**3GPP TSG-SA WG4 Meeting #130 *S4-241843***

**USA, Orlando, 18 – 22 November 2024**

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| *CR-Form-v12.2* | | | | | | | | |
| **PSEUDO CHANGE REQUEST** | | | | | | | | |
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|  | **26.942** | **CR** |  | **rev** |  | **Current version:** | **0.3.2** |  |
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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:*** | [FS\_MediaEnergyGREEN] Solution for KI3 based on French regulators study | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Orange | | | | | | | | | |
| ***Source to TSG:*** | S4 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | FS\_MediaEnergyGREEN | | | | |  | ***Date:*** | | | 2024-11-12 |
|  |  | | | |  | |  | | |  |
| ***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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
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| ***Reason for change:*** | | Add a potential solution for KI#3 Evaluation Framework | | | | | | | | |
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| ***Summary of change:*** | | Add a potential solution for KI#3 based on work done by the French regulators | | | | | | | | |
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| ***Consequences if not approved:*** | | No solution for KI#3 | | | | | | | | |
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| ***Clauses affected:*** | | 2, 3.3, 4.2.6 (new) and 7.2 (new) | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | |  | | |
| ***affected:*** | |  | **X** | Test specifications | | | |  | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | |  | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

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| **1st Change** |

# 2 References

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[ARCOM] ARCEP, "Arcom and Arcep, in tandem with ADEME, publish an unprecedented study on the environmental impact of audiovisual media consumption in France in 2022, and up to 2030", <https://en.arcep.fr/fileadmin/user_upload/57-24-english-version.pdf>

[26955] 3GPP TR 26.955: "5G Video Codec Characteristics"

[BatteryMgr] Android BatteryManager API, <https://developer.android.com/reference/kotlin/android/os/BatteryManager>

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| **2nd Change** |

## 3.3 Abbreviations

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AC Alternating Current

DTT Digital Terrestrial Television

HD High Definition

ISP Internet Service Provider

SoC System-on-Chip

SVoD Subscription Video-on-Demnd

TV Television

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

#### 4.2.6 Study on predicted environmental impact of audiovisual media consumption in France

In 2022, the audiovisual communications regulator for France, Arcom, and its communication networks regulator, Arcep, published a joint study [ARCOM] on the predicted environmental impact of audiovisual media consumption in France over the period from 2022 to 2030. The study assesses the environmental impact of consuming audiovisual mass media, taking all the component parts into account: hardware (user devices), networks (fixed broadband and superfast broadband, digital terrestrial, and satellite) and data centres. Its scope includes the main systems used to access audiovisual media: linear and time-shifted television and radio, audio and video streaming (including video-on-demand services), and video sharing platforms. Every type of impact has been assessed (carbon footprint, consumption of mineral and metal resources, final energy consumption) including energy usage, the target for the framework of the report.

In this study, energy usage (termed *final energy consumption*) is measured in kilowatt-hours (kWh) and refers to the quantity of electricity consumed during the usage phase of the three tiers of the digital value chain (user devices, networks and data centres). It concerns itself only with the usage stage of terminals, networks, and data centres; upstream electricity consumption for the manufacturing phase is not addressed by this indicator.

A comparative assessment of nine audiovisual usage scenarios (on the scale of one hour of audio or video content consumption in France in 2022) is considered in the report:

- **A1:** Listening to live FM radio on a radio set

- **A2:** Listening to live FM radio on a car radio

- **A3:** Listening to live radio via the Internet on a smartphone connected to the fixed network

- **A4:** Listening to music/podcast on a streaming platform (app) on a smartphone connected to the Internet via mobile network

- **V1:** Watching a TV channel in HD on a television via integrated Digital Terrestrial Television (DTT) access

- **V2:** Watching a TV channel in HD on a television connected to the Internet via a TV decoder linked to an ISP box (managed IPTV)

- **V3:** Watching catch-up TV in HD on a smart TV connected to the Internet via a TV decoder linked to an ISP box

- **V4:** Watching Subscription Video-on-Demand (SVoD) in HD on a smart TV connected to the Internet via fixed network

- **V5:** Watching online videos on a video sharing platform in HD on a smartphone connected to the Internet via mobile network

To estimate energy consumption of devices, four differents devices have been evaluated under laboratory test conditions (two smartphones, one PC and one smart TV set).

- For the smart TV and the PC, a measurement module (digital watt meter) is inserted between the device and the mains power outlet. This module measures energy consumption in Alternating Current (AC). The watt meter is connected to a computer to record the energy consumption measurements.

- For smartphones, measurements are taken using software probes to record energy and data consumption.

Energy is measured in units of milliwatt-hours per second (mWh/s) or milliamp-hours (mAh). The measurements are sampled for a period of one minute. Several iterations are performed (a minimum of three samples) to ensure relevance and to limit artifacts related to the measurement itself. Testing conditions are noted for traceability of the measurements.

Two measurement modes are possible:

- *Systematic content change between iterations.* This measurement mode has the advantage of eliminating the effects of content caching strategies in the terminal device or delivery network but has the disadvantage of introducing variability. Howeverm this measurement mode is more representative of real-world user behaviour.

- *Iterations are conducted on a continuously played video.* This measurement mode has the advantage of controlling for the variability of content but has the disadvantage of potentially underestimating consumption due to caching technologies.

The systematic content change solution is favoured in the scenario V5 (video sharing platforms). On the other hand, the continuous video strategy is used when it is useful to control for the content's impact and to study certain parameters (such as video codec).

Given the diversity of hardware studied, it was decided that the user journey would not be automated.

The data measured under laboratory test conditions are very specific. They are conducted on a single device (two for smartphones), which performs a single precise usage. This allows, for example, consumption during content playback to be differentiated from browsing a content catalogue. However, these measurements are not necessarily representative of the entire equipment landscape. Thus, comprehensive and representative data from the literature on a more diverse equipment pool were preferred over certain laboratory measurements for the quantification of audio and video usage at the national level in France.

In the context of the present document:

- The method to estimate the energy consumption of the mobile network described in [ARCOM] is not reusable because it uses a theoretical calculation based on the total amount of energy consumed by the mobile network, the mobile network usage duration per subscriber and a formula allocating energy consumption per subscriber per year and per data volume.

- The method to estimate the energy consumption of data centres described in [ARCOM] is not reusable either because it is based on external estimates.

- The method to estimate the energy consumption of a UE described in [ARCOM] could be used as a basis for evaluating the energy usage/savings of multimedia standards features and proposals on UEs.

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| **4th Change (all new text)** |

## 7.2 Solution #1: Evaluation framework based on French regulators work

### 7.2.1 Key issue mapping

This solution partially addresses Key Issue#3 (Evaluation Framework) described in clause 6.3.

### 7.2.2 Functional description

The methodology described in the ARCOM/ARCEP [ARCOM] study (as summarised in clause 4.2.6) is used as a point of departure for designing a UE energy consumption evaluation framwork in the context of the present document. However, it is observed that [ARCOM] does not include energy consumption during the usage phase of all three tiers of the digital value chain (user devices, networks and data centres). In particular, no metrics or APIs are available today for the network and data centre aspects. Their scopes would be too broad to be addressed. These parts are for further study outside the scope of the present document.

This is not the case for the user device part, because the required metrics and APIs are already available, at least on major smartphones Operating Systems, and are already used by regulators for evaluating the impact of some specific parameters. The ARCOM/ARCEP study [ARCOM] demonstrated their usefulness in evaluating the environmental impact of video codecs, video resolutions and frame rates. But this could easily be extended to other parameters such as different access network types (i.e., Wi-Fi, 5G, LTE) or content delivery modes (i.e., unicast, MBS, 5G Broadcast).

For example, the Battery Manager API is available on Android [BatteryMgr], allowing the status of the UE battery to be interrogated by an application without the need for any external network connection. Using this API, it is possible to query the battery status at various points/intervals and to collate results over time to be able to calculate the energy usage of a specific workload. Samples can be taken periodically (e.g. once per second) including the timestamp, instantaneous battery current in microamperes and current battery voltage. From the collection of these data points, the energy (measured in Joules) is calculated as follows:

joules = currentInAmps × timeDifference × voltage

There are a few limitations to measuring energy usage by this method:

1. Other applications or system processes running at the same time may affect the results.
2. The data collection itself service consumes some energy when collecting energy values. This artefact can be negated or controlled for by ensuring certain device conditions.

Contrary to the Test and Characterization Framework for Video Codecs described in TS 26.955 [26955], reference software tools are not used in this candidate solution. Real-life implementation is used as the anchor against which specific features are evaluated. Exact results from testing a specific model of device will not be generalised for all devices, nor for all implementations on that device or others.

### 7.2.3 Procedures

The following methodology is proposed to measure energy consumption in the UE:

1. A test scenario is defined and test conditions described in terms of:

a. Network (connection type, upload and download bandwith, latency).

b. User device (type, model, SoC, OS version, video player).

c. Test conditions (test duration, number of iterations, factory setting applied, etc.).

d. Anchor against which the specific features will be evaluated (i.e., 5GMS service delivering a 720p video at 2 Mbps in HEVC).

e. Reference sequence(s) used.

2. The application under test which implements the reporting of energy-related information is started.

3. The test is done for the anchor and the implementation including the feature evaluated.

- The measurement period and the number of iterations performed are required to ensure relevance and to limit artefacts relating to the measurement itself.

Two measurement modes are possible, selection is made according to the influence of the caching on the test:

- *Systematic content change between iterations.* This has the advantage of avoiding user-side CDN caching strategies but has the disadvantage of introducing variability with different content. This measurement also provides stronger representativeness of user behaviour.

- *Iterations are conducted on a continuously played video.* This has the advantage of controlling for the content, but the disadvantage of potentially underestimating consumption due to caching technologies.

4. Store results for non-real-time analysis.

5. Characterization is documented in terms of expected energy savings, and may include additional comparison parameters such as impact on the end user’s Quality of Experience, etc.

### 7.2.4 Impacts on existing services, entities and interfaces

- Collect per-application energy-related information allowing energy use by certain computational workloads (e.g., battery current and battery voltage) to be measured and analysed offline.

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| **End of Changes** |