**3GPP TSG-SA5 Meeting #148-e *S5-233238rev4***

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**Source: Huawei, Ericsson, AT&T, Deutsche Telekom**

**Title: KI#1 Consideration of four types of metrics to estimate VNF Energy Consumption**

**Document for: Approval**

**Agenda Item: 6.9.1.1**

# 1 Decision/action requested

**Include the proposed changes in TR 28.913**

# 2 References

[1] 3GPP TR 28.913: "Study on new aspects of EE for 5G networks phase 2"

# 3 Rationale

This pCR proposes to introduce a new potential solution to Key Issue #1 into TR 28.913 [1].

# 4 Detailed proposal

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| **First change** |

# 4 Key Issues and potential solutions

## 4.1 Key Issue #1: Considering additional virtual resources usage to estimate VNF energy consumption

### 4.1.1 Description

In Release 17 (see [2] clause 6.7.3.1), the Energy Consumption (EC) of VNFs is obtained by summing up the estimated energy consumption of its constituent Virtualized Network Function Components (VNFC), where the estimated energy consumption of a VNFC is obtained by taking the estimated energy consumption of the virtual compute resource instance on which the VNFC runs. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vCPU mean usage of the virtual compute resource instance X, by the sum of the vCPU mean usage of all virtual compute resource instances running on the same NFVI Node as X, during the same observation period.

This key issue investigates how additional performance measurements of virtual compute resources, also provided by NFV MANO, can be considered in the estimation of the energy consumption of VNFCs, and consequently of VNFs.

### 4.1.2 Potential solutions

#### 4.1.2.1 Potential solution #1: Estimated virtual compute resource instance energy consumption based on mean vCPU and vDisk usage

##### 4.1.2.1.1 Introduction

In this potential solution #1, it is proposed to consider the mean virtual disk usage of the virtualised compute resource instance, in addition to the mean vCPU usage, to estimate the energy consumed by the virtual compute resource instance. Thus, the definition of the estimated energy consumption of a virtual compute resource instance combines both virtual CPU mean usage and virtual disk mean usage.

##### 4.1.2.1.2 Description

In this potential solution #1, the energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource runs. This proportion is obtained by multiplying relative mean virtual CPU usage and virtual disk usage of the virtual compute resource instance X. The relative mean virtual CPU usage of the virtual compute resource instance X is obtained by dividing the vCPU mean usage of the virtual compute resource instance X, by the sum of the vCPU mean usage of all virtual compute resource instances running on the same NFVI Node as X, The relative mean virtual disk usage of the virtual compute resource instance X is obtained by dividing the vDisk mean usage of the virtual compute resource instance X, by the sum of the vDisk mean usage of all virtual compute resource instances running on the same NFVI Node as X. This is defined by the equation below:



, where:

- VCpuUsageMean is the mean virtual CPU usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

-  is the sum of the mean virtual CPU usage of all virtual compute resource instances running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.2 of [3],

- VDiskUsageMean is the mean virtual disk usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

- is the sum of the mean virtual disk usage of all virtual compute resource instances running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.6 of [3],

- ECNFVINode,measured is the measured energy consumption of the NFVI node on which the virtual compute resource instance runs, during the same observation period, as per ETSI ES 202 336-12 [4],

#### 4.1.2.2 Potential solution #2: Estimated virtual compute resource instance energy consumption based on mean vDisk usage

##### 4.1.2.2.1 Introduction

In this potential solution #2, it is proposed to consider the mean virtual disk usage of the virtualised compute resource instance only.

##### 4.1.2.2.2 Description

In this potential solution, the energy consumption of a virtual compute resource X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource runs, this proportion being obtained by dividing the vDisk mean usage of the virtual compute resource X, by the sum of the vDisk mean usage of all virtual compute resources running on the same NFVI Node as X, as defined by the equation below:



where:

- VDiskUsageMean is the mean vDisk usage of the virtual compute resource during the observation period, provided by NFV MANO,

-  is the sum of the vDisk mean usage of all virtual compute resources running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.6 of [3],

- ECNFVINode,measured is the measured energy consumption of the NFVI node on which the virtual compute resource runs, during the same observation period, as per ETSI ES 202 336-12 [4].

#### 4.1.2.3 Potential solution #3: Consideration of four types of metrics provided by NFV MANO

##### 4.1.2.3.1 Introduction

In this potential solution #3, it is proposed to consider four types of metrics related to virtualized compute resources which can be provided by ETSI NFV MANO:

# Mean virtual CPU usage of the virtualized compute resource (see clause 7.1.2 of [3]);

# Mean memory usage of the virtualized compute resource (see clause 7.1.4 of [3]);

# Mean disk usage of the virtualized compute resource (see clause 7.1.6 of [3]);

# I/O traffic of the virtualized compute resource, measured by the sum of the number of incoming bytes on virtual compute (see clause 7.1.8 of [3]) and the number of outgoing bytes on virtual compute (see clause 7.1.9 of [3]).

Thus, four separate definitions of the estimated energy consumption of a virtualized compute resource are proposed, based on the four aforementioned measurements.

Which of these four KPIs is to be used for estimating the energy consumed by different virtualized compute resources is not subject to standardization and is left to operators’ decision.

##### 4.1.2.3.2 Description

In this potential solution #3, the energy consumption of a virtualized compute resource X is estimated as a proportion of the energy consumption of the NFVI node on which the virtualized compute resource runs.

This proportion is obtained by considering either:

- the relative mean virtual CPU usage, or

- the relative mean virtual memory usage, or

- the relative mean virtual disk usage, or

- the relative incoming/outgoing traffic volume of the virtual compute resource instance X.

The relative mean virtual CPU usage of a virtual compute resource instance X is obtained by dividing the vCPU mean usage of the virtual compute resource instance X, by the sum of the vCPU mean usage of all virtual compute resource instances running on the same NFVI node as X.

The relative mean memory usage of a virtual compute resource instance X is obtained by dividing the mean memory usage of the virtual compute resource instance X, by the sum of the mean memory usage of all virtual compute resource instances running on the same NFVI node as X.

The relative mean disk usage of a virtual compute resource instance X is obtained by dividing the mean disk usage of the virtual compute resource instance X, by the sum of the mean disk usage of all virtual compute resource instances running on the same NFVI node as X.

The relative incoming/outgoing traffic volume of a virtual compute resource instance X is obtained by dividing the incoming/outgoing traffic volume of the virtual compute resource instance X, by the sum of the incoming/outgoing traffic volume of all virtual compute resource instances running on the same NFVI node as X.

###### 4.1.2.2.2.1 Estimated virtual compute resource instance energy consumption based on mean vCPU usage

See TS 28.554 [2] clause 6.7.3.1.4.

###### 4.1.2.2.2.2 Estimated virtual compute resource instance energy consumption based on mean vMemory usage

a) ECvirtualCompute,estimated,VMemoryUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vMemory mean usage of the virtual compute resource instance X, by the sum of the vMemory mean usage of all virtual compute resource instances running on the same NFVI Node as X. The unit of this KPI is J.

c)



d) ManagedFunction

e)

- VMemoryUsageMean is the mean memory usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

- is the sum of the mean memory usage of all virtual compute resource instances running on the same NFVI node during the same observation period, all separately provided by NFV MANO (see clause 7.1.4 of [3],

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10].

###### 4.1.2.2.2.3 Estimated virtual compute resource instance energy consumption based on mean vDisk usage

a) ECvirtualCompute,estimated,VDiskUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vDisk mean usage of the virtual compute resource instance X, by the sum of the vDisk mean usage of all virtual compute resource instances running on the same NFVI Node as X. The unit of this KPI is J.

c)



d) ManagedFunction

e)

- VDiskUsageMean is the mean disk usage of the virtual compute resource instance during the observation period, provided by NFV MANO,

- is the sum of the mean disk usage of all virtual compute resource instances running on the same NFVI Node during the same observation period, all separately provided by NFV MANO (see clause 7.1.6 of [3],

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10].

###### 4.1.2.2.2.4 Estimated virtual compute resource instance energy consumption based on I/O traffic volume

a) ECvirtualCompute,estimated,VDiskUsageMean

b) A KPI that gives an estimation of the energy consumption of a virtual compute resource instance. The energy consumption of a virtual compute resource instance X is estimated as a proportion of the energy consumption of the NFVI node on which the virtual compute resource instance X runs. This proportion is obtained by dividing the vDisk mean usage of the virtual compute resource instance X, by the sum of the vDisk mean usage of all virtual compute resource instances running on the same NFVI Node as X. The unit of this KPI is J.

c)



d) ManagedFunction

e)

- IOTrafficVolume is the sum of the incoming and outgoing traffic volumes of the virtual compute resource instance during the observation period, provided by NFV MANO.

# Incoming traffic volume is obtained by measuring the number of incoming bytes on virtual compute (VNetByteIncoming - cf. clause 7.1.8 of [3]) during the observation period.

# Outgoing traffic volume is obtained by measuring the number of outgoing bytes on virtual compute (VNetByteOutgoing - cf. clause 7.1.9 of [3]) during the observation period,



- is the sum of the incoming and outgoing traffic volumes of all virtual compute resource instances running on the same NFVI node during the same observation period, all separately provided by NFV MANO (see clause 7.1.8 and 7.1.9 of [3]),

- ECNFVINode,measured is the energy consumption of the NFVI node on which the virtual compute resource runs, measured during the same observation period, as per ETSI ES 202 336-12 [10].

### 4.1.3 Conclusion - Recommendation

The potential solution #3 for considering additional virtual resources usage to estimate virtual compute resource instance energy consumption is proposed to be introduced in the normative specification TS 28.554 [2].

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| **End of changes** |