**3GPP TSG-SA WG4 meeting #131 S4-250188r01**

**Geneva, 5** *revision of S4aI250050*

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| *CR-Form-v12.2* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **26.942** | **pCR** |  | **rev** | **01** | **Current version:** | **1.0.1** |  |
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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 | **x** | Radio Access Network |  | Core Network | **x** |

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| ***Title:*** | Solution #7: Potential solution to Key Issue #1: UE energy metrics abstraction | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia, Interdigital, BBC, Orange | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_MediaEnergyGREEN | | | | |  | ***Date:*** | | | 2025-02-11 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | B |  | | | | | ***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-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | The latest draft of 3GPP TR 26.942 contains clause 7 on Potential Solutions to the already defined and described key issues. In this context, under KI #1; the following questions were defined:  In this context, the subsequent analysis by this Key Issue should consider:  1. How should UE energy-related information be reported by a UE to the 5G System?  2. Which reference points should be used to report UE energy-related information to the Data Collection AF?  3. Would it be useful to expose energy-related information of the network to the Media Session Handler to help it optimize its media session in an energy-efficient way?  4. How to allow a UE to report its energy-related information without exposing its energy consumption rate?  It is proposed to add the proposed content to the latest draft of TR 26.942 v1.0.0 under clause 7.7 as one of the potential solutions so that it is not left incomplete. | | | | | | | | |
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| ***Summary of change:*** | | This CR proposes new text to be added in TR 26.942 on “Clause 7 Potential Solutions”. | | | | | | | | |
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| ***Consequences if not approved:*** | | Proposed objectives will not be met. | | | | | | | | |
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| ***Clauses affected:*** | | 2, 7.1, 7.7 (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/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | | S4-242024  S4aI250008  S4aI250044  S4aI250050 | | | | | | | | |

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| 1st Change |

# 2 References

[x] "[Electrochemical Energy Storage for Renewable Sources and Grid Balancing", 2015, pp. 411–435](https://www.sciencedirect.com/science/article/pii/B9780444626165000206).

[z] Accubattery: <https://play.google.com/store/apps/details?id=com.digibites.accubattery>

[A]            [https://docs.watttime.org/](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fdocs.watttime.org%2F&data=05%7C02%7Cdaniel.venmani%40nokia.com%7Cd647c48f35504333eaa208dd50077116%7C5d4717519675428d917b70f44f9630b0%7C0%7C0%7C638754715358083787%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=1jwdmZFFmkRGCMcVYqChDJRIlYExVr30dg0qFpK6JIY%3D&reserved=0)

[B]           [https://www.gridstatus.io/products/api](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fwww.gridstatus.io%2Fproducts%2Fapi&data=05%7C02%7Cdaniel.venmani%40nokia.com%7Cd647c48f35504333eaa208dd50077116%7C5d4717519675428d917b70f44f9630b0%7C0%7C0%7C638754715358117547%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=5ijP1AcuPwAg9NX6xBuBs6kVTlZ1zLxLP2dF8Llazd8%3D&reserved=0)

[C]            [https://app.electricitymaps.com/map](https://eur03.safelinks.protection.outlook.com/?url=https%3A%2F%2Fapp.electricitymaps.com%2Fmap&data=05%7C02%7Cdaniel.venmani%40nokia.com%7Cd647c48f35504333eaa208dd50077116%7C5d4717519675428d917b70f44f9630b0%7C0%7C0%7C638754715358142972%7CUnknown%7CTWFpbGZsb3d8eyJFbXB0eU1hcGkiOnRydWUsIlYiOiIwLjAuMDAwMCIsIlAiOiJXaW4zMiIsIkFOIjoiTWFpbCIsIldUIjoyfQ%3D%3D%7C0%7C%7C%7C&sdata=rURx7%2Fb%2FD6EaytlSbXT9lBZU0WyjExSX2TmDD0ZjYCY%3D&reserved=0)

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| 2nd Change |

## 7 Potential solutions

## 7.1 Mapping of solutions to Key Issues

Table 7.1-1: Mapping of solutions to Key Issues

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| --- | --- | --- | --- |
| Solutions |  |  |  |
|  | KI#1 | KI#2 | KI#3 |
| #1 |  |  |  |
| #2 |  |  |  |
| #3 |  |  |  |
| #4 |  |  |  |
| #5 |  |  |  |
| #6 |  |  |  |
| #7 | X |  |  |
| #8 |  |  |  |
| #9 |  |  |  |

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| 3rd Change **(all new text)** |

## 7.7 Solution #7: UE energy metrics abstraction

### 7.7.1 Key Issue mapping

This Candidate Solution addresses Key Issue #1.

### 7.7.2 Functional description

#### 7.7.2.1 Introduction

Clause 6.15A.5 of TS 22.261 [5] defines information exposure, which clearly states that information related to energy consumption and efficiency is not only necessary for network internal optimization, but also will benefit the service adjustment for third parties such as Application Service Providers. This Candidate Solution to Key Issue #1 determines the method of obtaining this additional energy-related information with the objective of measuring the effects of service adjustments on a single UE at a time. A summary is provided of energy-related information relevant to the UE that can be exposed by the UE to external entities in an abstract way, without exposing any internal information relating to the UE.

#### 7.7.2.2 Energy-related information relevant to the UE

Table 7.7.2.2-1 lists several device properties which are UE energy-related information. Alongside the entries defined by the deviceCapabilities object in table 8.4.2.2-1 of TS 26.565 [65], these may be useful in calculating a consolidated UE energy metric.

Table 7.7.2.2-1: UE-related energy information

|  |  |
| --- | --- |
| Property | Description |
| UE battery life | Level of the battery of the UE (e.g. in %).  Based on an estimate of how long the battery will power the device on a single charge. In simple terms, it indicates how long the device can run before needing a recharge which, depending on usage, can be a matter of hours or an entire day. |
| UE energy consumption (EC) | UE charging/discharging rate (e.g. in Watt-hours, negative or positive).  Calculated as the integral of power consumption over time as defined in TS 28.310 [2]. |
| UE energy saving duration preference | Remaining time during which the UE wants to be considered in energy saving (e.g. in minutes). |
| UE battery capacity | The total UE battery capacity (e.g. in mAh).  The total amount of electricity generated due to electrochemical reactions in the battery and is expressed in ampere hours. For example, a constant discharge current of 1 C (5 A) can be drawn from a 5 Ah battery for 1 hour [x]. |
| UE source of power supply | e.g. “battery”, “plugged in”.  Indicates whether the UE is currently operating on battery or is plugged in to an external power supply, which may or may not be renewable energy (e.g., solar panel).  This could include the ratio of renewable energy over different time granularities (e.g. plugged in 30% renewable over the last 24 hours as described in TS 28.310 [2]). |
| UE battery discharge rate | e.g. between 0 and 1000.  Calculated as the battery capacity (in mAh) divided by the number of hours it takes to /discharge the battery. For example, a battery capacity of 500 Ah that is theoretically discharged to its cut-off voltage in 20 hours will have a discharge rate of 500 mAh/20 h = 25 mA [x]. |
| UE measurement duration | Energy Measurement time interval. |
| UE carbon intensity | In -e/  A measure of the global greenhouse gases emitted per unit of generated electricity, measured in grams of CO₂ equivalents per watt-hour (for conversion to carbon emissions as defined in TS 22.261 [5] and TS 23.700-66 [20]). |

#### 7.7.2.3 Estimating the energy usage of media applications running on the UE

The Accubattery application [z] is an example, where we can understand that it allows the user to visualise the battery usage of each individual application installed on an Android UE, as illustrated in figure 7.7.2.3‑1 below.

A screenshot of a phone

Description automatically generated

Figure 7.7.2.3-1: Example of UE application showing per-application battery consumption  
(source: [z])

Similar techniques could be used to determine the battery consumption of individual media applications as input to the calculation of the UE energy-related information index.

NOTE: Further study is needed to identify the UE APIs used to obtain per-application battery consumption information on different UE operating systems.

#### 7.7.2.4 UE energy-related information index abstraction

UE energy-related information is private UE information, and it is possible that UE manufacturers do not want to share this raw information with third parties, network operators or with the Application Service Provider. Hence, this Candidate Solution proposes that the UE energy-related information is abstracted such that it does not reveal any internal properties of the UE such as its battery capacity, battery discharge rate, etc.

This abstract value of the UE energy-related information is an integer index value corresponding to a particular UE battery capacity, UE supply and UE energy consumption rate and UE carbon intensity. The index is, by design, a relative value which is not comparable with that calculated by another UE with similar energy capacity and energy supply, whether from the same or a different manufacturer.

For example, two UEs from the same manufacturer have 4000 mAh battery capacity. But the way that each of these UEs consume their energy (drain their batteries) is completely different for some or all of the following reasons, amongst others:

1. Different battery drain rate due to the age of each of the UEs. The older the UE’s battery drains faster than that of the newer UE.

2. Different battery drain rate at different ambient temperature (e.g. 40°C versus -5°C) as a result of different electrical efficiency in the UE.

3. A premium flagship model might consume energy at a different rate than a basic model, even if both are using the same application under the same conditions.

4. Different user behaviours that result in different energy consumption.

The set of criteria used to calculate the index value for UE could be extended to take additional criteria into account, such as the energy usage of individual applications as described in clause 7.2.2.3.

In summary, the UE energy-related information abstraction is unique to each UE, which allows the energy consumption rate using a particular energy supply to be identified. How such a value is derived is implementation-specific: it is left to each UE manufacturer to implement specific methods to derive this value, taking into consideration the energy capacity, energy supply and energy consumption rate of each individual UE model. This unique index value does not reveal any direct information about how a UE consumes its energy, allowing only an abstract value to be exposed beyond the UE. Hence, this information is unique to every UE and cannot meaningfully be compared with that provided by any other UE.

Because of this abstraction, any external entity (e.g., a Network Function) receiving this information is not aware of which UE (device type, model, battery capacity, etc.) has exposed that value. Rather, it is only aware of the corresponding energy consumption of a particular device (running a particular application).

### 7.7.3 Procedures

This Candidate Solution proposes a new metric; procedures for reporting this metric from the UE to an external entity are described in solution #4 in clause 7.5.

### 7.7.4 Summary

This Candidate Solution describes an abstractUE energy-related information index, which represents the energy consumed by the UE while using 3GPP services only. This index is an integer value that does not reveal information about the UE that can be fingerprinted. In addition, the energy index is a relative value which is unique to an individual UE and is not comparable with values calculated for any other UE, even if both UEs are apparently identical (e.g. from the same manufacturer, the same model with the same battery capacity and similar characteristics, etc.) for the reasons mentioned in clause 7.7.2.4.

- This Candidate Solution describes an abstractUE energy-related information index, which represents the energy consumed by the UE while using 3GPP services only.

(Note: Having the screen in full brightness or leaving the camera on with video recording, will also result in decrease in battery life, but this information is not useful to be sent as index to the network in order to optimize the content delivered.)

- The Candidate Solution does not propose any standardised methodology for the calculation of the proposed energy index value.

- Hence, the proposed methodology is limited by the lack of a standardised way to implement the calculation of the UE energy-related information index value.

- It is intentionally left to the discretion of the UE manufacturer to determine the most appropriate and most accurate method to calculate the index value depending upon individual UE characteristics.

- The only requirement is that more energy-intensive and carbon emission activities are reflected in a higher index value (which is a higher integer value).

(Note: There are several APIs available for estimating carbon intensity. See for example [A], [B], [C]).

Further study is needed to determine the exact APIs available to interrogate energy-related information on the UE, and to assess the accuracy of the information they expose to the API invoker.

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| End of change |