**3GPP TSG-**SA4 **Meeting SA4#127-bis-e** **S4-240998**

**online,** 8-4-2024 **–** 12-4-2024

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| *CR-Form-v12.3* | | | | | | | | |
| **PSEUDO CHANGE REQUEST** | | | | | | | | |
|  | | | | | | | | |
|  | 26.942 | **pCR** |  | **rev** | - | **Current version:** | 0.0.1 |  |
|  | | | | | | | | |
| *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:*** | [MediaGREEN] Network energy use | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | InterDigital Europe | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_MediaGREEN | | | | |  | ***Date:*** | | | 2-4-2024 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | D |  | | | | | ***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)* | |
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| ***Reason for change:*** | | Proposed addition of introductory text | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | The text proposed here adds currrently available information on network energy use | | | | | | | | |
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| ***Consequences if not approved:*** | | Critical background information would not be available to the 3GPP community, impairing future decision making. | | | | | | | | |
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| ***Clauses affected:*** | | 2, 4.1 | | | | | | | | |
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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:*** | |  | | | | | | | | |

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| 1st Change |

## 2 References

[BT.2521] ITU-R Report BT.2521, "Practical examples of actions to realize energy aware broadcasting".

[Lunden2022] D Lundén, J Malmodin, P Bergmark and N Lövehagen, "Electricity Consumption and Operational Carbon Emissions of European Telecom Network Operators", Sustainability 14(5):2637, 2022.

[Malmodin2020] J Malmodin, "The power consumption of mobile and fixed network data services-The case of streaming video and downloading large files." Electronics Goes Green, 2020.

[Malmodin2024] J Malmodin, N Lövehagen, P Bergmark and D Lundén, "ICT sector electricity consumption and greenhouse gas emissions – 2020 outcome", Telecommunications Policy (2024): 102701.

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| 2nd Change |

## 4 Introduction to energy efficiency for media delivery

## 4.1 General

#### 4.1.1 Motivation

The reason for studying energy consumption in media delivery stems from a concern for the current state of the climate, and the need to mitigate the effects of human-induced climate change. These effects are due to greenhouse gas emissions associated with human activity, including the production of energy. In this regard, mitigation strategies revolve around 1) producing cleaner energy, and 2) using less energy. The latter is relevant for any sector, system or device not directly involved in producing energy, including those defined by 3GPP. However, with 70–80% of network traffic being media, media data centres, the transmission of media data and media consumption on UEs contribute significantly to the total energy consumed by mobile networks. Considering the 5G System, energy efficiency of each of its components as well as the system as a whole is required.In order to achieve increased energy efficiency – both at the component level and at the system level – the system needs first to be characterised. Such characterisation additionally enables reporting, thereby informing the various stakeholders of the system's energy performance. High-level measurements illustrated in clauses 4.1.2 and 4.1.3 are too coarse to allow system performance improvements, nor does it allow individual stakeholders, including Application Service Providers, network operators, and end users to know their own instantaneous energy use. Having access to fine-grained information on energy use, for instance on streaming an individual content asset, would allow the identification of potential energy hot spots, and it would facilitate government-mandated reporting which is increasingly prevalent in certain markets.

This feasibility study therefore focuses on the possibility of putting infrastructure in place that would enable the measurement and reporting of energy consumption across the media delivery eco-system of 5G networks.

### 4.1.2 Energy and power in mobile networks

The terms power and energy are closely related, with power being the rate at which work is done. It is measured in Watts or equivalently Joules per second (symbol ), or in derived quantities such as , or . Energy is power integrated over time, measured in Joules (), or equivalently Watt-seconds (). Larger quantities are often measured in kilo-Watt-hours , mega-Watt-hours or tera-Watt-hours (TWh). One represents 3.6.

For the year 2020, the global annual electricity consumption (AEC) of mobile networks (including 2G up to 5G, as well as satellite communication) is estimated to have been 161 , of which 146  is spent by access networks, 6  by the core network, and 9  by support activities [Malmodin2024]. This represents 20  per subscription per year [Malmodin2024]. In the period 2015–2018 this figure was estimated at 17  per subscription per year [Lunden2022].

To characterize the energy used to transmit data in a more fine-grained manner, energy-per-data figures are often reported, for example in /. This suggests that a given network expends energy directly proportional to the amount of data communicated. This, however, has been shown to be an inaccurate measure due to the presence of significant fixed overheads. As an example, the servers in a data centre need to be cooled, irrespective of whether data passes through them or not.

For this, and other reasons, the transmission of data incurs a base load which is related to the presence and maintenance of the infrastructure itself, plus a mark-up that depends on the amount of data being transmitted. Thus, a more accurate way to characterise the performance of a network is to use a power model, rather than measurements based on energy. This has the advantage of allowing the base load to be accounted for in addition to a data-dependent term :

where is the power consumped (in ), is the base load (in ), is the data rate (in megabits per second, ), and b is the data-dependent term (in //). This model may be applied broadly to all equipment used for data transmission, including the IP core network, the radio access network, etc. Examples of power usage for 4G systems and use cases are given in table 4.1.2‑1 [Malmodin 2020].

Table 1. example of power usage in 4G mobile transmission systems (after [Malmodin2020])

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| System / Use case | Bit rate (/) | ( | (//) | ( |
| 4G RAN |  | 0.5 – 2 | 1 – 2 |  |
| 4G data transmission and IP core network |  | 0.05 – 0.5 | 0.03 |  |
| No data (inactive) | 0 | 1.2 | 1.53 | 1.2 |
| "YouTube" application service | 1.5 | 1.2 | 1.53 | 3.4 |
| "Netflix" application service | 4 | 1.2 | 1.53 | 7.3 |
| File download | 40 | 1.2 | 1.53 | 62 |

As can be seen in this table, the fixed overhead is relatively important at low bit rates. For larger bit rates (e.g. the file download example) the transmission rate dominates the power consumption.

### 4.1.3 Energy and power in mobile device

According to [Malmodin 2024] the global annual electricity consumption of smartphones and feature phones is estimated around 17 and 2 respectively.

The display of a terminal device is an important component of the electricity consumption. Today, an average a television set consumes 100 in operation, a laptop around 20 , and a mobile phone < 3 [BT.2521].

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| End of change |