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

Reference
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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.

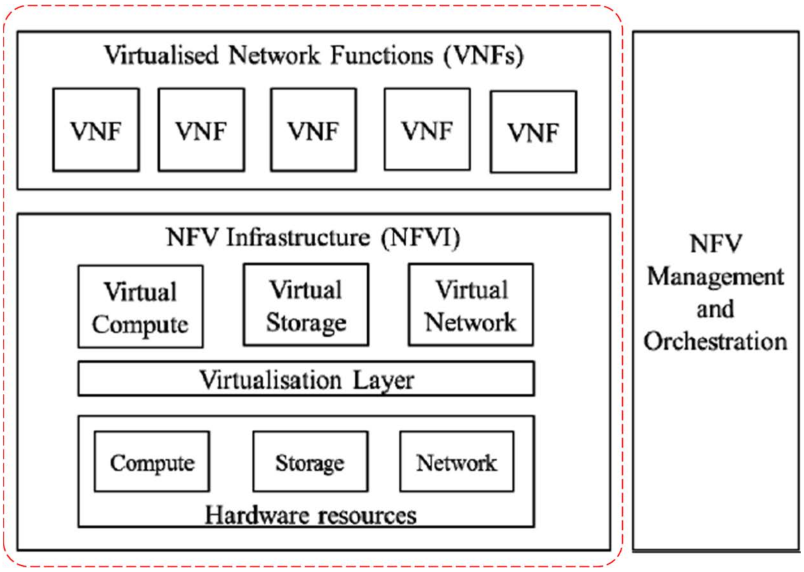

Figure 1: NFV function components in the scope of the present document

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

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.

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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.

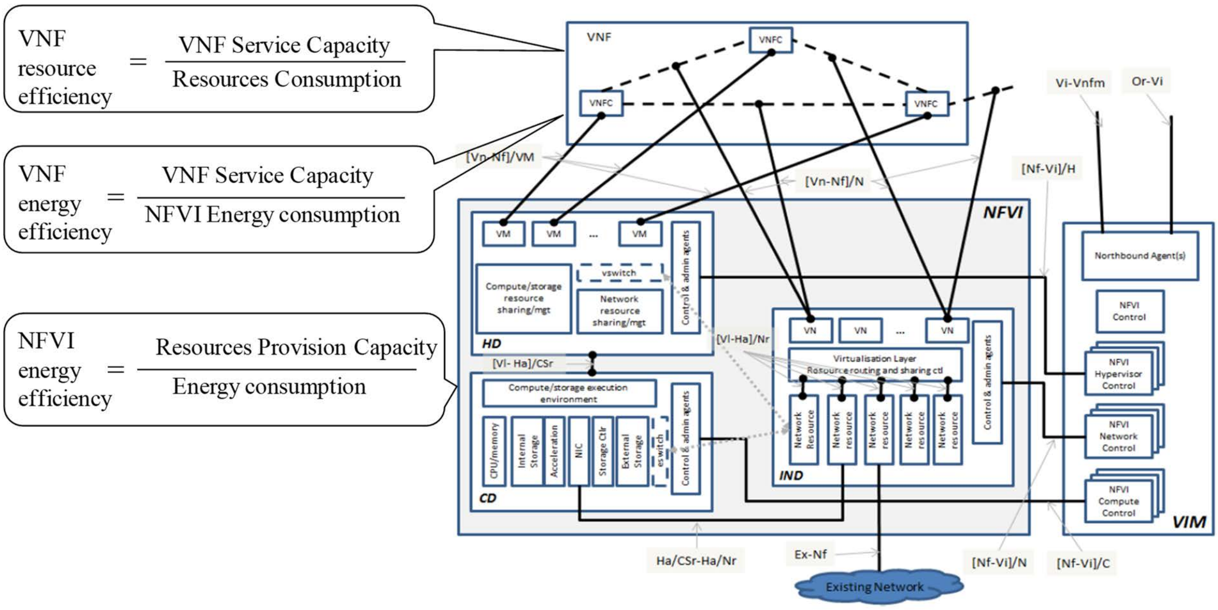

Figure 2: High level NFV architecture (from Figure 23 of ETSI GS NFV-INF 001 [i.2])

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.

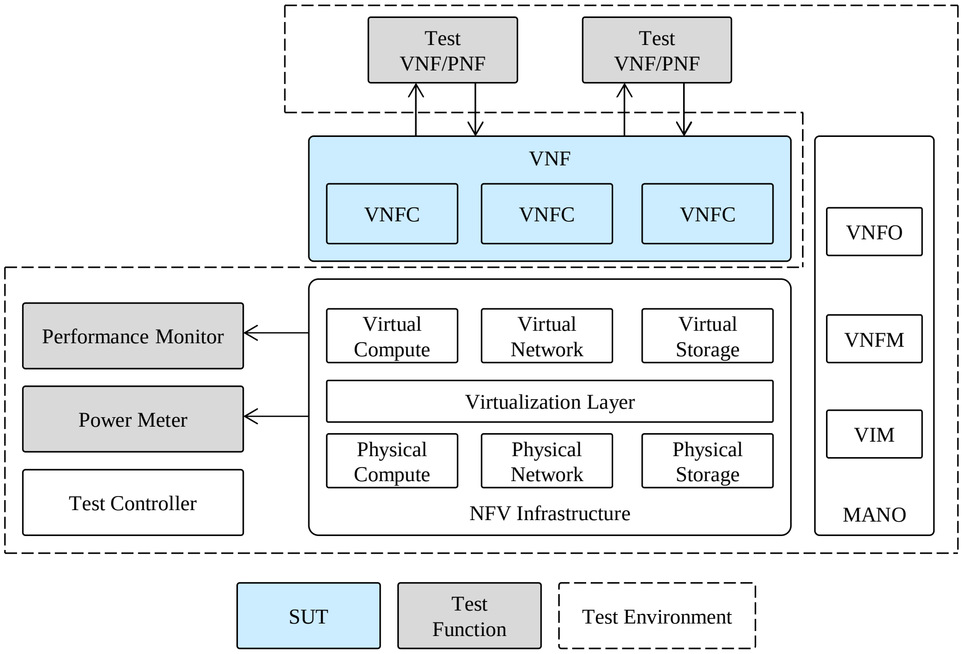

Figure 3: Functional architecture for VNF under test

- 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.

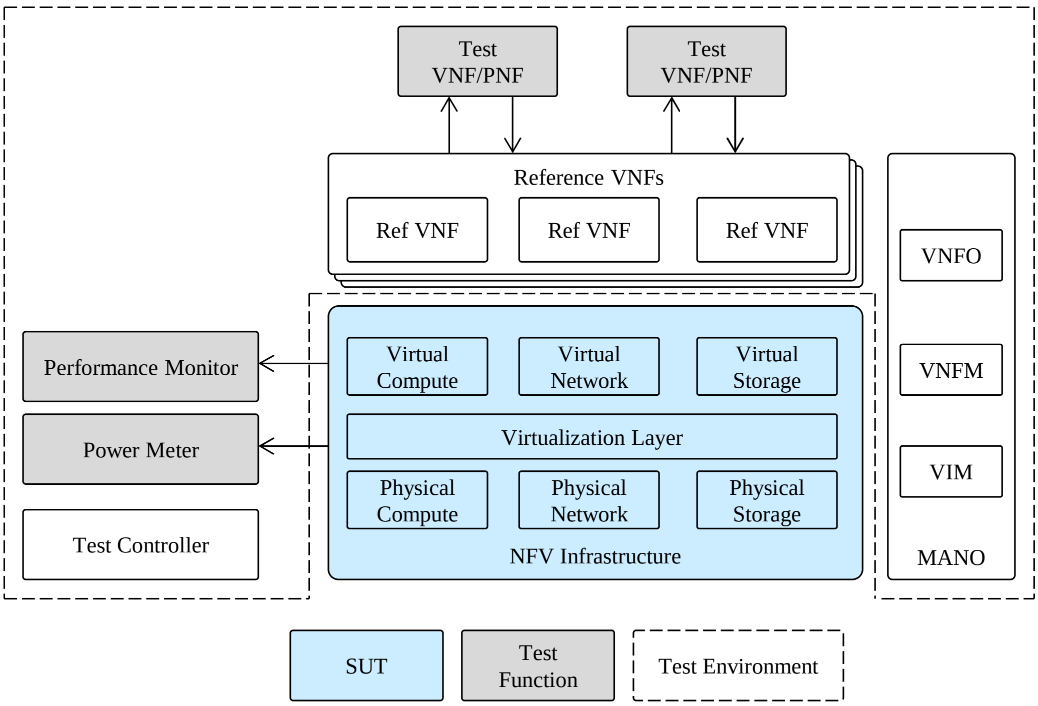

Figure 4: Functional architecture for NFVI under test

4.2 Metrics of VNFs

4.2.0 General

VNF is software application. Its energy consumption cannot be directly and hardware-independently measured with respect to the NFVI impact. Hardware has an idle power consumption regardless of the system activity and a dynamic power consumption caused by the software interactions with hardware components. Software can trigger hardware resources (e.g. CPU, memory, storage, network resources) to switch among different power states to influence the hardware resource utilization and energy consumption.

There are two methods for energy consumption measurement of VNF indirectly:

1) To measure energy consumption of NFVI which only deploy VNF under test.

2) To measure resource consumption of VNF under test which solely running on NFVI platform.

A VNF is scaled to provide different levels of service capacity by scaling one or more of its VNFCs depending on the work load. Most VNFs designed with fixed resource overhead for common management and control functions and elastic resources for service capacity. Increment of service capacity with VNF scaling is supported by resource increments. Different levels of VNF service capacity should be included into energy efficiency and resource efficiency metrics of VNF. The number of levels could be decided based on typical capacity of specific type of VNFs. Generally three levels of minimum, maximum and medium should be selected.

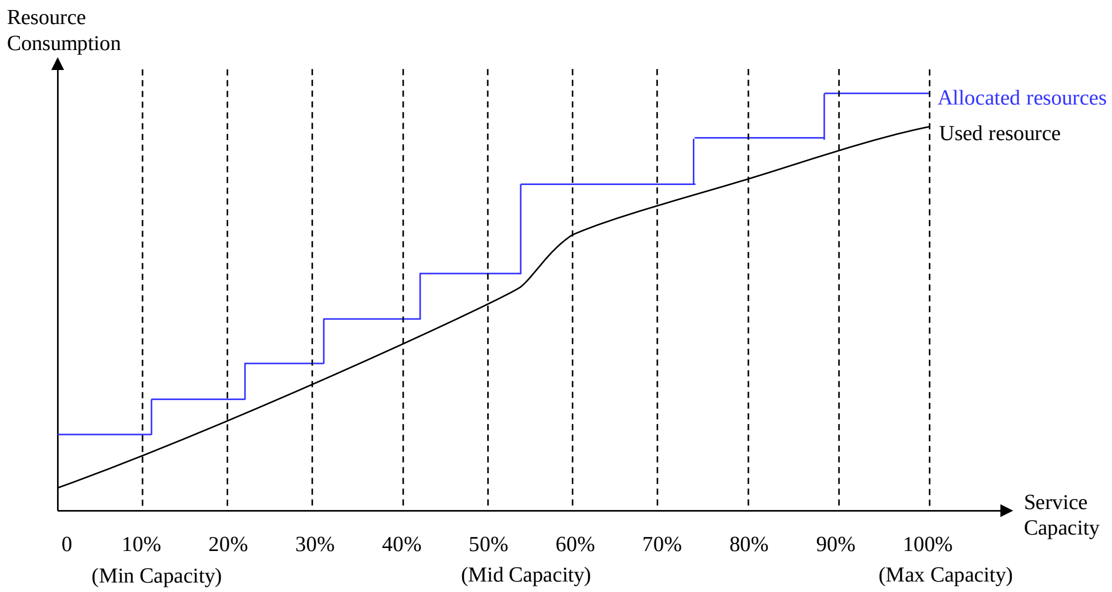

Figure 5: VNF scaling of service capacity and resource consumption

4.2.1 VNF energy efficiency

The VNF's Energy Efficiency Ratio (EER) metric is defined as:

$$VNF\_EER_i = \frac{\text{Useful output}}{\text{Power consumption}} = \frac{U_i}{P_i}$$

$$VNF\_EER = \sum_{i=1}^{N} (VNF\_EER_i \times w_i)$$

U_i is the useful output of VNF under service capacity level *i*. Depending on the different type of VNFs, it may be throughput (e.g. bps, pps) for data plane VNF, or capacity (e.g. subscribers, sessions) for control plan VNF.

P_i is power consumption of NFVI platform introduced by VNF deployed under service capacity level *i*.

VNF_EER_i is energy efficiency of VNF under service capacity level *i*.

VNF_EER is weighted energy efficiency of all service capacity levels.

N is the total number of service capacity levels, and w_i is the weight coefficient of level *i*.

4.2.2 VNF resource efficiency

The VNF's Resource Efficiency Ratio (RER) metric is defined as:

$$VNF\_RER_i = \frac{\text{Useful output}}{\text{Resource consumption}} = \frac{U_i}{\{R_{cpu}, R_{memory}, R_{storage}, R_{network}\}_i}$$

$$VNF\_RER = \sum_{i=1}^{N} (VNF\_RER_i \times w_i)$$

U_i is the useful output of VNF under service capacity level *i*. Depending on the different type of VNFs, it may be throughput (e.g. bps, pps) for data plane VNF, or capacity (e.g. subscribers, sessions) for control plan VNF.

VNF_RER_i is resource efficiency of VNF under service capacity level *i*.

VNF_RER is weighted resource efficiency of all service capacity levels.

N is the total number of service capacity levels, and w_i is the weight coefficient of level *i*.

Resource consumption of VMs allocated to VNF SUT under service capacity level *i* as following:

R_{cpu} is CPU resource consumption, defined as used CPU capacity of the underlying VMs related to VNF.

R_{memory} is memory resource consumption, defined as total memory used of the underlying VMs related to VNF.

$R_{storage}$ is storage resource consumption, defined as total storage used of the underlying VMs related to VNF.

$R_{network}$ is network resource consumption, defined as the sum of average network throughput of bytes transmitted and received per second.

4.3 Metrics of NFVI

NFV Infrastructure (NFVI) provide hardware resources and Virtualised resources through Virtualisation layer to support the deployment and execution of VNFs. The useful output of NFVI is resource provision capability. But the NFVI characteristics of resource provision depend on the VNF application. Energy efficiency of NFVI can be expressed as service capacity of reference VNFs running on it with amount of energy consumption.

The reference VNFs are either target VNFs to be deployed on NFVI SUT, or general typical VNFs which can be categorized according to workload operations specified in ETSI GS NFV-PER 001 [i.6] as data plane, control plane, signal processing and storage workloads. The well-acknowledged open source telco-grade VNFs can be used as test functions in the latter case if they are developed by industry community in the future. Some of the reference VNFs have been proposed as part of OPNFV Yardstick project [i.8], in which Network Service Benchmarking (NSB) extends the yardstick framework to provide several sample VNFs (e.g. vPE, vCG-NAT, vFirewall).

The NFVI's energy efficiency rating (EER) metric is defined as:

$$NFVI\_EER_{VNF_j} = \frac{\text{Useful output of VNF}_j}{\text{Power consumption}_j} = \sum_{i=1}^{N} \left(\frac{U_{i,j}}{P_{i,j}} \times w_i \right)$$

$$NFVI\_EER = \{NFVI\_EER_{VNF_j}\}, j \in \{1,2,\ldots\}$$

$U_{i,j}$ is the useful output of VNF_j under service capacity level *i*.

$P_{i,j}$ is power consumption of NFVI platform with VNF_j deployed under service capacity level *i*.

$NFVI\_EER_{VNF_j}$ is energy efficiency of NFVI platform with VNF_j deployed.

$NFVI\_EER$ is the aggregation of all energy efficiency of NFVI platform with different VNFs deployed.

5 Measurement methods

5.1 Measurement conditions

1) Configuration

All equipment part of the SUT shall be generally available and orderable by customers. SUT should be tested under normal test conditions according to the information accompanying the equipment.

It is important for energy efficiency test of SUT to isolate the SUT as a black-box in order to ensure that the test results are not being influenced by other devices. However, it is very challenging to test a specific VNF without having the NFVI present or test the NFVI without VNF present due to the nature of the NFV architecture. The recommended way to approximate SUT isolation in an NFV environment is to strictly control the configuration parameters of the NFV architecture elements that do not comprise the SUT (i.e. the test environment) while varying configuration parameters for the SUT.

Test functions which usually are hardware-based tools now can be virtualised as well. A mechanism should be used in order to make test functions not compete for the resources with the SUT, otherwise the test results will not be reliable.

Used versions of SW, firmware, Virtualisation SW, HW, data plane acceleration mechanisms, power saving features and other test configurations shall represent the normal intended usage and be listed in the measurement report.

2) Environment conditions

The power measurements shall be performed in a laboratory environment under the following conditions.

Table 1

Condition	Minimum	Maximum
Barometric pressure	86 kPa (860 mbar)	106 kPa (1 050 mbar)
Relative Humidity	25 %	75 %
Vibration	Negligible	
Temperature	+25 °C	
Temperature accuracy	±2 °C	

3) Power supply

Table 2

Type	Standard	Nominal value	Operating value for testing
DC	ETSI EN 300 132-2 [i.9]	-48 V	-54,5 V ± 1,5 V
AC	CENELEC EN 50160 [i.10]	230 V	±5 %

4) Measurement instruments

All measurement instruments used should be calibrated by counterpart national metrology institute and within calibration due date:

- Resolution: ≤ 10 mA; ≤ 100 mV; ≤ 100 mW
- DC current: ±1 %
- DC voltage: ±1 %
- AC power: ±1 %:
  - An available current crest factor of 5 or more.
  - The test instrument shall have a bandwidth of at least 1 kHz.

NOTE: Additional information on accuracy can be found in IEC 62018 [i.7].

5.2 Measurement procedure

The general measurement procedure consists of several steps as follows:

1) Define VNF service capacity levels to be tested based on specific type of VNF. Generally three levels of minimum, maximum and medium should be selected. The maximum capacity is decided according to the supplier's specification.

2) Setup NFVI configuration and VNF deployment for a capacity level to be tested. Number of virtual machines and physical machines, core and memory allocation, network configuration, deployment rules such as affinity and anti-affinity, acceleration techniques, etc. The test controller of the test environment configure and deploy VNF on the NFVI.

3) Workload generation based on pre-defined traffic profile of specific type of VNF. Workload could be provided by test VNFs/PNFs or external traffic generator. The test controller trigger the execution of test and control the workloads dynamically.

4) Check pass/fail of VNF performance test. The QoS requirements of VNF application need to be analysed to specify SLA values used for comparison against measured values, such as latency, packet loss rate and loss probability and so on. The set of configuration parameters could be changed to achieve the SLA targets.

5) Power consumption, resource consumption and useful output measurement. Measurement results shall be captured earliest when the equipment including the selected load level is in stable operating conditions.

6) Test result collection and metrics calculation. To iterate test for all load levels defined in first step. During and after the test execution, the test controller collects the metrics measurement results from the test functions. The energy efficiency or resource efficiency metrics can be aggregated and calculated according to metrics definition in clause 4.

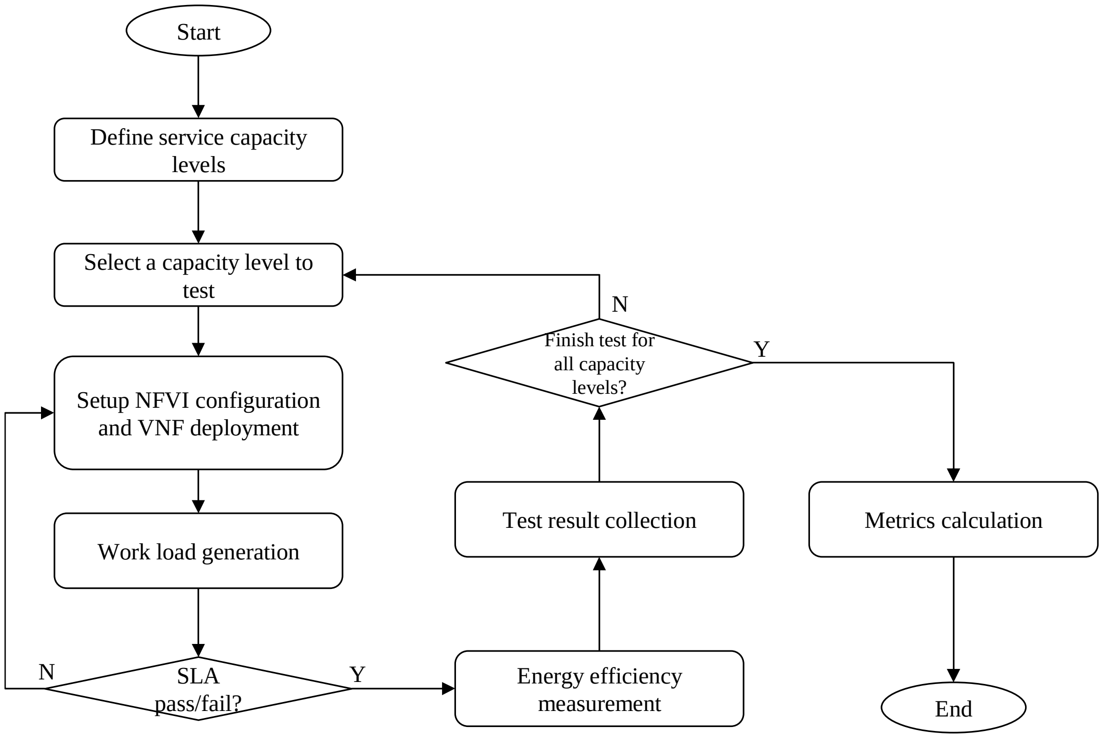

Figure 6: General measurement procedure

5.3 Measurement method for power consumption of VNF

The power consumption of VNF SUT is defined as the increased power consumption caused by the VNF software interactions with NFV infrastructure. The idle power consumption of NFVI without VNF deployment should be tested before performing the measurement procedure in clause 5.2. After finish test for each load level, the power consumption of VNF SUT is calculated as the power consumption of NFVI with idle power consumption subtracted.

$$P_i = P_{i\_load} - P_{i\_idle}$$

P_i is power consumption of NFVI platform introduced by VNF deployed under service capacity level *i*.

P_{i_load} is power consumption of NFVI platform with VNF deployed under service capacity level *i*.

P_{i_idle} is power consumption of NFVI platform without VNF deployed.

5.4 Measurement method for resource consumption of VNF

Virtual resource consumed by VNF is the summary of resources of all VMs and VNs allocated to VNF. As VNF SUT is only VNF running on NFVI, the virtual resource consumption of VNF actually is the increment of physical resource consumption of NFVI after VNF deployment. So idle resource consumption of NFVI without VNF deployment should be tested before the measurement procedure in clause 5.2. After finishing the test for each load level, the resource consumption of VNF SUT is calculated as resource consumption of NFVI with idle resource consumption subtracted.

$$R_i = R_{i\_load} - R_{i\_idle}$$

R_i is resource consumption of NFVI platform introduced by VNF deployed under service capacity level *i*. The resources include CPU, memory, storage and network.

$$R_i = \{R_{cpu}, R_{memory}, R_{storage}, R_{network}\}$$

R_{i_load} is resource consumption of NFVI platform with VNF deployed under service capacity level *i*.

R_{i_idle} is resource consumption of NFVI platform without VNF deployed.

Resource consumption can be measured through performance monitoring, which could be external monitoring tools or monitoring functions provided by NFV infrastructure. R_{cpu} is calculated as average CPU utilization (see clause 6.6 in ETSI NFV-TST 008 [i.11]) multiplied by clock speed in megahertz (MHz) of CPU and number of cores.

R_{memory} is the total memory used by VNF, which is derived from other memory metrics (see clause 8.6 in ETSI GS NFV-TST 008 [i.11]).

$R_{storage}$ is the amount of disk occupied by VNF on the host machine (see Annex A in ETSI NFV-IFA 027 [i.12]). As the methods of measurement for storage systems vary widely and depend on the implementation, storage metrics are not defined in ETSI NFV-TST 008 [i.11].

$R_{network}$ is the average network throughput of bytes transmitted and received per second by VNF external connection point (see clause 7.2 in ETSI NFV-IFA 027 [i.12]).

5.5 Measurement method for energy efficiency of NFVI

The reference VNFs are either target VNFs to be deployed on NFVI SUT or open source generic VNFs. For each reference VNF, the measurement process should follow the procedure defined in clauses 5.2 and 5.3.

The energy efficiency of NFVI is the aggregation of all energy efficiency metrics of NFVI with different reference VNFs deployed.

6 Measurement Report

The measurement results shall be reported accurately, clearly, unambiguously and objectively, and in accordance with any specific instructions in the required methods.

The measurement report shall include the following minimum information:

- All equipment software versions, hardware board revisions and device configurations used during the test. All commands applied to equipment for the purposes of static reconfiguration or run-time queries performed during the test should be disclosed.
- Traffic generator/measurement tool, actual voltage in power feeds and ambient (environmental) conditions at test site.
- The test set-up should be fully described, including topology, the choice of service capacity levels and test actions within a range of possible choices.
- Power and resource consumption measurement results, the calculated Energy Efficiency Ratio (EER) or Resource Efficiency Ratio (RER).

Annex A (informative): Example of VNF measurement

SUT: IMS Telephony Application Server (TAS)

KPI: subscribers/W

Table A.1: Service capacity levels

Capacity	Min	Mid	Max
Subscribers	0,1 M	1 M	2 M
Weight coefficient	0,2	0,5	0,3

Table A.2: Traffic model

Types	Parameters	Unit	Value
Subscribers	Proportion of 2G/3G/4G subscribers	%	20 %, 20 %, 60 %
	Proportion of VOLTE/ double standby /CSFB voice service subscribers	%	30 %, 50 %, 20 %
	Proportion of VOBB subscribers (2G+3G)	%	1 %
	Proportion of VOLTE subscribers roaming to 2G/3G	%	30 %
Registration and mobility management	Number of initial registration per user during busy hours	times	0,75
	Number of re-registration per user during busy hours	times	2
	Number of logout per user during busy hours	times	0,5
	Number of xSRVCC switch per user during busy hours	times	0,3
	T-ADS number per user during busy hours	times	0,75
	STN-SR update number per user during busy hours	times	0,75
Call	Voice call attempts per user during busy hours	times	1,5
	The average length of a voice call	second	60
	Proportion of video calls (VoLTE-VoLTE)	%	24 %
	Video call attempts per user during busy hours	times	1,5
	The average length of a video call	second	90
Intelligent services	Proportion of intelligent service subscribers	%	50 %
	Proportion of intelligent service play voice	%	10 %
Ring Back Tone (RBT)	Proportion of RBT user	%	90 %
	RBT play time	second	20
Short Message Service (SMS)	Proportion of SMS user	%	100 %
	Number of sending SMS per user during busy hours	times	3
	Number of receiving SMS per user during busy hours	times	1,5
Proportion of supplementary service subscribers	Proportion of call forwarding	%	0,5 %
	Proportion of call waiting		0,5 %
	Proportion of caller ID	%	0,5 %
	Proportion of call keeping	%	0,2 %
Play ringback tone	Proportion of play ringback tone	%	50 %
	The average length of play ringback tone	second	15
	Traffic of play ringback tone	Erl	0,003125

Table A.3: Hardware configuration

	Virtual resource		Physical resource	
	VM_Type_1	VM_Type_2	Server	Switch
Specification / Capacity	vCPU:2 memory: 8G disk: 40G	vCPU:4 memory: 16G disk: 60G	Model: xx Rack server CPU:2*processor 2,3GHz Disk: 4*SAS 300G Memory:192G	Model: xx Switch 24*10G SFP
Min	3	4	1	1
Mid	3	13	2	1
Max	3	18	2	1

Table A.4: Software configuration

Software	Description
Hypervisor	xxx V100R006
MANO	xxx V200R010
VNF	Xxx TAS V100R002

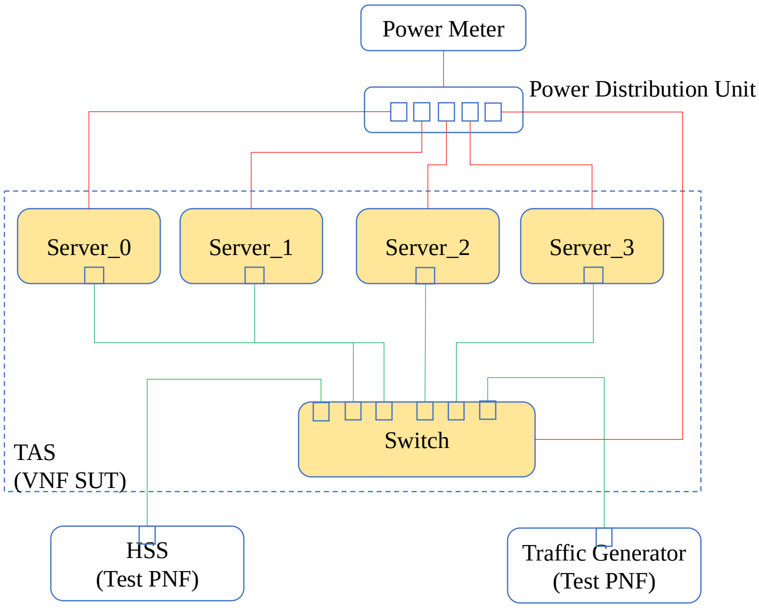

Figure A.1: Test Setup

Table A.5: Test devices

Test device	Number	Description
Traffic generator	1	type of traffic generator
Power meter	1	type of power meter
Home Subscriber Server (HSS)	1	xx HSS

Test Results:

Table A.6: Energy Efficiency (EE)

Load levels	Min	Mid	Max
U_i (subscribers)	0,1 M	1 M	2 M
P_{i_idle} (W)	200	400	400
P_{i_load} (W)	220	510	580
P_i (W)	20	110	180
VNF_EER_i (Subscribers/W)	5 000	9 091	11 111
w_i	0,2	0,5	0,3
VNF_EER (Subscribers/W)	8 878,8		

Table A.7: Resource efficiency

Load levels	Min	Mid	Max
U_i (subscribers)	0,1 M	1 M	2 M
R_{i_idle} (MHz)	138	322	322
R_{i_load} (MHz)	276	1 380	2 208
R_i (MHz)	138	1 058	1 886
VNF_RER_i (Subscribers/MHz)	725	945	1 060
w_i	0,2	0,5	0,3
VNF_RER (Subscribers/MHz)	935,5		

NOTE: Only consider CPU resource consumption for TAS, which is calculated based on CPU maximum frequency (2,3 GHz) and CPU utilization under different load levels.

History

Document history		
V1.1.0	March 2019	Membership Approval Procedure MV 20190524: 2019-03-25 to 2019-05-24
V1.1.1	June 2019	Publication