**3GPP TSG-SA5 Meeting #162 *S5-253927***

Goteborg, Sweden, 25 - 29 August 2025

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** | **1** | **Current version:** |  |  |
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| *For* [***HE******LP***](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:*** | Rel-19 CR TS 28.310 Updates to energy consumption VNF | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | NTT DOCOMO, Rakuten Mobile, Huawei | | | | | | | | | |
| ***Source to TSG:*** | SA5 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | Energy\_OAM\_Ph3 | | | | |  | ***Date:*** | | | 2025-08-28 |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | | Rel-19 |
|  | *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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
|  |  | | | | | | | | | |
| ***Reason for change:*** | | TR 28.880 has studied on energy efficiency and energy savings aspects of 5G networks and services. As part of the use case #2 documented in clause 5.2 of TR 28.880, solutions for alternative options to obtain energy consumption of VNF/VNFC have been documented (see clause 6.2 of TR 28.880), whereby it is recommended to document relevant solutions in the TS 28.310. In conclusion, alternative options to collect and measure KPIs related to energy consumption of VNF/VNFC based on OS containers as well as collecting energy consumption already associated to VNF/VNFC need to be specified. | | | | | | | | |
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| ***Summary of change:*** | | Change #1: update existing references and add new references concerning the support for the new alternative options.  Change #2: make clarification that estimation solution in clause 6.3.2.2 is “based on resource usage”.  Change #3: add new solution for energy consumption of VNF/VNFCs based on collecting their energy consumption. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Support for energy consumption in other common forms of deployment of 3GPP NF like based on OS containers will not be possible, as well as less accurate forms of estimating the energy consumption would remain in 3GPP management system related specifications. | | | | | | | | |
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| ***Clauses affected:*** | | 2, 6.3.2, 6.3.2.2, 6.3.2.A (new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **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 0242 | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | Rev1 in S5-253927 (revision of S5-253618) | | | | | | | | |

***Start of first 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] Void.

[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] Void.

[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 Management (ESM); Concepts and requirements".

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

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

[20] ETSI GR NFV 003 V1.9.1 (2024-12): "Network Functions Virtualisation (NFV); Terminology for Main Concepts in NFV".

[21] 3GPP TS 28.530: " Management and orchestration; Concepts, use cases and requirements".

[22] 3GPP TS 28.312: "Management and orchestration; Intent driven management services for mobile networks".

[23] ETSI ES 202 706-1 V1.7.1 (2022-08): "Environmental Engineering (EE); Metrics and measurement method for energy efficiency of wireless access network equipment; Part 1: Power consumption - static measurement method".

[24] Void.

[25] ETSI GS NFV-IFA 027 (V5.2.1) (2024-09): "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Performance Measurements Specification".

[26] ETSI ES 202 336-12 (V1.2.1) (2019-02): "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".

[27] ETSI GS NFV-IFA 008 V5.2.1 (2024-12): "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Ve-Vnfm reference point - Interface and Information Model Specification".

[28] ETSI GS NFV-TST 008 V3.3.1 (2020-12): "Network Functions Virtualisation (NFV) Release 3; Testing; NFVI Compute and Network Metrics Specification".

[29] ETSI GS NFV-IFA 006 (V5.2.1) (2024-11): " Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Vi-Vnfm reference point – Interface and Information Model Specification".

[30] 3GPP TS 28.111: "Fault management".

[31] 3GPP TS 22.261: "Service requirements for the 5G system; Stage 1".

[32] ETSI GS OEU 020: "Operational energy Efficiency for Users (OEU); Carbon equivalent Intensity measurement; Operational infrastructures; Global KPIs; Global KPIs for ICT Sites".

[33] ISO/IEC 30134-3:2016: "Information technology -- Data centres -- Key performance indicators -- Part 3: Renewable energy factor (REF)".

[34] 3GPP TS 23.501: "System architecture for the 5G System (5GS)".

[35] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[36] 3GPP TS 28.623: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Solution Set (SS) definitions".

[37] ITU-T L.1333: "Carbon data intensity for network energy performance monitoring".

[ref-ifa010] ETSI GS NFV-IFA 010 (V5.2.1) (2024-11): "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Functional requirements specification".

[ref-ifa040] ETSI GS NFV-IFA 040 (V5.2.1) (2024-12): "Network Functions Virtualisation (NFV) Release 5; Management and Orchestration; Requirements for service interfaces and object model for OS container management and orchestration specification".

[ref-28533] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

***Start of second change***

### 6.3.2 Solution for energy consumption of VNF/VNFCs

#### 6.3.2.1 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 [19] 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.

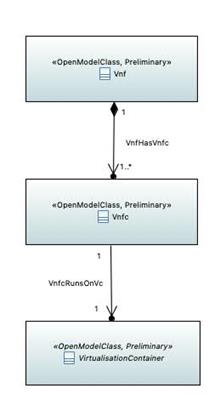


Figure 3.2.1-1: VNF-VNFC-Virtualisation Container relationship

where a Virtualisation Container is defined in ETSI GR NFV 003 [20] 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 based on resource usage, as described in the solution in clause 6.3.2.2, 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).

#### 6.3.2.2 Solution for VM-based VNF/VNFCs based on resource usage

##### 6.3.2.2.1 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 6.3.1), 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 [37] 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 [27] 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 [29] 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 [29] 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 [28] 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 [25] 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 [29] 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 [25] 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 [28] 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 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.

***Start of third change***

#### 6.3.2.A Solution for energy consumption of VNF/VNFCs based on collecting their energy consumption

##### 6.3.2.A.1 Introduction

NFV and related technologies have advanced the state of the art regarding the collection of energy consumption concerning VNF/VNFCs when NF are deployed and operated in virtualized/cloudified environments. For instance, as specified in clause 7.5 of ETSI GS NFV-IFA 010 [ref-ifa010], the VNFM has the capability to notify the availability of VNF/VNFC performance information, including performance measurements related to VNF/VNFC including power/energy consumption. Performance measurements related to energy consumption associated to VNF/VNFC are specified in clause 7.2 of ETSI GS NFV-IFA 027 [25]. VNFC instance energy consumption, total and mean, are specified in clauses 7.2.16 and 7.2.17 of ETSI GS NFV-IFA 027 [25], respectively; while VNF instance energy consumption, also total and mean, are specified in clauses 7.2.18 and 7.2.19 of ETSI GS NFV-IFA 027 [25], respectively. The producer of these performance measurements, like the VNFM, can compute the energy consumption based, in turn, on the energy consumption of the underlying virtual compute instance(s) (like VMs) or OS container workloads (like groups of one or more OS containers, or commonly referred as Pods), as supported forms of Virtualisation Container (see also clause 6.3.2.1).

The energy consumption measurements associated to VM and OS container workloads are feasible based on the use of tools available in virtualized and cloudified environments that enable collecting energy consumption and process information directly from the CPU and guest Operating System (OS) where the workloads run.

To estimate the Energy Consumption of VNF/VNFCs based on collecting their energy consumption, as described in the solution in clause 6.3.2.A.2, following pre-conditions apply:

- Pre-condition #1: there exists a Management Function (MF) in the 3GPP management system in charge of estimating the energy consumption of the VNFs (same as specified in clause 6.3.2.1); and

- Pre-condition #2: the MF knows from which VNF/VNFCs to collect the energy consumption.

Pre-condition #2 implies that the MF is requested to compute the estimated energy consumption of a selected 5GC NF and is capable to derive the set of VNF/VNFC instances that constitute the NF. This can be done by:

- As specified in clause 4.3.4 of 3GPP TS 28.622, ManagedFunction includes attribute vnfParametersList, which in turn contains vnfInstanceId. With this information, the MF can know the set of VNF instances that constitute the ManagedFunction.

- As specified in clause 5.3 of 3GPP TS 28.533, 3GPP management system is capable to consume NFV-MANO interfaces (among others) for VNF LCM, PM, FM, CM on resources supporting VNF, including over the Ve-Vnfm-em. The Ve-Vnfm-em interfarces and information model are specified in ETSI GS NFV-IFA 008 [37]. As examples, procedures in clauses 7.10 to 7.12 in 3GPP TS 28.531 [6] describe interactions involving 3GPP management system and NFV-MANO with references to the ETSI GS NFV-IFA 008 [37]. Therefore:

\* If the MF only needs to collect the energy consumption associated only to a VNF instance, the MF, with the known vnfInstanceId information, is enough to request the creation of PM notification subscriptions and PM Job with filtering/selection criteria indicating the vnfInstanceId of interest (see references to ETSI GS NFV-IFA 008 [37] in steps #1 and #2 of the solution description in clause 6.3.2.A.2).

\* If the MF needs to collect the energy consumption associated to specific VNFC instances of a VNF instance, the MF can know the set of VNFC instances of a VNF instance by querying the VNFM the VNF instance information by means of "Query VNF operation" as specified in clause 7.2.9 of ETSI GS NFV-IFA 008 [37]. The returned information (either filtered or in-full) makes available the list of VNFC instances of a VNF, along their identifiers; the vnfcInstanceId is an attribute in the returned VnfInfo->InstantiatedVnfInfo->VnfcResourceInfo (see clauses 9.4.2, 9.4.3 and 9.4.4 in ETSI GS NFV-IFA 008 [37]). With this information, then the MF can request the creation of PM notification subscriptions and PM Jobs in the same manner as indicated above and in steps #1 and #2 of the solution description in clause 6.3.2.A.2.

##### 6.3.2.A.2 Solution description

The procedure for collecting energy consumption associated to VNF/VNFCs is as follows:

1. The MF subscribes to PM notifications towards the VNFM, so as to receive notifications about the total and mean energy consumption of the known and of interest (referred as "selected") VNF/VNFC instances that constitute the 5GC NF of interest (see ETSI GS NFV-IFA 008 [37] clause 7.4.4) for a given period of time;

2. The MF requests the VNFM to create a PM job to collect the total and/or mean energy consumption of selected VNF/VNFC instances (see ETSI GS NFV-IFA 008 [27] clause 7.4.2);

NOTE: The following steps 3 to 6 are not in scope of the 3GPP management system and do not imply interactions of the 3GPP management system with an external management and orchestration system. These steps are only described for illustrative purposes to provide additional information about the scope of EC measurements and their relation to VNF/VNFC based on virtual compute resources and OS containers, and to keep aligned, from an end-to-end perspective, the present solution description with the solution specified in clause 6.3.2.2.1.

3. The VNFM subscribes to PM notifications towards the VIM, in case of virtual compute resource based VNFC instance, and/or towards the CISM, in case of OS container based VNFC instance, so as to receive notifications about the energy consumption of virtual compute on which VNFC instances run (see ETSI GS NFV-IFA 006 [29] clause 7.7.5) and energy consumption of OS container workload of the VNFC instance (see ETSI GS NFV-IFA 040 [ref-ifa040] clause 6.8), respectively;

4. The VNFM requests the VIM, in case of virtual compute resource-based VNFC instance, and/or the CISM, in case of OS container based VNFC instance, to create a PM job to collect the energy consumption of virtual compute instances on which the VNFC instance runs (see ETSI GS NFV-IFA 006 [29] clause 7.7.2) and energy consumption of OS container workload of VNFC instance (see ETSI GS NFV-IFA 040 [ref-ifa040] clause 6.8);

5. The VIM and/or CISM collect and aggregate the energy consumption of the virtual compute resource and OS container workload where the VNFC instance runs, and notify the VNFM about the corresponding measurements;

6. The VNFM maps the received energy consumption measurements of the virtual compute resources and OS container workloads to the respective VNFC instances and generates the measurement of total energy consumption of VNF/VNFC, as specified in clauses 7.2.16 and 7.2.18 of ETSI GS NFV-IFA 027 [25], and mean energy consumption of VNF/VNFC, as specified in clauses 7.2.17 and 7.2.19 of ETSI GS NFV-IFA 027 [25];

7. The VNFM notifies the MF in charge of the 5GC NF EC, about the total/mean energy consumption of the selected VNF/VNFC instance(s) which constitute the NF (see ETSI GS NFV-IFA 008 [28] clause 7.4.5);

8. The MF can then map and generate the NF energy consumption based on the sourced total/mean energy consumption of the VNF/VNFC instance(s) which constitute the NF.

***End of changes***