SLOVENSKI STANDARD
SIST ES 203 539 V1.1.1:2020

01-maj-2020

Okoljski inženiring (EE) - Metoda merjenja energijske učinkovitosti virtualizacije omrežnih funkcij (NFV) v laboratorijskem okolju

Environmental Engineering (EE) - Measurement method for energy efficiency of Network Functions Virtualisation (NFV) in laboratory environment

Ta slovenski standard je istoveten z: ETSI ES 203 539 V1.1.1 (2019-06)

ICS:

27.015	Energijska učinkovitost. Ohranjanje energije na splošno	Energy efficiency. Energy conservation in general
33.040.01	Telekomunikacijski sistemi na splošno	Telecommunication systems in general

SIST ES 203 539 V1.1.1:2020 **en**

ETSI ES 203 539 V1.1.1 (2019-06)

Environmental Engineering (EE); Measurement method for energy efficiency of Network Functions Virtualisation (NFV) in laboratory environment

Reference
DES/EE-EEPS19

Keywords
energy efficiency, NFV, SDN

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

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Foreword

This ETSI Standard (ES) has been produced by ETSI Technical Committee Environmental Engineering (EE).

The present document was developed jointly by ETSI TC EE and ITU-T Study Group 5. It is published respectively by ITU and ETSI as Recommendation ITU-T L.1361 [i.14] and ETSI ES 203 539 (the present document), which are technically-equivalent.

Modal verbs terminology

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Introduction

Network Functions Virtualisation (NFV) changes the traditional telecom network architecture to layered model by replacing physical equipment with network functions running on standard server platform. Three main domains are identified in high-level NFV architecture: Virtualised Network Functions (VNFs) is the software implementation of a network functions which is capable of running over the NFV Infrastructure (NFVI). NFVI include diversity of physical resources and virtualised resources to support the execution of the VNFs. NFV Management and Orchestration (MANO) covers the orchestration and lifecycle management of physical and/or software resources that support the infrastructure virtualisation, and the lifecycle management of VNF. The three decoupled elements with connection of standardized and open interface can be provided by different vendors. VNFs and NFVI are the dominant parts from energy consumption point of view.

Therefore the present document defines energy efficiency metrics and measurement methods for NFV components including VNFs and NFVI. The energy efficiency of VNF is evaluated according to hardware energy consumption, resource consumption and utilization related with VNF. The energy efficiency of NFVI is evaluated as resource provision capability which is expressed as service capacity of reference VNFs running on it with amount of energy consumption.

1 Scope

The present document defines the metrics and measurement methods for the energy efficiency of functional components of NFV environment. The NFV functional components include Virtualised Network Functions (VNFs) and NFV Infrastructure (NFVI) defined in NFV architecture framework as described in ETSI GS NFV 002 [i.1]. Management and Orchestration (MANO) is not included as system under test, but will be eventually taken as test environment.

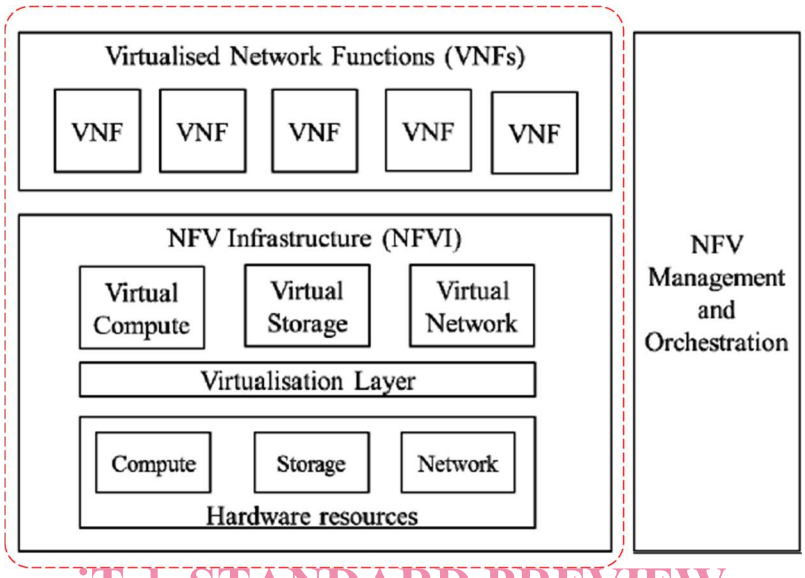

Figure 1: NFV function components in the scope of the present document

The measurement method described in the present document is intended to be used to assess and compare the energy efficiency of same functional components independently in lab testing and pre-deployment testing. Energy efficiency of co-located VNFs sharing same platform resources cannot be compared using the defined method in present document. The scope of the document is not to define measurement method in operational NFV environment.

The present document is intended to define common energy efficiency measurement methods for NFV environments, not try to cover all different types of VNFs (e.g. firewall, gateway, etc.), but it provides the basis to make extensible definition.

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/.

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

Not applicable.

2.2 Informative references

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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 002 (V1.1.1): "Network Functions Virtualisation (NFV); Architectural Framework".

[i.2] ETSI GS NFV-INF 001 (V1.1.1): "Network Functions Virtualisation (NFV); Infrastructure Overview".

[i.3] ETSI EN 303 470: "Environmental Engineering (EE); Energy Efficiency measurement methodology and metrics for servers".

[i.4] ETSI ES 203 136 (V1.1.1): "Environmental Engineering (EE); Measurement methods for energy efficiency of router and switch equipment".

[i.5] ETSI GS NFV-TST 001 (V1.1.1): "Network Functions Virtualisation (NFV); Pre-deployment Testing; Report on Validation of NFV Environments and Services".

[i.6] ETSI GS NFV-PER 001 (V1.1.2): "Network Functions Virtualisation (NFV); NFV Performance & Portability Best Practises".

[i.7] IEC 62018: "Power consumption of information technology equipment - Measurement methods".

[i.8] OPNFV Yardstick project: "Network Service Benchmarking (NSB) framework extension".

NOTE: Available at https://wiki.opnfv.org/display/yardstick/Network+Service+Benchmarking.

[i.9] ETSI EN 300 132-2: "Environmental Engineering (EE); Power supply interface at the input of Information and Communication Technology (ICT) equipment; Part 2: -48 V Direct Current (DC)".

[i.10] CENELEC EN 50160: "Voltage characteristics of electricity supplied by public electricity networks".

[i.11] ETSI GS NFV-TST 008: "Network Functions Virtualisation (NFV) Release 3; Testing; NFVI Compute and Network Metrics Specification".

[i.12] ETSI GS NFV-IFA 027: "Network Functions Virtualisation (NFV) Release 2; Management and Orchestration; Performance Measurements Specification".

[i.13] ETSI GS NFV 003 (V1.2.1): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[i.14] Recommendation ITU-T L.1361: "Measurement method for energy efficiency of network functions virtualization".

3 Definition of terms, symbols and abbreviations

3.1 Terms

For the purposes of the present document, the following terms apply:

energy consumption: amount of consumed energy

NOTE: It is measured in Joule or kWh (where 1 kWh = 3,6 × 106 J) and corresponds to energy use.

energy efficiency: relation between the useful output and energy consumption

erlang: average number of concurrent calls carried by the circuits

function: logical representation of a network element defined by 3GPP

node: physical representation of one or more functions

power consumption: amount of consumed power

NOTE: It is measured in W and corresponds to the rate which energy is converted.

resource consumption: VM resources, VN resources

system under test: node being measured

useful output: maximum capacity of the system under test which is depending on the different functions

NOTE: It is expressed as the number of Erlang (Erl), Packets/s (PPS), Subscribers (Sub) or Simultaneously Attached Users (SAU).

3.2 Symbols

Void.

3.3 Abbreviations

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

EER	Energy Efficiency Ratio
HSS	Home Subscriber Server
HW	HardWare
NFV	Network Functions Virtualisation
NFVI	NFV Infrastructure
QoS	Quality of Service
RER	Resource Efficiency Ratio
SLA	Service Level Agreement
SUT	System Under Test
SW	SoftWare
VNF	Virtualised Network Function

4 Metrics definition

4.1 Overview of System Under Test

In traditional networks, physical network elements provide network functions as a combination of vendor specific hardware and software. The System Under Test (SUT) is a physical network element which is usually taken as a "black box" in energy efficiency measurement standards. But in NFV environment, the functionality of physical network element is decoupled into software and hardware via Virtualisation. Network functions are executed as VNFs on NFVI composing of general purpose computing, networking and storage hardware resources, and Virtualisation layer. All of them are managed and orchestrated by MANO. There will be many potential suppliers for NFV sub-systems and components, which need to be measured separately on energy efficiency performance.

The energy efficiency metrics is typically defined as functional unit of useful output divided by the energy consumption. As shown in Figure 2, NFV architecture decompose the integrity of traditional energy efficiency measurement which tightly connect useful service output to energy consumption. VNF is software implementation of a network function which consumes resources provided by NFVI to produce service capacity to cloud service users. NFVI consume energy to provide infrastructure resources to support the execution of VNF. Such decoupled architecture introduces complexity on measurement process. Resource consumption should be monitored, internal configuration of SUT and test environment should be specified and reported to ensure repeatability and comparability.

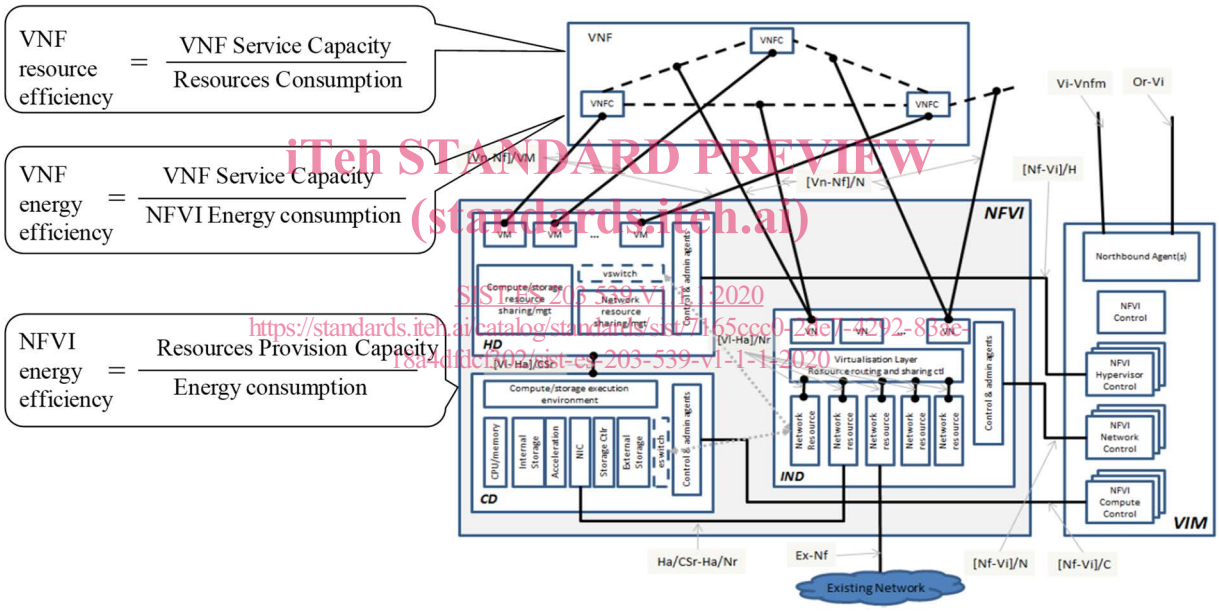

Figure 2: High level NFV architecture (from Figure 23 of ETSI GS NFV-INF 001 [i.2])

There are already several energy efficiency measurement standards for NFVI components, for example ETSI EN 303 470 [i.3] for server, ETSI ES 203 136 [i.4] for Ethernet switch.

In the following clauses the SUTs considered for energy efficiency measurement are a Virtualised Network Function (VNF) and the NFV Infrastructure (NFVI).

The definition of test environment and test function are described in ETSI GS NFV-TST 001 [i.5]. The test environment consists of reference implementation of those functional NFV components from the NFV architecture which do not represent the particular SUT, and contain test functions and entities to enable controlling the test execution and collecting the test measurement. Test function are entities that communicate with the SUT via standardized interfaces.

- VNF under test:
  - For energy efficiency measurement of VNF, the SUT is VNF under test as illustrated in Figure 3.
  - The test environment consists of reference implementation of NFVI and MANO functional components plus a Test controller and Test VNF/PNFs, Performance monitor, Power meter. A Performance Monitor as test function is required to measure the performance indicators from the NFVI.

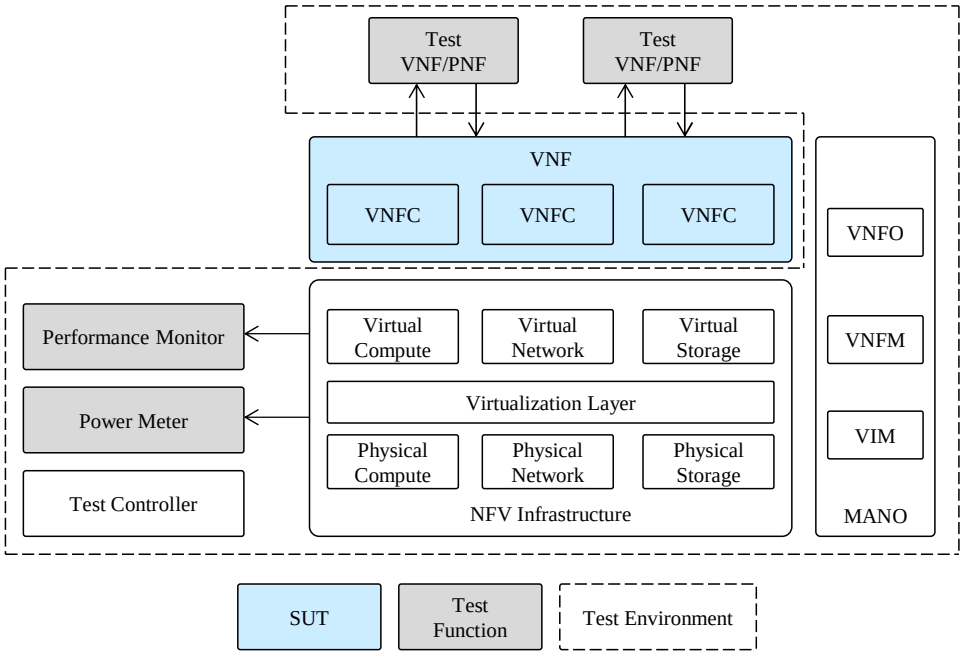

Figure 3: Functional architecture for VNF under test

- NFVI under test:
  - For energy efficiency measurement of NFVI, the SUT is NFVI under test as illustrated in Figure 4.
  - The SUT comprise of physical hardware resources and virtual resources including computing, storage and network, and Virtualisation layer.
  - The test environment consists of a reference implementation of the NFV MANO functional components plus a Test Controller, Test PNFs/VNFs, Reference VNFs, Performance Monitor and Power Meter.

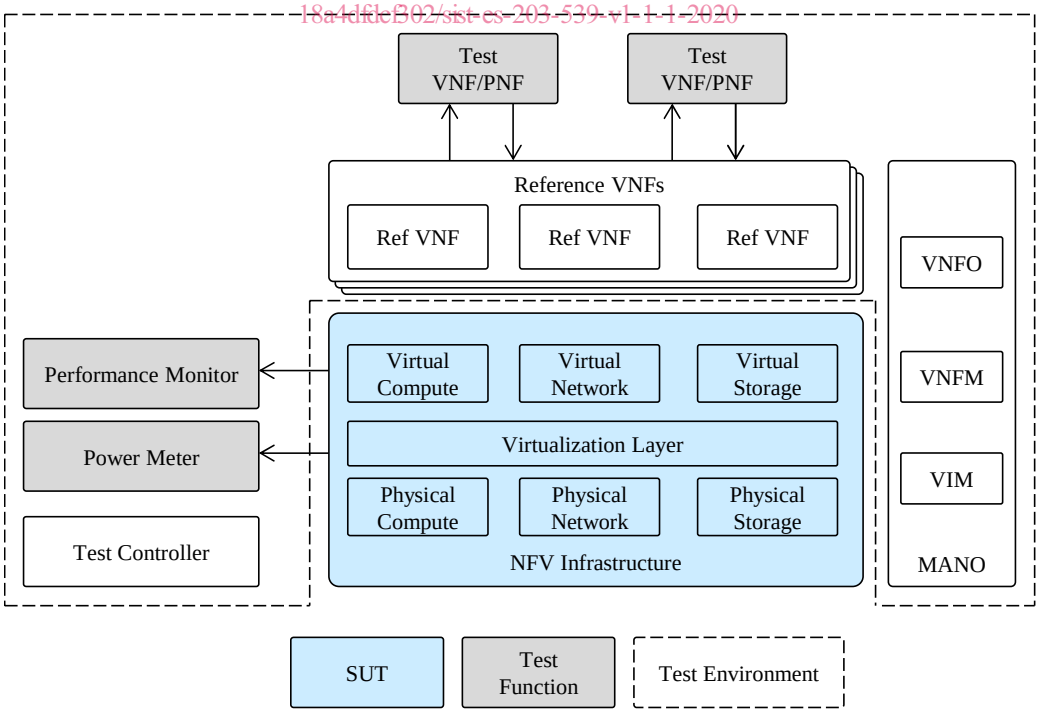

Figure 4: Functional architecture for NFVI under test