**3GPP TSG-WG SA2 Meeting #161 *S2-2403159***

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**Source: Huawei, HiSilicon**

**Title: KI#1, new solution: Energy Related information obtained from OAM**

**Document for: Approval**

**Agenda Item: 19.4**

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*Abstract: The papers proposed a solution based on the assumption that the Energy Related information (Energy consumption, Renewable ratio and Carbon Intensity) per NF and Physical nodes is provided by OAM system and further processed in the 5GC.*

# 1. Introduction

## 1.1 Discussion

The KI#1 currently includes the issue on how and what energy related information is obtained. Obtaining energy related information is a fundamental issue to be addressed since other key issues also need the input of energy related information.

In KI#1, it highlights that:

- How and what network energy related information from the Network entities (i.e., RAN nodes, 5GC NFs) can be obtained in order to support network energy related information exposure.

This paper proposes consideration on the EC measurement and architecture assumptions.

In several of the proposed solution it is assumed that the CN NF can determine by its own the Energy Consumption. In this paper we would like to clarify some key aspects that such Energy consumption measurements may not be the case. SA5 specification in TS 28-series, as also reported in Annex A, refer to the ESTI TS describing that the EC can be determined according to the type of measurements:

- Type 1: Built-in measurements inside ICT equipment down-stream from power interface A (or A3).

- Type 2: External measurement at input junction box measurements up-stream from power interface A (or A3).

- Type 3: Power frame measurement at output of power supply system.

It shall be noted that currently SA5 specification does not support type 3 measurements, furthermore for type 2 measurement the communication of measured information from sensors is specified to interface to management system, therefore the SA2 level CN node cannot obtain such information.

Type 2 and Type 3 measurement are depicted in Figure 1.1-1 and 1.1-2, respectively.

**Observation 1: A physical node is able to determine its own EC only if it supports built-in measurement (type 1).**



Figure 1.1-1: type 2 measurement



Figure 1.1-2: type 3 measurement

In case of virtual implementation, there is an additional aspect to be considered, that the more than one NF can be hosted on the same server, therefore the EC measured is those of the hosting server. Therefore TS 28.554 define metrics to derive the estimation of the Energy Consumption of the Virtual NF process running on the hosting server, based on metrics collected from ETSI MANO.

These metrics and the EC evaluation is currently defined in TS 28.554. The EC related to an NF is provided by OAM directly to the NF which makes use for evaluation of Energy related information, depending by the solution, or may be provided to the NF itself, which will forward the value to the other NF which will make use of that information. The two approaches have their pros and cons which depends whether the Energy related information are used in a centralize architecture, i.e., with a specific network function or in a distributed approach, where different NF makes use of such information for the evaluation. Furthermore, how this information is provided by OAM needs to be considered, i.e., if it is received via Management interface or whether a new SBI in defined between CN and management system is defined. This aspect needs to be discussed and verified with SA5.

**Observation 2: An NF deployed as Virtual NF process running on a hosting server cannot determine its own EC.**

## 1.2 Proposal

Considering the following observations:

* **Observation 1: A physical node is able to determined its own EC only if it supports built-in measurement (type 1).**
* **Observation 2: An NF deployed as Virtual NF process running on a hosting server cannot determine its own EC.**

It can be concluded that:

* **The EC for NF is provided by OAM**
* **Whether and how EC is provided by OAM required to be coordinated with SA5.**

It is proposed to capture the following changes vs. TR 23.700-66.

\* \* \* \* 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] 3GPP TS 23.501: "System Architecture for the 5G System; Stage 2".

[3] 3GPP TS 23.502: "Procedures for the 5G system, Stage 2".

[4] 3GPP TS 23.503: "Policy and Charging Control Framework for the 5G System".

[5] 3GPP TR 22.882: "Study on Energy Efficiency as service criteria".

[6] 3GPP TS 28.554 "5G end to end Key Performance Indicators (KPI)".

[7] 3GPP TS 28.310 "Management and orchestration; Energy efficiency of 5G".

[8] 3GPP TS 22.261 "Service requirements for the 5G system".

[9] ETSI EN 202 336-12: "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.

[10] 3GPP TS 28.552: "Management and orchestration; 5G performance measurements".

[11] 3GPP TS 28.532: "Management and orchestration; Generic management services".

[12] 3GPP TS 28.533: "Management and orchestration; Architecture framework".

[13] 3GPP TS 28.622: "Telecommunication management; Generic Network Resource Model (NRM) Integration Reference Point (IRP); Information Service (IS)".

[14] 3GPP TS 23.288: "Architecture enhancements for 5G System (5GS) to support network data analytics services".

[15] 3GPP TS 29.510: "Network Function Repository Services".

[16] 3GPP TS 28.104: "Management and orchestration; Management Data Analytics (MDA)".

[x] 3GPP TS 28.522: "Telecommunication management; Performance Management (PM) for mobile networks that include virtualized network functions;".

\* \* \* \* Second change

## 6.0 Mapping of Solutions to Key Issues

Editor's note: This clause describes the mapping between solutions and key issues.

Table 6.0-1: Mapping of Solutions to Key Issues

|  |  |
| --- | --- |
| Solutions | Key Issues |
|  | 1 | 2 |  | X |
|  |  |  |  |  |
| x | x |  |  |  |
| … |  |  |  |  |

\* \* \* \* Third change \* \* \* \* all new text

## 6.x Solution #X: Energy related information collection based on two granularities

### 6.x.1 Key Issue mapping

This solution maps to KI#1.

### 6.x.2 Functional Description

#### 6.x.2.1 Principles about how related information is determined and processed energy

This clause describes how the energy related information, specifically the Energy Consumption, Renewable Energy and Carbon emission information is obtained via OAM and the principal requirements for the processing of energy related information.

The specification TS 28.554 [6] defines the Energy Consumption KPI of a Physical Node in clause 6.7.3 based on Power and other Energy Environmental Parameters for the equipment based on ETSI EN 202 336-12 [9] and TS 28.522 [x].

Since the Energy Consumption is mainly determined from measurement on power interface and/or estimation based on CPU, memory and disk usage in case of a virtual NF, it is difficult (if not impossible) to derive this information directly at the NF. It should however not be a problem to retrieve the Energy Consumption information per NF (irrespective of whether it is realized as virtual NF or a physical node) as defined in TS 28.554 [6] clause 6.3.2.1.

For Renewable Energy and Carbon emission information we assume that they can be obtained in the same way via the OAM.

NOTE: Whether and which granularity of renewable energy information would be available from OAM is under SA5 responsibility.

For simplicity reasons and due to the fact that this information is already standardized, we focus only on the retrieval and usage of Energy Consumption information in the following description. The approach can however be used in the same way for the retrieval and usage of Renewable Energy and Carbon emission information.

The energy related information retrieved from the OAM can then be further processed in the CN. From the SA1 requirements, one can derive two main scenarios, one that is related to the rather accurate energy consumption information of a specific UE or PDU Session and another that is related to the energy consumption in a coarser granularity of areas, application traffic, UE group, and so on. And given that the collection of energy related information and its processing in the CN is creating additional costs and is consuming energy as well, it only makes sense to look for the most efficient approach, even if this comes with a certain reduction in accuracy or actuality.

Based on the above considerations, it is therefore proposed to use the fine granular and relative accurate collection and processing of energy consumption information only for those situations and UEs where it really matters, i.e., where a user specific energy credit/budget is to be enforced or where the energy consumption is used for traffic policing/charging. In all other situations, a coarse granular approach should be applied for the collection and processing of energy consumption information that makes use of certain assumptions, averages, statistics and whatever simplification is helpful to keep the efforts as low as possible. It should be clear that it is not possible (from scalability as well as from energy consumption perspective) to collect fine granular and accurate energy consumption information for every UE in the network. And it should also not be necessary since the simplifications that are taken in the coarse granular approach can be the same for the different NFs, use cases or scenarios and do therefore lead to comparable results.

#### 6.x.2.2 Architectural model and functional entities

This solution is based on existing OAM capabilities enabling to collect and expose energy consumption information of network entities (i.e., RAN nodes, 5GC NFs) with the granularity of network slice and NF.

The principles of the solution are:

- SMF and NWDAF retrieve the energy consumption information of the relevant NFs from the OAM on a per Node/NF and slice granularity via the Provisioning Management Service (MnS) and with the granularity period defined in TS 28.532 [11].

- The NWDAF is responsible for the calculation of the energy consumption information for coarser granularities (e.g., per area, per application, per group of UEs, …):

- The calculation of the energy consumption information can take further input from other NFs into account (e.g., measurements, context information, …) including energy consumption information of specific PDU Sessions (provided by the SMF)

- The SMF is responsible for the finer granularity and relative accurate collection of energy consumption information with the granularity of a PDU Session (or even a QoS Flow):

- The energy consumption information for a PDU Session is calculated under consideration of the actual traffic volume that is transferred, the UPF and RAN node energy consumption information.

- The NEF supports the exposure of energy consumption information with fine as well as coarse granularity:

- The NEF forwards the subscriptions and notifications to/from the NWDAFs and SMFs;

- The NEF may need to aggregate energy consumption information of specific PDU Sessions provided by the SMF(s) in order to expose the energy consumption information for a UE.

- The CHF can receive fine granular and relative accurate energy consumption information a PDU Session (or even a QoS Flow) and can provide energy credit/budget control information to the SMF.

The reference architecture in figure 6.x.2.2-1 shows MnS which sends the energy related information per NF, node and slice granularity, and the SMF, NWDAF, NEF and CHF which further process and expose the energy related information according to the desired granularity, i.e. per area/application, per UE, pre PDU session or even per QoS Flows.

**OAM (MnS)**

**SMF/**

**EECF**

**NWDAF/**

**EECF**

**NEF/**

**EECF**

**AF**

**Other NFs**

b

a

c

d

e

f

**CHF**

g

**Transferred information:**

1. (Other NFs to SMF): Data Volume (DV) or other useful input of the desired granularity (e.g., per PDU Session/QoS Flow);
2. (Other NFs to NWDAF): DV or other useful input of the NF(s) (e.g., NFs belong to a certain NS);
3. (OAM to SMF): DV or other useful input of the involved NF(s), EC of the involved Network entities;
4. (OAM to NWDAF): DV or other useful input of the involved NF(s), EC of the involved Network entities;
5. (SMF to NEF): Fine granularity of EC/EE e.g., PDU Session/QoS Flow;
6. (NWDAF to NEF): Coarse granularity of EC/EE e.g., per area, per application, per group of UEs;
7. (Between CHF and SMF): Charging related control.
8. (NEF to AF): desired granularity of EC/EE e.g., per QF, per PDU Session, per UE, per NF, per area, per application, per group of UEs;
9. (SMF to NWDAF): Fine granularity of EC/EE e.g., PDU Session/QoS Flow;

i.

h

i

Figure 6.x.2.2-1: Reference architecture and the information flow

### 6.x.3 Procedures

NOTE 1: The message names in the procedure below are descriptive. It is assumed that the names are updated with corresponding SBI based names where applicable during the normative phase.

**RAN**

**NFs**

**OAM**

**SMF/**

**EECF**

**UDM**

**NEF/EECF**

**NWDAF/EECF**

1. Nnef\_EventExposure\_Subscribe Request

2. Nnwdaf\_EnergyInformation\_Exposure\_Subscribe

3. Obtain energy related management information

11. Nnef\_EventExposure\_Notify

4. Obtain other useful input information, e.g., Data Volume.

**AF**

6. Nudm\_UECM\_Get request/response

7. Nsmf\_EnergyInformation\_Exposure\_Subscribe Request

8. Obtain energy related information

9. Obtain other useful input information, e.g., Data Volume.

10. Nsmf\_EnergyInformation\_Exposure\_Notify

5. Nnwdaf\_EnergyInformation\_Exposure\_Notify

**In case of Coarse granularity**

**In case of fine granularity**

1a. Authorization

Figure 6.x.3-1: Procedure for Energy related information collection and exposure.

1. AF triggers the energy information exposure by invoking Nnef\_EventExposure\_Subscribe service. In addition to the information defined in 5.2.6.2.2 of TS 23.502 [3], AF includes the following information in the request for energy related execution:

- Desired granularity: Desired granularity of the Energy related information, i.e., per QoS Flow, per PDU Session, per UE, per area, per application, per group of UEs;

- Desired Information Type: Energy Consumption, Energy Efficiency, Renewable Energy information, Carbon Emission information;

- Other optional information: UE ID(s)/GPSI, DNN, S-NSSAI, Filter Information (e.g., per QoS Flow, per application), Area of Interest.

1a. NEF checks authorization of AF. If geographical area information or civic address information was provided by the AF as the requested service area, NEF performs the translation.

NOTE 2: NEF is not required if AF is in trusted domain. In this case, only step 2-10 are needed and the interactions between NEF and NWDAF/UDM/SMF also apply for an AF in the trust domain.

2. In case the Desired Information Type indicates a coarse granularity (e.g., per area, per application), the NEF sends Nnwdaf\_EnergyInformation\_Exposure\_Subscribe Request message to NWDAF/EECF. The message includes the Desired granularity, Desired Information Type and Other information received in Step 1.

3. NWDAF/EECF obtains Energy Related Management Information from OAM. The Energy Related Management Information includes:

- Energy Consumption of the Network Entities: e.g., Energy Consumption of the RAN nodes and UPF(s);

- Renewable Energy Ratio;

- Carbon Emission Factor;

- other additional information required for the evaluation of the KPI, for example the contribution of Transport network, non-3GPP access node if provided by OAM.

NOTE 3: The interactions between OAM (e.g., MnS) and NWDAF/EECF will be further coordinate with SA5 and the details of the exchanged information (e.g., data format, services) will be determined then.

4. NWDAF/EECF obtains other required input information from the 5GC NFs, such as:

- Data Volumes of the desired granularity: e.g., the Data Volume of the UL/DL path of the N3 interface from UPF (directly or via SMF);

 In case the Desired granularity is per area, the NWDAF/EECF may interact with e.g., NRF to identify the target 5GC NFs within the Area.

In case the Desired granularity is per application, the NWDAF/EECF will further interact with the associated SMF(s) to get the required information (e.g., EC information) of the QoS flows.

Editor’s Note: How does the NWDAF/EECF find the SMF(s) is FFS.

NOTE 4: The NWDAF/EECF retrieves from 5GC NFs the information required to evaluate the KPI and performs the evaluation of the required KPIs. The KPIs are a separate issue and will be described in other solutions.

5. The NWDAF/EECF responds the NEF with Nnwdaf\_EnergyInformation\_Exposure\_Notify. The message includes the required Energy related information. Before responds to NEF, the NWDAF/EECF may further process the obtained information received in step 3 and step 4. Specifically:

- In case the Desired granularity is per area, the NWDAF/EECF aggregates the collected EC information of the NFs within the area (i.e., within the Area of Interest).

- In case the Desired granularity is per application, the NWDAF/EECF aggregates the collected EC information of the QoS flows from SMF.

- In case the Desired Information Type is Energy Efficiency, the NWDAF/EECF figures out the Energy Efficiency based on the EC (obtained in step 3 or calculated in step 5) and useful input (i.e., DV information obtained in step 3).

- In case the Desired Information Type is Renewable Energy information or Carbon Emission information, the NWDAF/EECF figures out the Desired Information based on EC (obtained in step 3 or calculated in step 5) and Renewable Energy Ratio/Carbon Emission Factor (obtained in step 3).

NOTE 5: The NWDAF/EECF may consider other additional inputs, e.g., analytics, when figuring out the he Energy Consumption or Energy Efficiency.

6. In case the Desired Information Type indicates a fine granularity (e.g., per QoS Flow, per PDU Session, per UE), the NEF determines the target NF(s) (i.e., SMF) by invoking the Nudm\_UECM\_Get service.

If the Desired granularity is per group of UEs, the NEF will interact with the associated SMF(s) to get the required information (e.g., EC information) of the PDU Sessions.

7. The NEF sends Nsmf\_EnergyInformation\_Exposure\_Subscribe Request message to the SMF(s). The message includes the Desired granularity, Desired Information Type and Other information received in Step 1.

8. SMF obtains Energy Related Management Information from OAM. The Energy Related Management Information includes:

- Energy Consumption of the Network Entities: e.g., Energy Consumption of the RAN nodes and UPF(s);

- Renewable Energy Ratio;

- Carbon Emission Factor.

NOTE 6: The SMF may further authorize the request based on the subscription information, which should be under the remit of KI#2.

NOTE 7: The interactions between OAM (e.g., MnS) and SMF will be further coordinate with SA5 and the details of the exchanged information will be determined then.

9. SMF obtains other useful input information from the 5GC NFs.

 In case the granularity is per QoS Flow, the SMF get the data volume of the specific QoS Flow from UPF, by providing the Filter Information to UPF.

In case the granularity is per PDU Session, the SMF gets the data volume of the PDU Session from UPF. The SMF performs the evaluation of the required KPIs would be a separate issue and will be described in other solutions.

NOTE 8: UPF records the data volume per QoS Flow/per PDU session, this could be done by e.g., during the PDU Session Establishment/Modification procedure.

Editor’s Note: It is FFS whether extra information regarding energy consumption is needed to calculate the Energy Consumption or Energy Efficiency.

10. The SMF responds the NEF with Nsmf\_EnergyInformation\_Exposure\_Notify. The message includes the required Energy related information. Before responds to NEF, the SMF may further process the obtained information received in step 8 and step 9. Specifically:

- In case the Desired granularity is per UE, the NEF aggregates the collected EC information of all the related SMF(s) of the UE.

- In case the Desired granularity is per group of UEs, the NEF aggregates the collected EC information of the involved UEs.

- In case the Desired Information Type is Energy Efficiency, the SMF figures out the Energy Efficiency based on the EC (obtained in step 8 or calculated in step 10) and useful input (i.e., DV information obtained in step 3).

- In case the Desired Information Type is Renewable Energy information or Carbon Emission information, the NWDAF/EECF figures out the Desired Information based on EC (obtained in step 8 or calculated in step 10) and Renewable Energy Ratio/Carbon Emission Factor (obtained in step 8).

11. The NEF provides the required information for exposure to AF via Nnef\_EventExposure\_Notify message.

### Editor’s Note: It is FFS whether functionalities at NEF regarding energy related execution can be implemented by NWDAF.6.x.4 Impacts on existing services, entities and interfaces

**NWDAF/EECF:**

- Handles the energy related information collection and calculation for the coarse granularity.

**SMF/EECF:**

- Handles the energy related information collection and calculation for the fine granularity.

**UPF:**

- Provides the date volume information as per the request from SMF.

**NEF:**

- Identify the involved NF(s) and handles the energy related information calculation (for the fine granularity) and exposure.

**AF:**

- There is impact on existing Nnef\_EventExposure\_Subscribe service.

\* \* \* \* End of changes \* \* \* \*