**3GPP TSG-WG SA2 Meeting #162 *S2-2404794***

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**Source: Huawei, HiSilicon**

**Title: KI#1, Evaluation and Conclusion: Way forward proposal**

**Document for: Approval**

**Agenda Item: 19.4**

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*Abstract: The evaluation and conclusion for KI#1 are proposed.*

# 1. Introduction/Discussion

This document proposes evaluation and conclusion based on TS 22.261 requirements and a first interim resume of main characteristics of the solutions addressing the KI#1.

# 2 Evaluation and conclusion based on TS 22.261 requirements

The R19 requirements related to energy efficiency have been defined in TS 22.261 as conclusion of SA1 normative work after the approval of SA2 SID. At this stage of the work, this paper intents to consider the SA1 normative outcome in the evaluation and definition of conclusion SA2 study.

The normative requirements are defined in clause 6.15a, the details are not copied here, in the following they are analyzed to show the implication on SA2 study work.

### 2.1 Granularity

Regarding the granularity to be supported, we need to consider the SA1 requirements in TS 22.261 in clause 6.15a.2.2, specifically to the requirement copied below:

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| *Calculation of energy related information as described in the following requirements is done by means of averaging or applying a statistical model. The requirements do not imply that some form of 'real time' monitoring is required.**…..**For best-effort traffic, that is, without QoS criteria, policies can be defined to limit energy use for services. This is not in conflict with the principle that performance policies will not be traded off for energy efficiency, since best-effort service has no performance guarantees.* *Specifically, best-effort traffic can be subject to a policy that limits the maximum energy consumption over time, or further constrained by location (so that the energy consumption limit only applies when used in a specified service area.)**….**[below only 1 requirement is copied as reference]**Subject to operator’s policy, the 5G system shall support a means to define subscription policies and means to enforce the policy that define a maximum energy consumption (i.e., quantity of energy for a specified period of time) for services without QoS criteria.* |

It shall be noted that SA1 requirement refers to the *best-effort traffic, that is, without QoS criteria* which from SA2 point of view, it is not correct since all traffic has a QoS criteria associated, i.e., a 5QI and a set of QoS parameters to be fulfilled. Therefore, a QoS criteria is always supported. In TS 23.501 we may have several 5QIs for Non-GBR traffic which may be associated to a best-effort traffic, which seems to be the implication of these requirements.

The evaluation per UE granularity does not fulfil the requirements, since it represents the Energy Consumption for all traffic, best effort and not best effort. The evaluation with per PDU session granularity, again may refer to different QoS flow associated to different kind of traffic, therefore the per PDU session granularity does not fulfil SA1 requirement.

The Energy Consumption per QoS flow granularity is the only one that allows to separate the contribution of Non-best-effort traffic from the best-effort traffic. Furthermore, if several QoS flows are carrying traffic which can be considered as best-effort, the EC for all these QoS flows shall be summed in order to derive the EC for the best-effort traffic.

In addition to the above requirements, in clause 6.15a.4.2 it requests that energy consumption monitoring is performed at network slice and per subscriber granularity for all services, this can be understood as per UE granularity.

*Excerpt of clause 6.15a.4.2 of TS 22.261:*

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| *Subject to operator's policy, the 5G network shall support energy consumption monitoring at per network slice and per subscriber granularity.**NOTE 1: Energy consumption monitoring as described in the preceding requirement is done by means of averaging or applying a statistical model. The requirement does not imply that some form of 'real time' monitoring is required. The granularity of the subscription policies can either apply to the subscriber (all services), or to particular services.*  |

And TS 22.261 also defines the granularity of "application service" in 6.15a.5.2:

*Excerpt of clause 6.15a.5.2 of TS 22.261:*

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| *Based on operator’s policy and agreement with 3rd party, the 5G system shall be able to expose energy consumption information and prediction on energy consumption of the 5G network per application service to the 3rd party.* |

**Proposal #1 on granularity: in order to fulfil the requirements in TS 22.261 clause 6.15a.2.2 the granularity required are:**

**- per QoS flow granularity in order to be applied to “***services without QoS criteria”;*

**- per UE granularity in order to monitor the energy consumption per** *subscriber granularity;*

**- per application granularity in order to expose per** *application service***.**

**Note, that if SA2 identifies that the above granularity is not feasible or limiting the space of solution, this shall be brought to SA1 attention and the corresponding requirement in TS 22.261 shall be changed.**

### 2.2 Information Monitoring

The requirement in TS 22.261 clause 6.15a.4.2 requires to monitor the energy consumptions and it is not required to monitoring the renewable energy or carbon emission. Furthermore, the monitoring of EC can be done based on averaging or applying statistical model and it is not required to perform real time monitoring.

The monitoring per service represents several difficulties from SA2 point of view, since a service may be supported with a single QoS flow or multiple QoS flows (depending how the mapping is defined). In TS 22.261 clause 6.15a.2.2 the requirements refer to the “services without QoS criteria”, therefore if the interpretation is to monitoring “services without QoS criteria”, i.e., best effort, the monitoring is performing per QoS flow, but it may not be possible to distinguish the single services that are mapped to the same “QoS profile” (unless the binding policy indicates a new QoS Flow is needed). Whether it is feasible to estimate the energy consumption per services from the energy consumption per QoS flow requires further considerations.

*Excerpt of clause 6.15a.2.2 of TS 22.261:*

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| *Subject to operator's policy, the 5G network shall support energy consumption monitoring at per network slice and per subscriber granularity.**NOTE 1: Energy consumption monitoring as described in the preceding requirement is done by means of averaging or applying a statistical model. The requirement does not imply that some form of 'real time' monitoring is required. The granularity of the subscription policies can either apply to the subscriber (all services), or to particular services.* *Subject to operator’s policy and agreement with 3rd party, the 5G system shall be able to monitor energy consumption for serving this 3rd party.**NOTE 2: The granularity of energy consumption measurement could vary according to different situations, for example, when several services share a same network slice, etc.* *NOTE 3: The energy consumption information can be related to the network resources of network slice, NPNs, etc.**Subject to operator policy and regulatory requirements, the 5G system shall be able to monitor the energy consumption for serving the 3rd party, together with the network performance statistic information for the services provided by that network, related to same time interval e.g. hourly or daily.* *NOTE 4: The network performance statistic information could be the data rate, packet delay and packet loss, etc.* |

**Proposal #2 on information monitoring:**

**- Only the Energy Consumption monitoring is supported in this release;**

**- The granularity for monitor is per UE and per QoS flow, and whether it is feasible to estimate the energy consumption per services requires further considerations.**

### 2.3 Information Exposure

The specification for the information exposure defined in clause 6.15a.5.2 of TS 22.261 requires that based on operator’s policy:

1) to expose energy consumption;

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| *Subject to operator’s policy and agreement with 3rd party, the 5G system shall be able to expose information on energy consumption for serving this 3rd party.* |

2) to expose the ratio of renewable energy and carbon emission information when available. The reporting period could be set to a on monthly or yearly basis and can vary based on location. (See note 1). This trim eperiod is typical for the measurement performed at OAM. However as required to expose if they are available, in SA2 work we can support in the exposure, but it should be noted that this information needs to be provided by OAM.

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| *NOTE 1:**Energy consumption information can include ratio of renewable energy and carbon emission information when available. The reporting period could be set, e.g., on monthly or yearly basis and can vary based on location.* |

3) the network performance statistic information (e.g. the data rate, packet delay and packet loss) together with energy consumption information resulting from service provided to the customer for a measurement period e.g. hourly or daily.

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| *Subject to operator’s policy, agreement with 3rd party and consent by the customer, the 5G system shall be able to expose the network performance statistic information (e.g. the data rate, packet delay and packet loss) together with energy consumption information resulting from service provided to the customer, to the authorized third party, related to the same time interval e.g. hourly or daily.* |

4) energy consumption information related to the condition of energy credit limit (e.g. when the energy consumption is reaching the energy credit limit).

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| *Subject to operator’s policy, the 5G system shall support a means to expose energy consumption to authorized third parties for services, including energy consumption information related to the condition of energy credit limit (e.g. when the energy consumption is reaching the energy credit limit).* |

5) energy consumption information and prediction on energy consumption of the 5G network per application service to the 3rd party

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| *Based on operator’s policy and agreement with 3rd party, the 5G system shall be able to expose energy consumption information and prediction on energy consumption of the 5G network per application service to the 3rd party.* |

6) 3rd party can ask/configure the information to be exposed as describe in bullet 3, 4 and 5.

From the above requirements, the exposure of renewable energy and carbon emission is required if available, furthermore the reporting period is on monthly or yearly period and it may be based on location. Since the information and measurement period are typical for the management system (i.e., under the remit of SA5), it's better to address this feature in SA5. Note that we apply the same paradigm regarding the exposure of per NF, per slicing and per 5GC granularities.

In addition, R20 SA1 study targets to further consider the requirements and the use cases, and may identify the potential involvement regarding the service architecture aspects.

Therefore, it is proposed that for this release the SA2 study does not consider the exposure of renewable energy and carbon emission information by NEF.:

**Proposal #3 on Information exposure:**

1. **In this release of specification to expose via NEF the energy consumption with the associated network performance statistic information (e.g. the data rate, packet delay and packet loss) and energy credit limit;**
2. **In this release of specification to expose energy consumption information and prediction on energy consumption of the 5G network;**
3. **the exposure of renewable energy and carbon emission information is supported, and it is exposed if available. IN this release is assumed that the information per NF is provided by OAM;**
4. **The granularity of the information exposed is per Service and QoS flow. The exposure per UE and PDU session is not required per TS 22.261 requirements (e.g. per application service);**
5. **3rd party can ask/configure the information to be exposed.**

# 3 Key issue #1 evaluation and conclusion

The solutions have different level of details in the description, but for the scope of the evaluation and comparison the main principles and assumptions are described in order to be able to derive conclusions.

It shall be noted that providing pros and cons evaluation for each solution may be not straight forward and does not help to derive a conclusion. A selection of the principles needs to take place considering the majority of the approached proposed and most probably not a single solution can be selected as baseline.

The main decision to be taken related to the KI#1 are described in the following:

1. *Whether and what network energy related information can be exposed*.
	1. Several solutions refer to a generic “energy related information” other than Energy Consumption, Renewable and Carbon emission information;
	2. Which information can be evaluated depend by system external to 5G CN under SA2 responsibility, i.e. to OAM system and/or provided by AF (see KI#2 & 3);
	3. We may consider at this stage the Energy Consumption, the Renewable Energy ratio and the Carbon Emission.

**Proposal #4:**

1. **Based on considerations and proposed conclusion in clause 2.3, the Energy Consumption is considered in the scope of normative work,**
2. **Based on considerations and proposed conclusion in clause 2.3, the Renewable Energy ratio and the Carbon Emission are considered in the scope of the normative work.**

**C) The Energy Consumption, carbon emission and Renewable Energy ratio per CN NF level are provided by OAM.**

**D) The Energy Consumption per gNB level can be provided by OAM. Whether Energy Consumption per gNB can be provided directly by gNB is FFS depending by RAN decision.**

1. *At what granularity (e.g. per network slice, UE, NF, PDU Session, QoS flow, etc) the network energy related information can be exposed.*
	1. per network slice and NF is provided and evaluated at OAM level;
	2. PDU session granularity is not considered since it does not fulfil the TS 22.261 requirement (see clause 2.1);
	3. per UE granularity and per QoS flow granularity is evaluated at SA2 CN level (together with the feedback from RAN WGs) and the information can be exposed to AF;
2. *How the network energy related information is exposed.*

All solutions have the following commonalities:

- the energy related information is exposed via NEF to AF;

- the energy related information is exposed with the relevant granularity;

- the energy related information is the evaluated in the measurement period and/or the result of analytic;

- the application function may ask which information, at which granularity, at which period and for which UE the information shall be exposed;

The details are different regarding the information granularity, and where the evaluation is performed. The conclusion on the details require to take a decision on the technical aspect related to the other KI and to the KPI. Therefore, is proposed to have an interim decision as the following:

**Proposal #5: The exposure of network energy related information follow the following principles:**

**- The exposure is performed via NEF;**

**- The granularity of the information is based on the decision of proposal #2;**

**- The information exposed are based on decision of proposal #1;**

**- The information is obtained by the NF responsible for the evaluation based on decision of proposal #4;**

**- The AF may ask to expose the information as defined in above bullets.**

1. *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.*

The way of obtaining the energy related information is based on the decision regarding the proposal #3. At this stage we can leave this issue open and address those once SA2 reaches the consensus on the previous proposals. It is mainly on the following principals: **- Which Network function that handles the collection of the energy related information (i.e., NWDAF, EECF, SMF or others);**

**- Whether different granularities are to be handled by different NFs (considering the performance perspective).**

# 4. Decision to be taken

In this clause we summarizes the proposals related to KI#1, for some of the decision a SoH needs probably to take place. i.e., the following shall be decided:

**Proposal #1 on granularity: see clause 2.1.**

**Proposal #2 on information monitoring: see clause 2.2.**

**Proposal #3 on Information exposure: see clause 2.3.**

**Proposal #4 on whether and what network energy related information can be exposed: see clause 3.**

**Proposal #5 on the exposure of network energy related information: see clause 3.**

# 5. Text Proposal

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

\* \* \* \* First change \* \* \* \*all new text

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# 8 Conclusions

## 8.1 Interim conclusion

This clause defines the conclusions of the study which apply to all Key Issues derived from TS 22.261 [8] specification.

### 8.1.1 Interim conclusion on KI#1

#### 8.1.1.1 Energy related information as a service criteria

The conclusion of the study on information exposure derived from TS 22.261 [8] specification:

Regarding the granularity of energy related information:

a) per QoS flow granularity in order to be applied to “*services without QoS criteria”;*

b) per UE granularity in order to monitor the energy consumption per *subscriber granularity;*

c) Per PDU Session granularity

d) per application granularity in order to expose per *application service*.

e) per NF, per slice,

*(the proposal in 4243 below are covered by above bullets*

*- Energy consumption, energy efficiency, cabon emission information, renewable energy information (e.g., renewable energy ratio) at different granularities (e.g. per network slice level, per UE level, per NF level, per PDU Session level, per QoS flow level) can be exposed by the network to authorized consumers (e.g., AF).*

f) 5GC may modify the QoS parameters of a QoS flow to NG-RAN with considering the energy efficiency requirement. Or the 5GC may send the energy efficiecny indication to NG-RAN for specific QoS flow.

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

Regarding the monitoring information:

- See clause 8.1.1.3.

Regarding the information to be exposed:

- See clause 8.1.1.4.

#### 8.1.1.2 Support of different energy states

Editor's note: This clause will list conclusions that have been agreed in the study related to energy states.

#### 8.1.1.3 Monitoring and measurement

The conclusion of the study on information exposure derived from TS 22.261 [8] specification:

a) In this release of specification, the monitoring of energy consumption, renewable ratio and carbon emission is supported

b) The supported granularity is per UE and per QoS flow

c) Energy consumption monitoring as described in the preceding requirement is done by means of averaging or applying a statistical model. The requirement does not imply that some form of 'real time' monitoring is required.

Editor’s note: Whether it is feasible to estimate the energy consumption per services requires further considerations

d) per NF and per slice level, the existing OAM method is applied.

Editor’s note: Data collection for other granularities is FFS.

Alt 1 4012

e.1) Energy consumption per gNB provided from gNB.

Alt 2 4243

e.2) Energy related inforamtoin can be obtained from OAM, 5GC NFs to generate and calculate the energy consumption, energy efficiency etc. to be exposed.

NOTE x: Obtain and report energy related information from NG-RAN at granularity of per PDU session level, per QoS flow level and per UE level is out of scope of R19.

Alt 3 4387

e.3) In the R19, the gNB does not measure per UE, per PDU session and per Qos flow energy consumption.

NOTE: gNB energy consumption at per-UE, per-PDU session or per-Qos flow granularity can be derived by implementation, e.g. static average.

f) Subject to operator policy and regulatory requirements, the 5G system shall be able to monitor the energy consumption for serving the 3rd party, together with the network performance statistic information

g.1) 5GC NF (e.g., NWDAF, EECF) take the responsibility to collecting and handling energy related information to be exposed.

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g.2) The EECF is responsible for collecting, calculating the Energy consumption and efficiency data.

Editor’s note: Whether the EECF is a new 5G NF, or an enhancement to an existing NF (e.g. NWDAF) is FFS.

#### 8.1.1.4 Information exposure

The conclusion of the study on information exposure derived from TS 22.261 [8] specification:

a) In this release of specification to expose via NEF the energy consumption with the associated network performance statistic information (e.g. the data rate, packet delay and packet loss) and energy credit limit;

*a.1 The energy related information exposure to 3rd is via NEF API.*

b)- In this release of specification to expose energy consumption information and prediction on energy consumption of the 5G network;

c) In this release of the exposure of renewable energy and carbon emission information is supported and it is exposed if available,;

d.1) The granularity of the information exposed is per Service and QoS flow. The exposure per UE and PDU session is not required per TS 22.261 [8] requirements (e.g. per application service);

d,2) The following granularity of energy related information can be exposed.

- per NF, per slice, per application service;

- per UE, per PDU session, per Qos flow (per UE per service flow)

e)- Which information can be exposed is based on operator’s policy;

f) 3rd party shall be able to ask which of the information listed above may be exposed;

#### 8.1.1.5 Procedure for addressing KI#1

Based on the conclusion in clause 7 the solution described in this clause is adopted.

The procedure description includes the decision to be taken in order to conclude the KI#1.



Figure 8.1.1.5-1: Procedure for network energy related information exposure to AF

1. The AF request to be provided with the energy related information. The request includes the following parameters:

- Requested granularity (see clause 8.1.1.1);

- Information associated with granularity, e.g., UE ID, service ID, ….

2. The NEF receives the request from AF and sends the request to the NWDAF/EECF with including the parameters received from AF.

3. NWDAF/EECF interacts with 5GC NFs to get information requested for evaluation of energy related KPI, e.g., data volume.

4. NWDAF/EECF interacts with the OAM to get the energy related information.

Editor's note: whether the EECF function is a standalone NF or integrated in an existing NF needs to be determined.

Editor's note: The support of EC collection from RAN node depends on the positive feedback from RAN WG.

5. NWDAF/EECF responds to the NEF with the requested EC granularity.

6. NEF responds AF with the requested EC granularity.

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