**3GPP TSG-WG SA2 Meeting #162 *S2-2404012merge version***

**Changsha, China, April 15- April 19, 2024**

**Source: China Mobile, Huawei? vivo?,ZTE?**

**Title: Evaluation and conclusion on KI#1: Network energy related information exposure**

**Document for: Approval**

**Agenda Item: 19.4**

**Work Item / Release: FS\_EnergySys / Rel-19**

*Abstract of the contribution: Propose an evaluation and conclusion on KI#1: Network energy related information exposure.*

# 1 Discussion

This paper provides evaluation and conclusion of KI#1: Network energy related information exposure.

# 2 Proposal

It is proposed to include the below changes into TR 23.700-66 v0.4.0.

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*FIRST CHANGE (all new text)*

## 7.x Evaluation for KI#1: Network energy related information exposure

The following solutions are for KI #1: Network energy related information exposure.

Table 7.x-1: Solutions for KI #1

|  |  |  |
| --- | --- | --- |
| Solution | Energy related information collected by | Granularity |
| #1: Energy related information collection and exposure | new NF (EECF) | NF, network slice, UE, UE+service, PDU Session, QoS flow |
| #2: Network energy related information exposure | new NF (EESSF) | NF, network slice, UE, PDU Session, QoS flow |
| #3: Enhanced network exposure and analytics for energy saving | NWDAF | service, UE |
| #4: Renewable energy ratio information exposure | NWDAF | UE |
| #5: Exposing energy usage information to 3rd party server | NWDAF | service |
| #6: Energy information collection for service level | new NF (EEF) | UE, PDU Session, service |
| #16: Energy Brokerage Function for energy related information acquisition and processing | new NF (EBF) | NF, network slice |
| #17: Energy related information collection based on two granularities | new NF (EECF) or SMF+NWDAF | area, service, NF, network slice, UE, PDU Session, QoS flow |
| #18: Collecting of Energy Consumption information on per UE level (RAN assisted) | new NF (ECF) | UE or finer |
| #19: NG-RAN node QoS flow PDU session and UE level energy related information report | SMF | PDU Session, QoS flow |
| #20: Exposure, charging and handling of energy related information based on UP reporting from RAN | SMF | QoS flow |

**Solution #1 and #2** utilizes new NF (EECF/EESSF) and can exposure energy related information of varied granularities. EECF/EESSF collects or calculates energy related information based on AF request, and exposes the energy related information to AF.

AF provides requested granularity, location, reporting mode and reporting threshold/time period. Based on the AF request, EECF/EESSF collects energy consumption related information per NF or per S-NSSAI (e.g. energy efficiency information, energy consumption information of RAN, renewable energy information for an area) from OAM, and collects information to generate the required energy related information, as following:

- Collecting from AMF: number of registered subscribers; for each registered UE: UE specific DRX values, paging time window, paging area, periodic registration update timer.

- Collecting from SMF: number of PDU Sessions; for each PDU Session: QoS parameters.

- Collecting from UPF: data volume, bit rate.

- Collecting from NG-RAN through OAM: data volume.

**Solution #3** utilizes NWDAF to collect energy consumption related information per UE or per service and to exposure the information to AF. The energy consumption related information may include energy consumption related information, energy efficiency related information, renewable energy and carbon emission related information, etc.. The NWDAF collects information from OAM and provides energy related information analytics. It is not clear how the network analytics is performed and whether information from OAM can support energy related information analytics per UE or per service.

**Solution #4** utilizes NWDAF to collect information and expose renewable energy ratio analytics per UE to consumer. The NWDAF retrieves UE location information from AMF and determines the RAN and NFs serving the UE. The NWDAF collects related information from OAM, and exposes renewable energy ratio analytics to the consumer. This solution only focus on exposure of renewable energy information. Besides, it is unclear whether it is able to generate per UE renewable energy information analytics based on the information from OAM.

**Solution #5** utilizes NWDAF to collect information to help determine the network energy related information and to expose the energy usage estimation per application. 3rd party application server requests network analytics for how much energy would be needed given an application configuration (i.e. QoS Reference or QoS parameters, and optionally a bit rate, delay etc.). NWDAF collects information to help determine the network energy related information from 5GC NFs and MDAF, OAM. Which information does NWDAF collect from other NFs or MDAF, OAM for the energy usage estimation per application needs further clarification.

**Solution #6** utilizes new NF (EEF) for UE and PDU session level Energy information collection and exposure for per service. EEF calculates the energy consumption per service based on data volume of service, data volume of the slice and energy consumption of the slice. It is unclear how to collect the information, and whether energy consumption is in direct proportion to data volume.

**Solution #16** utilizes new NF (EBF) to expose energy related information to consumer per NF or per network slice granularity. Based on subscription, the EBF collects energy relevant counters to generate energy efficiency related KPIs, performance relevant counters to generate performance related KPIs, and calculates energy efficiency, carbon emissions, ratio of renewable energy, etc.. This solution is for energy related information exposure per NF and per network slice, and is not used for UE, service, PDU Session or QoS flow granularities.

**Solution #17** utilizes new NF (EECF) which equipped on NWDAF, SMF and NEF for energy related information collection and exposure, as following:

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

- The SMF is 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 NEF is for the exposure of energy consumption information.

For SMF, the interface c illustrated in Figure 6.17.2.2-1 is between SMF and OAM, which is SA5 dependency. Besides, it is not session management related functionality to obtain and expose energy consumption, energy efficiency, renewable energy ratio or carbon emission, therefore SMF is not suitable to manage such information. For NWDAF, it is unclear whether energy related information exposure may involve complex calculation that need network analysis. For the architecture in Figure 6.17.2.2-1, it has much impact on current interfaces, and is not good for forward compatible.

**Solution #18** utilizes new NF (ECF) to expose energy consumption information to AF, in per UE or finer granularity. The RAN creates EC assistance information and notifies the ECF. In this solution, the RAN is responsible to calculate part energy consumption information, therefore it is RAN dependent.

**Solution #19 and #20** utilizes SMF to expose energy related information. In both solutions, RAN calculates energy related information and forwards to SMF. In solution #19, RAN sends the information via N2 SM message. In solution #20, RAN appends the information in GTP-U extension headers. These solutions are RAN dependent.

To summarize the solutions:

1) Collection and exposure at different granularities should be supported, since energy saving policy or adjustment may take place in different granularities. At least per UE, per PDU Session, per QoS flow granularities shall be supported.

2) According to the solutions above, new NF/NWDAF/SMF supports Energy related information collection and exposure, renewable energy information calculation and exposure. The processing mentioned above do not involve complex calculation, therefore network analysis is not needed. Besides, different granularities should be supported other than per PDU Session granularity. As a result, a new NF is recommended to be introduced.

3) In order to guarantee end-to-end energy consumption exposure, energy consumption per gNB shall be supported.

4) In order to support energy saving policy update or network adjustment, UE subscription shall be enhanced to include energy related subscription. For example, requirement for energy consumption/energy efficiency/renewable energy usage is included in UE subscription.

*NEXT CHANGE (all new text)*

## 8.x Conclusion for KI#1: Network energy related information exposure

The interim conclusion of KI#1 based on the 5 conclusion papers (S2-2404012,S2-2404243,S2-2404387,S2-2404794, S2-2404487):

Part A: Consensus Part

- 5GC NF (e.g. EECF or NWDAF) support the following functionalities: energy related information collection, energy related information exposure, renewable energy information and carbon emission information collection and exposure.

- 5GC NF can obtain energy related information from OAM, and calculate the energy consumption, energy efficiency etc. to be exposed.

- Energy related information collection and exposure should be supported at least the following granularities: per UE, per PDU Session, per QoS flow.

- In the R19, the gNB does not support to report per-UE-per-PDU session and/or per-UE-per-QoS flow level energy consumption. Energy consumption information per gNB level can be provided from gNB/OAM.

- Energy related UE subscription information is stored in UDM, e.g. requirement for energy consumption/energy efficiency/renewable energy usage.

- Energy credit information per UE or per-UE-per-Application can be based on 5GC local configuration or from AF(represent of 3rd party) provision.

Part B: Potential Consensus Part

- The service area maybe considered when do the energy related information collection and exposure.

- To expose energy consumption information and prediction on energy consumption of the 5G network.

Part C: Discussed and Decision PartNew NF vs existing NF:

- A new NF e.g. EECF should be defined to support the above energy related information collection and handling, and information exposure.

- Or an existing NF i.e. NWDAF, can be enhanced to support the energy related information collection and handling, and information exposure.

The granularity of information exposure:

- Per UE, per-UE-per-PDU session, per-UE-per QoS flow;

- Or per Service and QoS flow, not support per UE and per PDU session .

*End of CHANGES*