ETSI GR NFV-TST 012 V1.1.1 (2024-02)

Network Functions Virtualisation (NFV); Testing; VIM & NFVI Control and Management Performance Evaluation

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Reference
DGR/NFV-TST012

Keywords
NFV, NFVI, performance, testing

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Sous-Préfecture de Grasse (06) N° w061004871

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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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1 Scope

The present document is a group report on methods and metrics for the evaluation of VIM and NFVI control and management performance. The evaluated NFV components in the present document include the NFV Infrastructure (NFVI) and the Virtualised Infrastructure Manager (VIM). The evaluating area considered by the present document is the capability of the operation and management of virtual resources which are performed by VIM and executed by NFVI, e.g. the time for virtualization container instantiation, scaling, migration.

Based on the performance evaluation results, the present document provides guidelines for relative comparison of different implementations of VIM and NFVI. The present document also provides advises about how to choose the most suitable implementation in different scenarios.

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] OVP Test Specifications.

[i.2] Dovetail home page.

[i.3] OPNFV Samplevnf home page.

[i.4] ETSI GR NFV 003: "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.5] ETSI GS NFV-IFA 010: "Network Functions Virtualisation (NFV) Release 4; Management and Orchestration; Functional requirements specification".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the terms given in ETSI GR NFV 003 [i.4] the following apply:

infrastructure domain: represents the combination of VIM and NFVI

3.2 Symbols

Void.

3.3 Abbreviations

For the purposes of the present document, the abbreviations given in ETSI GR NFV 003 [i.4] and the following apply:

GB	GigaByte
MB	MegaByte
NUMA	Non-Uniform Memory Access

4 Overview

4.1 Introduction

As described in ETSI GR NFV 003 [i.4], NFV Infrastructure (NFVI) is the key component of the NFV architecture that encompasses the hardware and software components on which Virtual Network Functions (VNFs) are deployed. The Virtualized Infrastructure Manager (VIM) is a key component of the NFV-MANO architectural framework which is responsible for controlling and managing the NFV Infrastructure (NFVI) compute, storage, and network virtual resources. The detailed functional requirements applicable to the VIM have been defined in ETSI GS NFV-IFA 010 [i.5].

The main job of infrastructure domain performance evaluation is to measure how well the control and management functional requirements are fulfilled. In other words, it is aimed to evaluate the control and management capability of VIM. The primary assumption of performance evaluation is that the functional requirements have been realized correctly according to the corresponding functional requirements specified in ETSI GS NFV-IFA 010 [i.5] NFV standards definition. And the interoperability requirements between VIM and NFVI have been met.

Under the current logical NFV framework, the operations for controlling and managing the NFVI resource are initiated by VIM and then executed by NFVI. So, infrastructure domain control and management performance is affected by two main parts:

- The ability of VIM to control and manage the resources.
- The capability of NFVI to respond to the requests from VIM.

With regard to industrial implementation, VIM and NFVI are often delivered as one product bundle. As a consequence, the two parts are closely related and therefore it is difficult to separate them from each other during the evaluation process. Based on those considerations, VIM and NFVI are considered as a unified system under test/evaluation in the present document.

The performance evaluation in the present document can serve the following purposes:

1) It can be used for the relative comparison of different infrastructure domain implementations. In reality, different NFVIs can be implemented based on different virtualization technologies and different VIMs can have different controlling and managing strategies and algorithms. Even for the same cloud management platform (e.g. Openstack®), there exist different enterprise editions. There is a lack of unified and comprehensive performance metrics and methods to find out which implementation performs better. The present document provides the corresponding metrics and methods to measure the performance of different infrastructure domain implementations. It can also provide some guide for infrastructure domain selection in different scenarios. The type and size of VNFs vary in different deployment scenarios. Therefore, operators can have different preferences about the capability of infrastructure domain. The performance evaluation in the present document can help operators gain a comprehensive and detailed understanding about the capability of infrastructure domain, in order to guide operators to choose the most suitable implementation for a specific deployment scenario.

2) It can be used to describe the performance requirements for both operators and vendors. The present document provides a set of metrics for performance evaluation. On the one hand, those metrics can be used by operators to quantitatively describe their own performance requirements. On the other hand, vendors can offer the benchmarking results of these metrics to demonstrate whether the infrastructure domain implementation meets performance requirements from operators.

3) It can help to locate resource-related problems. When a failure happens to the whole system (VNF + NFVI + NFV-MANO), it can be caused by failed resource management, wrong VNF configurations or even a breakdown of NFV-MANO. With the help of the proposed benchmarking methods in the present document, the operators can easily find out whether the infrastructure domain is responsible for the failure and thus improve the efficiency of troubleshooting.

4.2 Background

For infrastructure domain implementation, there are a lot of different choices provided by companies and communities. OpenStack® is an open source virtualisation management platform which can support operators to deploy VNFs by using Virtual Machines (VMs) on COTS hardware and the OPNFV community (now part of Anuket) has implemented the VIM component using OpenStack®.

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In addition to OpenStack®, there are some other commercial implementations which also use VMs for VNF deployment provided by different companies. With the development of virtualization technologies, more and more companies are considering to build a container-based platform for NFV.

The present document provides metrics and methods which can be used to evaluate the performance of different infrastructure domain implementations. There are some projects in communities and industries which can be as the reference to the present document.

Project Rally in OpenStack® designs the test tool to check whether OpenStack® works well under high load. The following table lists the test cases provided by Rally which are related to infrastructure domain control and management performance evaluation.

Table 4.2-1: Reference Use Cases from Project Rally

OpenStack® Component	Test cases	Corresponding requirement
Cinder	Create-and-attach-volume Create-and-delete-volume Create-and-list-volume Create-and-update-volume	Related to performance evaluation for VIM's storage resource management
	Create-and-delete-snapshot Create-and-list-snapshot	Related to performance evaluation for VIM's virtualized resource snapshot management
Swift	Create-container-and-object-then-delete-all Create-container-and-object-then-list-object	Related to performance evaluation for VIM's storage resource management
Glance	Create-and-deactivate-image Create-and-delete-image Create-and-get-image Create-and-list-image Create-and-update-image	Related to performance evaluation for VIM's software image management
Neutron	Create-and-delete-network Create-and-delete-ports Create-and-delete-routers Create-and-delete-subnets Create-and-show-subnets Create-and-update-subnets	Related to performance evaluation for VIM's network resource management
Nova	Boot-and-block-migrate Boot-and-delete Boot-and-list Boot-and-live-migrate Boot-and-migrate	Related to performance evaluation for VIM's resource instance (VM for OpenStack) management

The OPNFV Verified Program (OVP) [i.1] provides a series of test areas aimed to evaluate the operation of an NFV system in accordance with carrier networking needs. OPNFV implements OVP in the Dovetail project [i.2]. Each test area contains a number of associated test cases which are described in detail in the associated test specification. The following table lists the test specifications for image test, VM resource scheduling on multiple nodes test and common virtual machine life cycle events test provided by OVP.

Table 4.2-2: Reference Test Specification from Project OVP

Test Specification	Test Cases	Corresponding requirement
Tempest Image test specification	Register Image Upload Image Get Image	Related to performance evaluation for VIM's image management
VM Resource Scheduling on Multiple Nodes test specification	Schedule VM to compute nodes Create and delete multiple server groups with same name and policy Create and delete server group with affinity policy Create and delete server group with anti-affinity policy List server groups Show server group details	Related to performance evaluation for VIM's resource instance (VM) management
Common virtual machine life cycle events test specification	Resize a server Resizing a volume-backed server Cold migrate a server Live migrate a server	Related to performance evaluation for VIM's resource instance (VM) management

The test cases provided by OVP are designed for function test of VIM and NFVI only. They can be used as the reference for the design of test method in the present document.

4.3 Use cases

4.3.1 Use cases related to implementation selection

The use case is limited to the case that multiple infrastructure domain candidates are provided for operators to select. They are installed in the same test environment with same set of testing VNFs. The set of testing VNFs is designed with simple function and different resource requirements. They will be operated (instantiated, scaled, destroyed, etc.) in order to test the control and management plane of infrastructure domain. Continuous monitoring allows the testers (operators) to get the performance data about the infrastructure domain control and management functional behaviours in the same operator environment.

With those performance data, operators can run relative comparison between different infrastructure domains. Those performance data can also help operator to have comprehensive understanding about their capabilities from different dimensions. Combining with the requirements from different VNF deployment scenarios, operator can choose the most suitable infrastructure domain implementation.

EXAMPLE: In the scenarios which have a lot of micro-VNFs with short life cycle, operator could prefer the implementation with better flexibility in resource control and management. The performance data collected from the measurement can help operators to find the most suitable one.

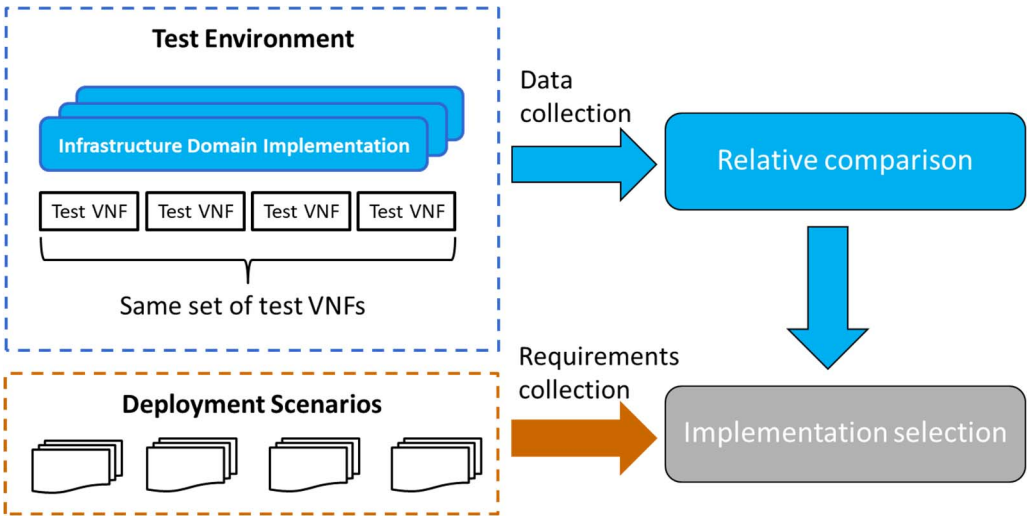

Figure 4.3.1-1: Use Case Related to Implementation Selection

5 Framework for Metric and Measurement Definition

5.1 Performance Metric Definition Template

The present document provides a set of performance metrics definitions according to the following template, where each performance metric is defined with the following elements:

a) Background Introduction:

- This subclause contains the background information of the performance metric.

b) Name:

- This subclause contains the name of performance metric. For the metric which may already exist in industry, it may be renamed in this subclause.

c) Parameters:

- This subclause contains the parameters (input factors) which need to be specified in order to collect the performance metric.

d) Unit(s):

- This subclause specifies the unit(s) of performance metric.

e) Definition:

- This subclause contains the definition of performance metric. It explains which control and management function of VIM the metric is defined to measure.

f) Method of Measurement:

- This subclause contains the method to measure the performance metric.

5.2 Performance Measurement Definition Template

The present document provides a set of performance measurement definitions according to the following template, where each performance measurement is defined with the following elements:

a) Description:

- This subclause contains the description of the performance measurement.

b) Measurement Name:

- This subclause contains the name which is used to identify the performance measurement.

c) Measurement Method:

- This subclause contains the methods by which the measurement is obtained.

d) Measured Metric(s):

- This subclause lists the metrics which can be measured through the performance measurement.

e) Trigger:

- This subclause contains the trigger which starts the measurement.

f) Sources of Error:

- This subclause lists the factors which may cause failure to the performance measurement.

g) Measurement Procedure:

- This subclause provides the procedure of the performance measurement.

6 Test Set-ups and Configuration

6.1 Test Setups

In the context of performance evaluation, the System Under Test (SUT) consists of infrastructure domain (VIM and NFVI) coming from different providers.

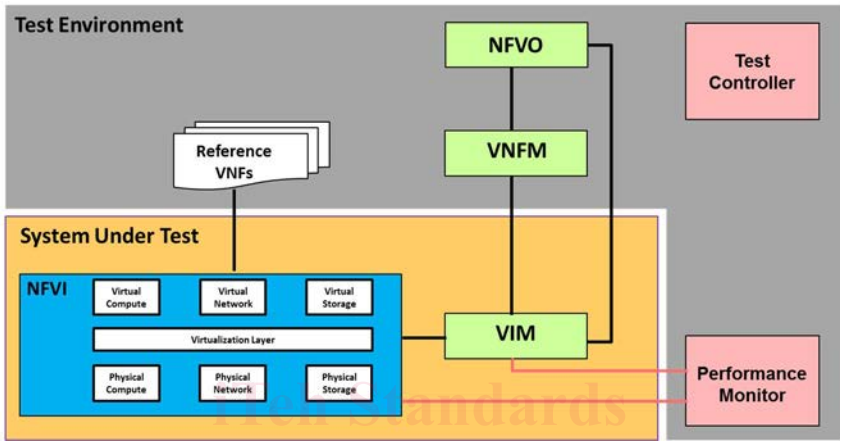

Figure 6.1-1: System Under Test and Test Environment

As illustrated in figure 6.1-1, the test environment consists of a reference implementation of the NFV MANO functional components (NFVO and VNFM), reference VNFs, one performance monitor and one test controller.

The testing domain is the performance of the operations and management resource instance and virtual resource. The NFV MANO functional components (NFVO and VNFM) are responsible to help VIM to trigger the control and management operations to be evaluated. The test controller in figure 6.1-1 is used to control the whole test procedure. The performance monitor measures the performance indicators from the VIM. According to the definition of testing domain, the performance of VNFs is out of the scope. During the evaluation, a set of VNFs with simple functions and different resource requirements are used as the reference VNFs.

6.2 Configurations

The one purpose of performance measurement is to help operators select the most suitable implementation of the infrastructure domain. The performance measurement results are intended to be used for the relative comparison of different implementations. To ensure fairness of performance measurement, the configuration of the measured infrastructure domain all aspects of hardware, software, and reference VNF is clearly specified.

The following hardware related configuration parameters are specified before the measurement:

1) The number of NFVI nodes: To measure the control and management capability of the infrastructure domain, the number of NFVI nodes are specified the same for different implementations.

2) The available resource provided by each NFVI node: The number of NFVI nodes and the available resource provided by each NFVI node are two important parameters that describe the available resource managed by VIM. For example, ten small NFVI nodes and five big NFVI nodes require different management capabilities from VIM, even their total amounts of available resources are equal. The available resources provided by each NFVI node are specified by using the following configuration parameters:

   - The number of available CPU cores.

   - Type and size of available memory.