**3GPP TSG-SA5 Meeting #145-e *S5-225222rev3***

**Online, 15 - 24th August 2022**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **28.310** | **CR** | **0021** | **rev** | **1** | **Current version:** | **17.3.0** |  |
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| *For* [***HELP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME |  | Radio Access Network | **X** | Core Network | **X** |

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| ***Title:*** | Solutions to calculate the energy consumption of PNF/VNF/VNFCs | | | | | | | | | |
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| ***Source to WG:*** | Huawei, Deutsche Telekom | | | | | | | | | |
| ***Source to TSG:*** | S5 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | TEI17 | | | | |  | ***Date:*** | | | 2022-08-04 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-17 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
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| ***Reason for change:*** | | The solutions for calculating the energy consumption of PNFs, VNFs, VNFCs is missing. | | | | | | | | |
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| ***Summary of change:*** | | Introduce the method used to calculate the energy consumption of PNFs, VNFs, VNFCs. | | | | | | | | |
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| ***Consequences if not approved:*** | | There will be no solution described for calculating the energy consumption of PNFs, VNFs, VNFCs, leaving thus room for diverse interpretations and interoperability issues. | | | | | | | | |
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| ***Clauses affected:*** | | 2, 4.1, 6.X (new) | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **x** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | | **X** |  | O&M Specifications | | | | TS 28.554 CR 0098 | | |
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| ***Other comments:*** | | This CR is to be addressed and approved together with TS 28.554 CR 0098. | | | | | | | | |
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| ***This CR's revision history:*** | | Main update is in clause 4.1 (deletion of ‘EC definition and measurement method for 5G VNFs are not in the scope of 3GPP’). | | | | | | | | |

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| **Start of Change** |

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] ETSI ES 203 228: "Environmental Engineering (EE); Assessment of mobile network energy efficiency".

[3] ETSI ES 202 336-1 V1.2.1: "Environmental Engineering (EE); Monitoring and Control Interface for Infrastructure Equipment (Power, Cooling and Building Environment Systems used in Telecommunication Networks) Part 1: Generic Interface".

[4] ETSI ES 202 336-12 V1.1.1: "Environmental Engineering (EE); Monitoring and control interface for infrastructure equipment (power, cooling and building environment systems used in telecommunication networks); Part 12: ICT equipment power, energy and environmental parameters monitoring information model".

[5] 3GPP TS 28.550: "Management and orchestration; Performance assurance".

[6] 3GPP TS 28.531: "Management and orchestration; Provisioning".

[7] 3GPP TS 28.545: "Management and orchestration; Fault Supervision (FS)".

[8] 3GPP TS 32.432: "Telecommunication management; Performance measurement: File format definition".

[9] 3GPP TS 32.435: "Telecommunication management; Performance measurement; eXtensible Markup Language (XML) file format definition".

[10] 3GPP TS 32.436: "Telecommunication management; Performance measurement: Abstract Syntax Notation 1 (ASN.1) file format definition".

[11] 3GPP TS 28.541: "Management and orchestration; 5G Network Resource Model (NRM); Stage 2 and stage 3".

[12] 3GPP TS 38.401: "NG-RAN; Architecture description".

[13] 3GPP TS 38.300: "NR; Overall description; Stage-2".

[14] 3GPP TR 37.816: "Study on RAN-centric data collection and utilization for LTE and NR".

[15] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[16] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[17] 3GPP TS 32.551: "Energy Saving Managament (ESM); Concepts and requirements".

[18] 3GPP TS 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[a] ETSI GR NFV-IFA 015 V3.4.1 (2020-06): "Network Functions Virtualisation (NFV) Release 3; Management and Orchestration; Report on NFV Information Model".

[b] ETSI GR NFV 003 V1.6.1 (2021-03): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

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| **Next Change** |

## 4.1 EE KPIs Overview

Telecommunication networks energy efficiency KPIs are defined by various SDOs / organizations and are of various natures. They can be applied to either:

- whole networks (i.e. end-to-end), or to

- sub-networks (e.g. the radio access network), or to

- single network elements, or to

- telecommunication sites, which contain network elements and site equipment.

NOTE 1: Data centers used by network operators are considered in the present document as telecommunication sites.

Moreover, EE KPIs can also be categorized according to the operator's network life cycle phase they may apply to, e.g.:

- during the Buy phase, mobile network operators may be willing to compare network elements from various vendors from an EE standpoint. Some EE KPIs and measurement methods have been specified for this purpose.

- during the Design / Build phase, mobile network operators are always faced to several design options, and may be willing to compare them from an EE standpoint. This may happen for the whole network, sub-networks and for telecom sites. For telecom sites, EE KPIs have been specified.

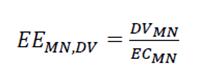
- during the Run phase, mobile network operators need to assess the energy efficiency of the live network, as a whole (i.e. end-to-end), or for sub-networks, or for single network elements or telecom sites. Some EE KPIs and measurement methods have also been specified for this purpose.

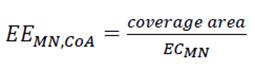
NOTE 2: EE KPIs in the present document are only applicable for the Run phase.

Generally, EE KPIs for network elements are expressed in terms of Data Volume divided by the Energy Consumption of the considered network elements. In the case of radio access networks, an EE KPI variant may also be used, expressed by the Coverage Area divided by the Energy Consumption of the considered network elements.

The calculation of the energy efficiency of 5G networks relies on the following principles:

- it is based on the two high-level EE KPIs defined in ETSI ES 203 228 [2]:

- , and

- 

- EEMN,DV may apply to the whole 5G network whereas EEMN,CoA may apply only to NG-RAN;

- EEMN,DV requires the collection of both Data Volumes (DV) and Energy Consumption (EC) of 5G Network Functions (NF);

- In NG-RAN, DV is measured per cell;

- In 5GC, DV is measured per NF;

- EC definition and measurement method for 5G PNFs rely on ETSI ES 202 336-1 [3] and ETSI ES 202 336-12 [4];

- EC is measured by PEE parameters (cf. ETSI ES 202 336-12 [4] – Annexes A and B);

- PEE measurements requirements for all deployment scenario in NG-RAN: The 3GPP management system responsible for the management of the gNB (single or multiple vendor gNB) shall be able to collect PEE measurements data from all PNFs in the gNB, in the same way as the other PM measurements;

- When gNBCU/gNBCU-CP/gNBCU-UP energy consumption is assumed to be very small compared to gNBDU and given that, in some cases, the gNBCU/gNBCU-CP/gNBCU-UP may be virtualized, the present document only considers the energy consumed in gNBDU(s) (in case of split scenarios) and in non-split gNBs (see clause 4.2.1 of 3GPP TS 28.541 [11] and clause 6.1.1 of 3GPP TS 38.401 [12]). There might be a need for some correction in KPI between the different deployment scenarios.

NOTE 3: The vendor(s) of 2-split (gNBDU/gNBCU) or 3-split gNB/en-gNB components (gNBDU/gNBCU-CP/gNBCU-UP) may be same or different depending on the implementations.

- In the present document, it is assumed that NG-RAN is only composed of base stations with built-in sensors (cf. ETSI ES 202 336-12 [4] – clause 4.4.1).

Besides the parameters required to calculate the energy efficiency, e.g. DV and EC, other parameters may be used to interpret variations in energy efficiency KPI values from different networks. These parameters can be classified into demography, topography and climate classes (cf. ETSI ES 203 228 [2] – section 4.3), which describe the network characteristics with regard to population density, geographical conditions and climate zones. For each class of parameters, there can be subclasses, e.g. demography can be further classified into dense urban, urban, sub-urban, rural or unpopulated scenarios. For each class / subclass, the energy efficiency KPI values may be interpreted differently.

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| **Next Change** |

## 6.X Solutions for energy consumption

### 6.X.1 Solution for energy consumption of PNFs

TS 28.552 [15] clause 5.1.1.19 defines measurements for the Energy Consumption (EC) of Physical Network Functions (PNF), associated to corresponding ManagedElement IOC instances.

The method for collecting these measurements is described in ETSI ES 202 336-12 [4].

### 6.X.2 Solution for energy consumption of VNF/VNFCs

#### 6.X.2.1 Introduction

In case of Network Functions (NF) composed of Virtualized Network Functions (VNF) running on a Network Function Virtualization Infrastructure (NFVI), it is expected to be able to measure the energy consumption of each VNF separately. However, in a NFVI, the finest grain at which Energy Consumption can be measured is the NFVI Node, making it impossible to measure the energy consumed by each and every VNF separately given that a) a VNF can run on more than one NFVI node and b) a NFVI node can support more than one VNF. Therefore, this clause describes a solution for estimating the energy consumption of VNFs.

ETSI GR NFV-IFA 015 [a] states that:

- a VNF is composed of 1-to-many VNF Component(s) (VNFC) – see diagram below.

- a VNFC runs over a single VirtualisationContainer – see diagram below.

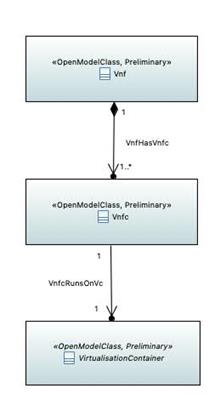


Figure X.2.1-1: VNF-VNFC-Virtualisation Container relationship

where a Virtualisation Container is defined in ETSI GR NFV 003 [b] as follows:

"

*partition of a compute node that provides an isolated virtualised computation environment.*

*NOTE: Examples of virtualisation container includes virtual machine and OS container.*

".

Hence, a Virtualisation Container runs on a single NFVI Compute Node. A NFVI Compute Node may support 1-to-many Virtualisation Container(s).

To estimate the Energy Consumption of VNF / VNFCs, it is assumed that:

- Pre-condition #1: there exists a Management Function (MF) in charge of estimating the energy consumption of the VNFs.

- Pre-condition #2: this MF knows on which NFVI node(s), the VNF/VNFC instances run;

- Pre-condition #3: NFVI nodes are equipped with embedded or external sensors (see ETSI ES 202 336-12).

#### 6.X.2.2 Solution for VM-based VNF/VNFCs

##### 6.X.2.2.1 Solution based on vCPU usage of virtual compute resources

The procedure for estimating the energy consumption of VNF/VNFCs based on the vCPU usage of underlying virtual compute resources is as follows:

1. The MF in charge of estimating the energy consumption of VNFs collects Power, Energy and Environmental (PEE) measurements from NFVI nodes (see clause 6.X.1), during a given period of time. The procedure described here is independent from whether the NFVI nodes are equipped with embedded sensors or external sensors;

2. The MF subscribes to PM notifications towards the VNFM, so as to receive notifications about the vCPU mean usage of selected VNF/VNFC instances (see ETSI GS NFV IFA 008 [14] clause 7.4.4) for a given period of time (same observation period as in 1);

3. The MF requests the VNFM to create a PM job to collect the vCPU usage of selected VNF/VNFC instances (see ETSI GS NFV IFA 008 [14] clause 7.4.2);

4. The VNFM subscribes to PM notifications towards the VIM, so as to receive notifications about the vCPU usage of the virtual compute instances on which each VNF/VNFC instance runs (see ETSI GS NFV IFA 006 [20] clause 7.7.5);

5. The VNFM requests the VIM to create a PM job to collect the vCPU usage of the virtual compute instances on which each VNF/VNFC instance runs and whose IDs are provided as input parameters of the CreatePMJob request (see ETSI GS NFV IFA 006 [20] clause 7.7.2);

6. The VIM gets, at pre-defined intervals, the process utilization compute metric values from all CPU Cores of the NFVI (see ETSI NFV TST 008 [14] – clause 6.6). Whether the VIM gets this data in pull mode or in push mode is out of scope of the present document;

7. The VIM aggregates them per virtual compute resource and calculates their arithmetic mean per virtual compute resource; this per virtual compute resource arithmetic mean of process utilization compute metric values is called VCpuUsageMean (see ETSI GS NFV IFA 027 clause 7.1.2);

8. The VIM notifies the VNFM about VCpuUsageMean measurement(s) for the virtual compute instance(s) (see ETSI GS NFV IFA 006 [20] clause 7.7.6);

9. The VNFM maps the received VCpuUsageMean measurement(s) from virtual compute instances to the VNF/VNFC instance(s);

10. The VNFM generates the measurement for the subject VNF/VNFC instances by assigning the value of the multiple VCpuUsageMean measurements received (see ETSI GS NFV IFA 027 [18] clause 7.2.2);

11. The VNFM notifies the Management Function in charge of estimating the 5GC NF EC, about the average VCpuUsageMean of each virtual compute instance used by the VNF/VNFC instance(s) which constitute the NF (see ETSI GS NFV IFA 008 [14] clause 7.4.5);

12. NF energy consumption can be now estimated as follows:

- The energy consumed by the NF is the sum of the energy consumed by all its constituent VNF/VNFC instances.

- For each VNF/VNFC instance, its estimated energy consumption is a proportion of the NFVI node energy consumption (see step 1 above) on which it runs.

- This proportion is equal to the vCPU mean usage of the VNF/VNFC instance relatively to the sum of the vCPU mean usage of all VNF/VNFC instances running on the same NFVI node.

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| **End of Change** |