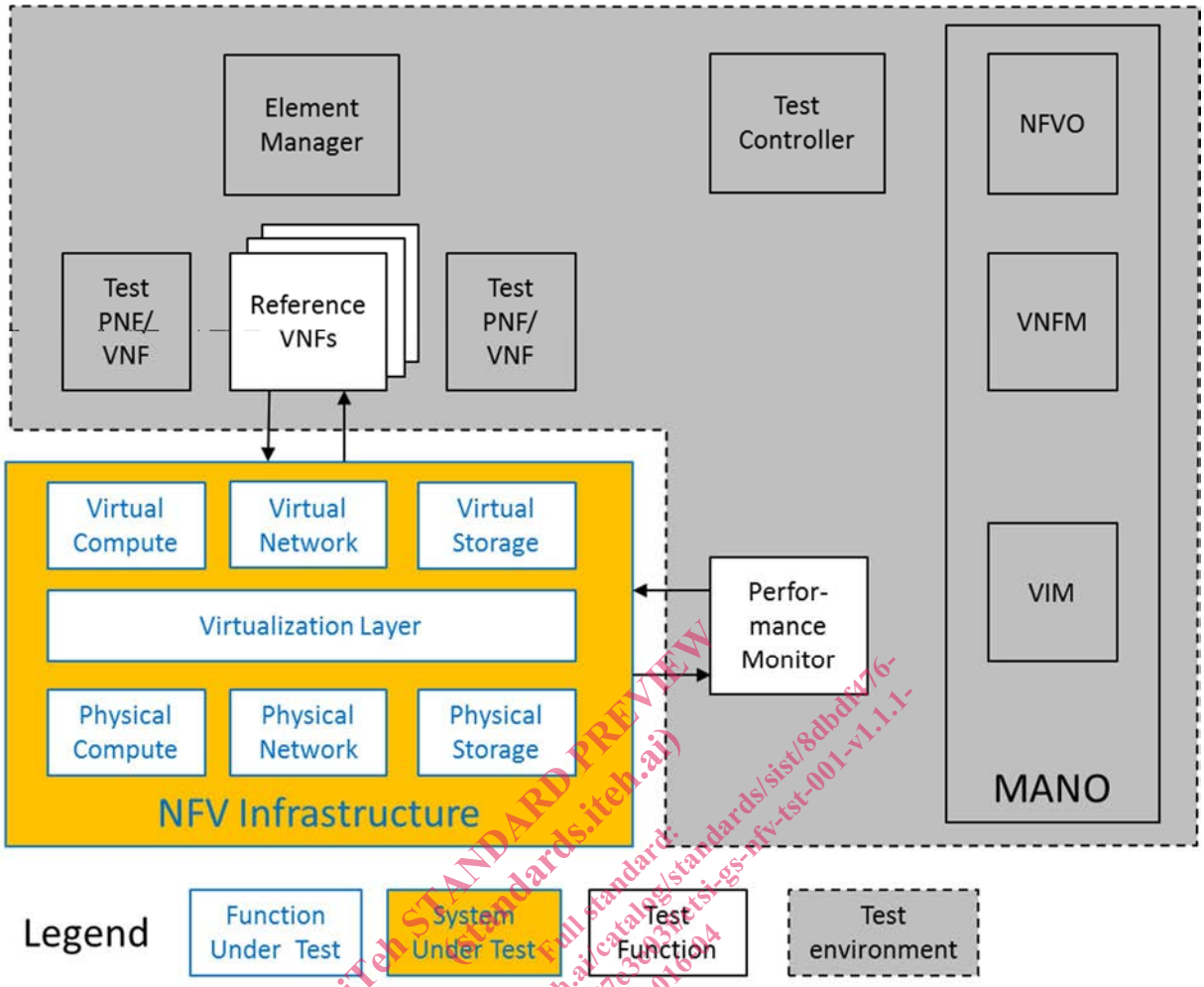

Figure 4.1: Functional architecture for NFVI under test

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As illustrated in figure 4.1, the SUT comprises of the following functions under test (FUT):

- Physical Compute
- Physical Network
- Physical Storage
- Virtualisation Layer
- Virtual Compute
- Virtual Network
- Virtual Storage

The test environment consists of a reference implementation of the NFV MANO functional components plus a Test Controller, Test PNFs/VNFs, Reference VNFs and a Performance Monitor. In case required for maintaining the test and reference PNFs/VNFs, an optional Element Manager might be part of the test environment as well.

Different Reference VNFs as test functions are required to cover all aspects concerning different VNF types. The Reference VNFs are expected to be of the types described in ETSI GS NFV-SWA 001 [i.1], annex B, and shown in figure 4.2.

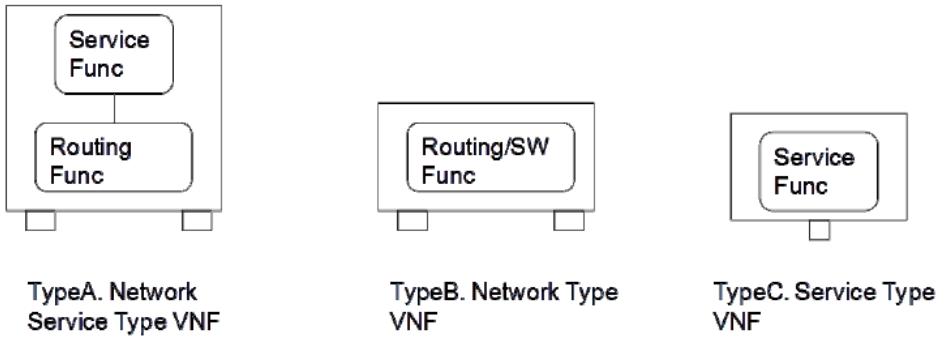

Figure 4.2: Reference VNF types (ETSI GS NFV-SWA 001 [i.1])

A Performance Monitor as test function is required to measure the performance indicators from the NFVI.

Optional test PNFs/VNFs might be required for certain test methods to enable traffic scenarios towards the Reference VNFs.

4.6 VNF Under Test

For pre-deployment validation of a Virtualised Network Function (VNF), the SUT consists of one FUT which is the VNF Under Test, see figure 4.3.

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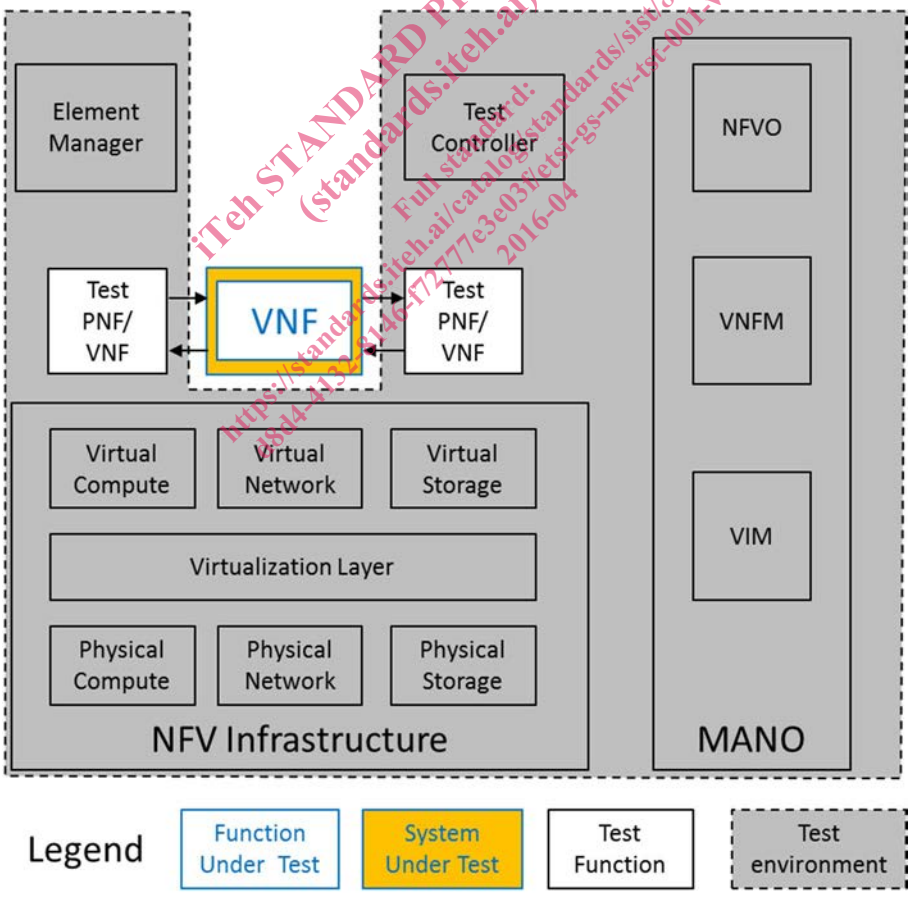

Figure 4.3: Functional architecture for VNF Under Test

The test environment consists of reference implementations of NFVI and NFV MANO functional components plus a Test Controller and Test PNFs/VNFs. In case required for maintaining the test PNFs/VNFs and the VNF Under Test, an optional Element Manager might be part of the test environment as well.

The Test PNFs/VNFs enable traffic scenarios towards the VNF Under Test and provide interfaces exposing access to functional and performance indicators.

4.7 NS Under Test

For pre-deployment validation of a Network Service (NS), the NS represents the SUT.

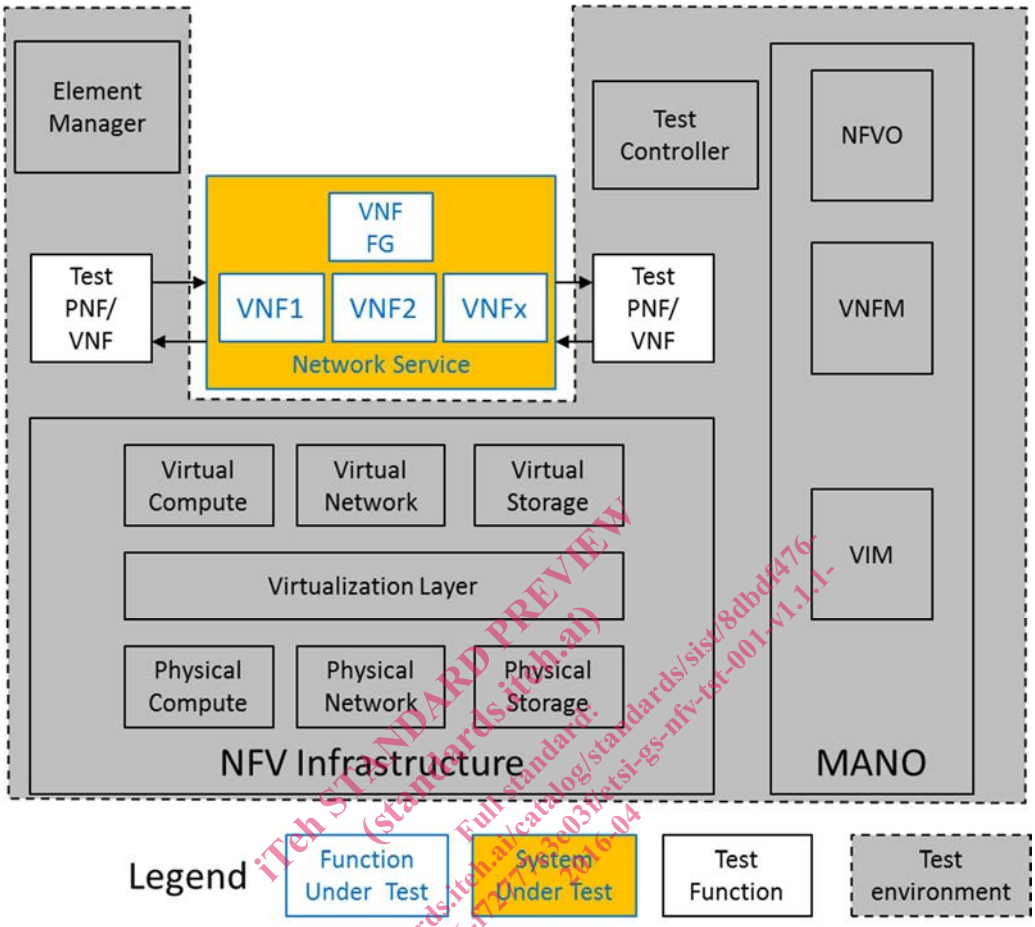

Figure 4.4: Functional architecture for NS Under Test

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Note that in figures 4.1, 4.2, 4.3, 4.4, 4.5 and 4.6, there is a physical overlap between the SUT and the NFVI in the Test Environment. For example, the VNF FG overlaps with the Virtual Network aspect of the NFVI.

The SUT consists of two or more VNFs and a VNF Forwarding Graph (VNF FG) which represent the Functions Under Test respectively.

The test environment consists of reference implementations of NFVI and NFV MANO functional components plus a Test Controller and Test PNFs/VNFs. In case required for maintaining the test PNFs/VNFs and the VNFs as FUTs of the NS Under Test, an optional Element Manager might be part of the test environment as well.

The Test PNFs/VNFs enable traffic scenarios towards the NS Under Test and provide interfaces exposing access to functional and performance indicators.

4.8 Management and Orchestration Under Test

For pre-deployment validation of the Management and Orchestration (MANO), the MANO represents the SUT. As mentioned before, no direct pre-deployment validation methodologies of the MANO are in the scope of the present document but the corresponding SUT is listed for completeness and for further studies.

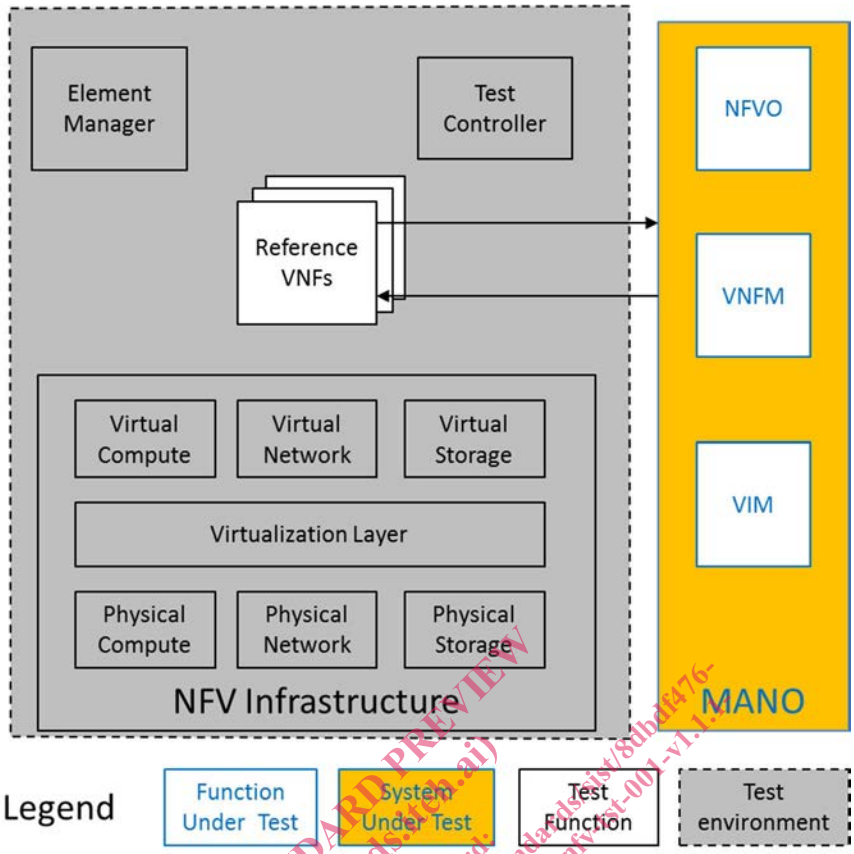

Figure 4.5: Functional architecture for MANO Under Test

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The SUT consists of the NFV Orchestrator (NFVO), the VNF Manager (VNFM) and the Virtual Infrastructure Manager (VIM) which represent the functions under test respectively. See also figure 4.5.

The test environment consists of a reference implementation of NFVI plus a Test Controller and reference VNFs. In case required for maintaining the reference VNFs, an optional Element Manager might be part of the test environment as well.

Different Reference VNFs are required as test functions to cover all aspects concerning different VNF types. The Reference VNFs are expected to be of the types as described in ETSI GS NFV-SWA 001 [i.1], annex B, and shown in figure 4.2.

4.9 NFV Infrastructure + VIM Under Test

A variant of the NFVI Under Test could be acombination of the NFVI and the Virtual Infrastructure Manager (VIM) Under Test. For pre-deployment validation of the NFV Infrastructure (NFVI) including the VIM, the NFVI and the VIM represent the SUT. Even though this report does not contain direct pre-deployment validation methodologies for this combination, it is listed for completeness and for further studies.

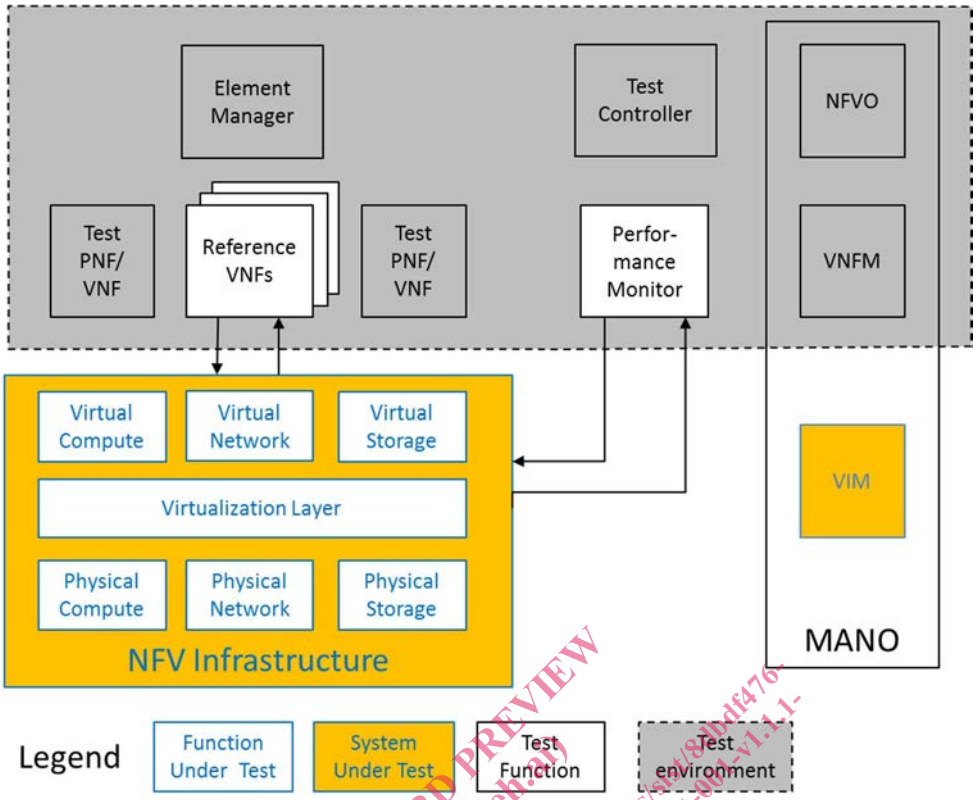

Figure 4.6: Functional architecture for NFVI + VIM Under Test

As illustrated in figure 4.6, the SUT comprises of the following functions under test (FUT):

- Physical Compute
- Physical Network
- Physical Storage
- Virtualisation Layer
- Virtual Compute
- Virtual Network
- Virtual Storage
- Virtual Infrastructure Manager

The test environment consists of a reference implementation of the NFV MANO functional components excluding the VIM plus a Test Controller, Test PNFs/VNFs, Reference VNFs and a Performance Monitor. In case required for maintaining the test and reference PNFs/VNFs, an optional Element Manager might be part of the test environment as well.

Different Reference VNFs as test functions are required to cover all aspects concerning different VNF types. The Reference VNFs are expected to be of the types described in ETSI GS NFV-SWA 001 [i.1], annex B, and shown in figure 4.2.

A Performance Monitor as test function is required to measure the performance indicators from the NFVI.

Optional test PNFs/VNFs might be required for certain test methods to enable traffic scenarios towards the Reference VNFs.

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