**3GPP TSG SA WG 1 Meeting #108 S1-244791**

**Orlando, USA, 18 – 22 Nov 2024** *(revision of S1-244468, 4462, 4415, 4202)*

**Source: Nokia, NTT DOCOMO**

**pCR Title: New Use case on notifying UEs about network energy-related characteristics**

**Draft Spec: 3GPP TR 22.883**

**Agenda item: 7.2 (FS\_EnergyServ\_Ph2)**

**Document for: Approval**

**Contact: Laurent-Walter Goix <laurent-walter.goix@nokia.com>**

*Abstract:* *This pCR proposes a new use case on* *notifying users about network energy-related characteristics, including (limited) network energy availability.*

**1. Introduction**

This pCR proposes a new use case on notifying users about network energy-related characteristics.

It matches the scope of the study item: “Information exposure of energy-related characteristics of the network for the communication service (i.e. energy consumption, energy supply mix, carbon footprint, energy capacity and availability conditions) to authorized users or authorized 3rd parties”.

Whilst not targeting net energy savings per se, this use case aims at indirectly optimizing energy consumption especially when scarce, by enabling either UEs or end-users to take this information into account.

4415:

* Added NTT Docomo as supporting company

4462

* removed PR#1 (huawei), thus addressing BMWK comment on that PR
* generalized PR#2 to notify UEs in general (Vivo)
* clarified PR#4 (Huawei, vivo)
* added existing features to highlight the gap eg with respect to existing network analytics (futurewei)

4468

* removed changes on changes
* renumbered notes in PRs
* fixed 4462 list of changes
* fixed NTT DOCOMO name in source

4791

* editorial fixes (“to” > “for…to”, “also based on” > “considering”) (Qualcomm)

**2. Reason for Change**

With the increasing use of renewable energy (eg solar, wind) to power network elements (eg base stations), energy availability may be limited or variable. In addition, risks of energy outage, or energy costs increase, may induce operators to cap the energy consumption of their network in some areas to a maximum “energy budget”.

These “energy-related characteristics” can be made available to users, UEs or 3rd parties (applications, enterprise customers etc), in order to create awareness also to avoid misinterpretations on potentially limited service availability & performance.

Yet alone such information may not be actionable from a user or UE. Furthermore, the criticality of such information may be closely related to the load and traffic characteristics in the network, thus could vary over time.

Depending on the changes of such characteristics (e.g. energy, load, traffic), dynamic service and performance adjustments of the delivered communication service may happen (including QoS-based services), both from 5G network and UE perspective. For example, some service may be barred or limited and the UE should be properly notified.

**3. Conclusions**

None.

**4. Proposal**

It is proposed to agree the following use case and add it to TR 22.883.

FIRST CHANGE

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

- References are either specific (identified by date of publication, edition number, version number, etc.) or non‑specific.

- For a specific reference, subsequent revisions do not apply.

- For a non-specific reference, the latest version applies. In the case of a reference to a 3GPP document (including a GSM document), a non-specific reference implicitly refers to the latest version of that document *in the same Release as the present document*.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications".

[2] 3GPP TR 22.882: "Study on Energy Efficiency as a service criteria".

[3] 3GPP TS 22.261: "Service requirements for the 5G system".

[4] ETSI EN 303 472: "Environmental Engineering (EE); Energy Efficiency measurement methodology and metrics for RAN equipment".

[5] 3GPP TR 28.554: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[6] Internet draft "Green networking metrics"; draft-cx-opsawg-green-metrics

[7] Internet draft " Challenges and Opportunities in Management for Green Networking"; draft-irtf-nmrg-green-ps

[8] ETSI GS OEU 020 (v1.1.1): "Operational energy Efficiency for Users (OEU); Carbon equivalent Intensity measurement; Operational infrastructures; Global KPIs; Global KPIs for ICT Sites".

[9] <https://ghgprotocol.org/corporate-value-chain-scope-3-standard>. Accessed 05/08/2024.

[10] 3GPP TS 23.041: "Technical realization of Cell Broadcast Service (CBS)".

[11] 3GPP TR 23.700-66: "Management and orchestration; 5G end to end Key Performance Indicators (KPI)".

[12] E. D. Fitkov-Norris and A. Khanifar, "Dynamic pricing in mobile communication systems," First International Conference on 3G Mobile Communication Technologies, London, UK, 2000, pp. 416-420, doi: 10.1049/cp:20000083.

[X] https://analysesetdonnees.rte-france.com/en/ecowatt. Accessed 05/11/2024.

SECOND CHANGE

## 3.1 Terms

For the purposes of the present document, the terms given in 3GPP TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in 3GPP TR 21.905 [1].

**carbon intensity:** quantity of CO2 equivalent emission per unit of final energy consumption for an operational period of use [8]

**energy availability**: the remaining amount of energy (e.g. in kWh) locally available for consumption. For devices, network elements and functions, energy availability may be limited and/or intermittent, in particular when relying on batteries and/or renewable energy sources (e.g. off-grid base stations, satellites etc) or during power grid heavy load or disruptions.

**energy capacity**: the maximum amount of energy (e.g. in kWh) that can be locally available for consumption (either locally produced and/or stored) by a device or a network element or function.

**energy supply mix**: the combination of the various energy sources (i.e. renewable and not) used to meet energy needs of a device or a network element or function.

**renewable energy**: energy from renewable sources as energy from renewable non-fossil sources, namely wind, solar, aerothermal, geothermal, hydrothermal and ocean energy, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases.

NOTE: This definition was taken from [4].

THIRD CHANGE (NEW TEXT)

## 5.x Use case on notifying UEs about network energy-related characteristics

### 5.x.1 Description

With the increasing use of renewable energy (eg solar, wind) to power network elements (eg base stations), energy availability may be limited or variable. In addition, risks of energy outage, or energy costs increase, may induce operators to cap the energy consumption of their network in some areas to a maximum “energy budget”.

These “energy-related characteristics” can be made available to users, UEs or 3rd parties (applications, enterprise customers etc), in order to create awareness also to avoid misinterpretations on potentially limited service availability & performance. Yet alone such information may not be actionable from a user or UE. Furthermore, the criticality of such information may be closely related to the load and traffic characteristics in the network, thus could vary over time.

Depending on the changes of such characteristics (e.g. energy, load, traffic), dynamic service and performance adjustments of the delivered communication service may happen (including QoS-based services), both from 5G network and UE perspective. For example, some service may be barred or limited and the UE should be properly notified.

The underlying assumption is that each type or characteristic of a service provided by the network consumes some energy, also depending on traffic load and characteristics. As such, disabling or reducing some service characteristics can help the network to save energy. This is particularly helpful for network energy saving and for example to extend the operational lifetime of the network or to maintain critical/emergency service as long as possible.

In order words, adjusting network service and/or performance characteristics will allow longer operation time, as some are more energy consuming than others.

For example, network may enter reduced operations, with some services (e.g. data, video, sensing) either barred/disabled or limited/capped in terms of performances. These adjustments can be triggered when the forecasted energy availability goes below a certain threshold.

Yet in other cases, such service and/or performance adjustments may favor “better-than-normal” operations, meaning that they can easily handle additional traffic because of particularly good energy production conditions (e.g. low cost, low carbon etc) and low consumption/load forecast.

Note that the electricity grid (see EcoWatt in France [X]) has already put in place a mechanism to inform users and third parties (e.g. industries) about the forecast of its service operability (e.g. over the next 3 days, at 1h granularity). A simple “level” indicator is provided, based both on grid load (consumption) and energy production capacity and availability. Depending on the level, some recommendations are given, which are more or less impacting the availability of the grid service. Many enterprises have signed a common charter to agree to take specific measures based on the provided level.

For example the EcoWatt service has defined the following 4 levels of service operability:

* Green + leaf: “virtuous” (ie low-carbon) grid service availability with foreseen consumption lower than 95% of production. Grid service can be fully exploited with very low emissions and no risk on service availability
* Green: normal operation
* Orange: some load on the grid / limited production. Actions to reduce load are welcome.
* Red: heavy load on the grid / critical production. Restrictions/shortages are pending if actions to reduce load are not taken, in particular by industries.

### 5.x.2 Pre-conditions

MNO Green has covered some rural areas with off-grid base stations powered by solar and/or wind energy only (and local storage batteries). The energy consumption (and operability) of such base stations can be quite sensitive to the weather, further depending on traffic load.

MNO Green has defined a “NETScore” to map its service availability and characteristics onto the following “levels”:

* **Dark Green/leaf:** triggeredwhen its base stations are powered via renewable energy with no foreseen limitation, and that current and expected network load is low. This is an indication to UEs to welcome any traffic (e.g. non time-critical) as a privileged time to transmit/receive data.
* **Green**: normal operation. This is an indication to UEs that some energy-saving actions are possible to be taken by the network without QoS degradation for QoS-enabled services.
* **Orange:** Entering this level is caused by entering some load threshold or some energy-based threshold (e.g. limited remaining energy). This is an indication to UEs that some service can be barred/limited, eg « all services OK but IMS video. Data up to 5Mbps ». “Eco-actions” from users are welcome.
* **Red**: Entering this level may be caused eg by high load on the network or by very limited available energy. This is an indication to UEs that only some service is available, eg « only emergency and SMS »

NiceFarm has subscribed to MNO Green for its various IoT sensors to monitor crops, vines, soil etc. It also uses some connected webcams and a camera-equipped drone for inspections. NiceFarms’s information system and mobile application is connected to MNO Green APIs to get informed about the (planned) “NETScore” in the area.

NiceFarm’s IoT subscriptions from MNO Green allow to preconfigure UEs (e.g. in USIM or subscription) to allow or block some actions based on the “NETScore”.

The IoT devices’ operating system can be designed to centrally manage all non-time critical traffic to optimize network and UE battery usage, and so can take action upon receiving the “NETScore” planning.

### 5.x.3 Service Flows

1. It is a sunny day over the countryside with nice breeze and so MNO Green network is fully powered and recharging its batteries. On demand, it notifies served UEs in the area that all services are available and will be for the day (NETScore: Green+leaf). Such information is also provided via APIs to NiceFarm’s information system.
2. The weather forecast changes for the next 3 days in the afternoon for rainy days. Based on this information and its internal energy capacity and availability, MNO Green network understands that it will have to adjust the provided communication service over the next few days, e.g. by capping data traffic to 5Mb/s. It starts notifying high-consuming UEs (e.g. webcams) in the area about these changes (NETScore: Orange). Webcams receiving this information lower their resolution in UL video streaming.
3. After 1 day of heavy rain, one of the base stations on which the webcams are connected is getting under 20% of available battery and local renewable sources. Based on internal predictions about the requested services and their consumption, it starts notifying all UEs in the area that it now only supports emergency calls for the next day (also based on the safety risks for the population) (NETScore: Red), but that the following day should allow voice calls. Webcams don’t get data service anymore and start recording their video locally.
4. As good weather conditions resumed earlier than expected, more power is available and the base station can provide data service again on the next day. Since weather should stay stable, it starts notifying UEs in the area that it now runs normally (NETScore: Green), but that ideal conditions (NETScore: Green+leaf) should happen in 4h from now. Webcams start streaming again when receiving this information but wait for the “leaf” (and some random timer) to upload their previously recorded video.

In the meantime, NiceFarm farmers can monitor the NETScore via their information system and mobile application in order to have a better understanding of the network service availability and conditions, especially when limited, and the impacted UEs.

### 5.x.4 Post-conditions

NiceFarm is happy with this service that allows its own IoT setup to adapt and run optimally despite the changing network service availability in its area due to energy-related characteristics.

### 5.x.5 Existing features partly or fully covering the use case functionality

This use case can be addressed via an application and exposure of such information by the network without UE involvement. However, making this information available to UEs may trigger local (automated) actions or adjustments (e.g. deferring a service request, prefetching content etc).

Unified Access Control (UAC) and in particular Access Class Barring (ACB) is also an existing feature that relates to this use case. UAC is a 5G function that defines who has access to which RAN cells at what time and is primarily defined to address network congestion. For example, if a congestion occurs the gNB may broadcast UAC configuration. Prior to any access, the UE has to evaluate whether the actual access attempt can be made or not.

In this scenario UAC could be used to inform UEs whenever the network wants to restrict service operability (e.g. to only emergency calls, no data, no video etc). However, when used alone, it has the following drawbacks:

* the UE is not provided with any information about time planning/forecast to anticipate some behaviour,
* only service restrictions are supported, with no flexibility e.g. for intermediate service performance adjustments such as limited MBRs.
* all UEs are notified with the same information, with no ability to target specific UEs when needed

Rel-19 has defined the ability to estimate the energy consumed in the network by a UE. Such information can be used to notify specific UEs.

5G network analytics already exist to provide, for example to 3rd parties, statistics and predictions related to network performance, QoS sustainability, amongst others, in a target geographic area. In addition, it also provides network analytics on observed service experience for a (group of) UE, or to retrieve all UEs based on a service experience threshold.

5G network already allows to assist to an application function to select a group of UEs based on various criteria. However, it does not allow to identify which UEs are currently – or will be – under restricted service availability and performance, or under specific energy-related characteristics of the network, for example to adapt the delivered application service (e.g. by sending information or instructions, by adapting some functionalities etc).

### 5.x.6 Potential new requirements needed to support the use case

[PR.5.x.6-1] Subject to operator’s policy, regulatory requirements and user consent, the 5G system shall be able to provide UEs with information related to the current and planned service availability, service performance characteristics and energy-related characteristics of their serving network.

NOTE 1: A subset of target UEs can be selected, for example, based on their location, their energy consumption in the network, their service experience, etc.

NOTE 2: Planned information can refer to the next hour(s) or day(s), to the remaining serving time before shutdown/shortage etc.

[PR.5.x.6-2] Subject to operator’s policy, regulatory requirements and user consent, the 5G system shall be able to support a means to configure and provision policies enabling a UE to take action (e.g. defer background traffic, change access type, disable video service etc) based on the received service availability and/or service performance and energy-related characteristics of the serving network.

NOTE 3: The resulting UE actions, if any, can depend on the UE type or class (e.g. MPS/MCS, IoT, smartphone etc). In some cases, the device operating system can be designed to centrally manage all non-time critical traffic to optimize both network and UE battery usage, also by leveraging this information.

[PR.5.x.6-3] Subject to user consent, operator policy and regulatory requirements, the 5G network shall be able to assist an authorized 3rd party to identify a set of target UEs for whom to adjust the provided application service, considering criteria such as the current and planned energy-related characteristics of their serving network.

END OF CHANGES