**3GPP TSG-WG SA2 Meeting #166*****S2-2412567***

**18 - 22 November, 2024, Orlando, USA**  **(****revision of S2-2411404)**

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| *CR-Form-v12.2* |
| **CHANGE REQUEST** |
|  |
|  | **23.501** | **CR** | **5628** | **rev** | **14** | **Current version:** | **19.1.0** |  |
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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 |  | Radio Access Network |  | Core Network | **X** |

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|  |
| ***Title:***  | Support of Energy Efficiency and Energy Saving |
|  |  |
| ***Source to WG:*** | China Mobile, Rakuten Mobile, SK Telecom, China Unicom, NEC, Tencent, TOYOTA MOTOR CORPORATION, Samsung, ZTE, LG Electronics, ETRI, KDDI, Orange, Interdigital, NTT DOCOMO, KPN, Deutsche Telekom, vivo, Huawei, HiSilicon, Telefonica, Nokia |
| ***Source to TSG:*** | SA2 |
|  |  |
| ***Work item code:*** | EnergySys |  | ***Date:*** | 2024-11-08 |
|  |  |  |  |  |
| ***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 canbe 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)* |
|  |  |
| ***Reason for change:*** | This paper provides the basic framework and function design to support energy related information collection, energy consumption information calculation, and exposure. New NF EIF is introduced to support the above functionality.The methods of calculation for the Energy consumption information of different granularities are provided.The Energy Consumption information of the different granularities are derived from user plane traffic transmission, i.e. the combination of Energy Consumption information in NG-RAN, I-UPF(s) and PSA-UPF(s), and the data volume is the main contributor. The Energy Consumption Assisted information include: Node-level energy consumption information, Node-level data volume, and data volume of the required granularities.  |
|  |  |
| ***Summary of change:*** | Add new NF EIF for architecture and function design to support energy consumption information collection and calculation.Adding further information or detailed description to clarify the EIF service and interaction.Removing the Ens |
|  |  |
| ***Consequences if not approved:*** | The energy saving features cannot be supported. |
|  |  |
| ***Clauses affected:*** | 2; 3.2; 5.X;6.2.5;6.2.10; Annex XX |
|  |  |
|  | **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:*** |  |

\* \* \* \* 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 TS 22.261: "Service requirements for next generation new services and markets; Stage 1".

[3] 3GPP TS 23.502: "Procedures for the 5G System; Stage 2".

[4] 3GPP TS 23.203: "Policies and Charging control architecture; Stage 2".

[5] 3GPP TS 23.040: "Technical realization of the Short Message Service (SMS); Stage 2".

[6] 3GPP TS 24.011: "Point-to-Point (PP) Short Message Service (SMS) support on mobile radio interface: Stage 3".

skip

[195] 3GPP TS 38.414: "NG-RAN; NG data transport".

[196] 3GPP TS 38.799: "Study on Additional Topological Enhancements for NR".

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

[x] 3GPP TS 28.310: "Management and orchestration; Energy efficiency of 5G".

\* \* \* \* Second change \* \* \* \*

## 3.2 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

5GC 5G Core Network

5G DDNMF 5G Direct Discovery Name Management Function

5G LAN 5G Local Area Network

5GS 5G System

5G-AN 5G Access Network

5G-AN PDB 5G Access Network Packet Delay Budget

5G-EIR 5G-Equipment Identity Register

5G-GUTI 5G Globally Unique Temporary Identifier

5G-BRG 5G Broadband Residential Gateway

5G-CRG 5G Cable Residential Gateway

5G GM 5G Grand Master

5G NSWO 5G Non-Seamless WLAN offload

5G-RG 5G Residential Gateway

5G-S-TMSI 5G S-Temporary Mobile Subscription Identifier

5G VN 5G Virtual Network

5QI 5G QoS Identifier

ADRF Analytics Data Repository Function

AF Application Function

AI/ML Artificial Intelligence/Machine Learning

AKMA Authentication and Key Management for Applications

AnLF Analytics Logical Function

AMF Access and Mobility Management Function

AoI Area of Interest

AS Access Stratum

ATSSS Access Traffic Steering, Switching, Splitting

ATSSS-LL ATSSS Low-Layer

AUSF Authentication Server Function

BMCA Best Master Clock Algorithm

BSF Binding Support Function

CAG Closed Access Group

CAPIF Common API Framework for 3GPP northbound APIs

CH Credentials Holder

CHF Charging Function

CN PDB Core Network Packet Delay Budget

CP Control Plane

CQRCI Clock Quality Reporting Control Information

DAPS Dual Active Protocol Stacks

DCCF Data Collection Coordination Function

DCS Default Credentials Server

DetNet Deterministic Networking

DL Downlink

DN Data Network

DNAI DN Access Identifier

DNN Data Network Name

DRX Discontinuous Reception

DS-TT Device-side TSN translator

EAC Early Admission Control

EIF Energy Information Function

ePDG evolved Packet Data Gateway

EBI EPS Bearer Identity

EUI Extended Unique Identifier

FAR Forwarding Action Rule

FL Federated Learning

FN-BRG Fixed Network Broadband RG

FN-CRG Fixed Network Cable RG

FN-RG Fixed Network RG

FQDN Fully Qualified Domain Name

GBA Generic Bootstrapping Architecture

GEO Geostationary Orbit

GFBR Guaranteed Flow Bit Rate

GIN Group ID for Network Selection

GMLC Gateway Mobile Location Centre

GPSI Generic Public Subscription Identifier

GUAMI Globally Unique AMF Identifier

HMTC High-Performance Machine-Type Communications

HR Home Routed (roaming)

IAB Integrated access and backhaul

IMEI/TAC IMEI Type Allocation Code

IPUPS Inter PLMN UP Security

I-SMF Intermediate SMF

I-UPF Intermediate UPF

LADN Local Area Data Network

LBO Local Break Out (roaming)

LEO Low Earth Orbit

LMF Location Management Function

LoA Level of Automation

LPP LTE Positioning Protocol

LRF Location Retrieval Function

L4S Low Latency, Low Loss and Scalable Throughput

MBS Multicast/Broadcast Service

MBSF Multicast/Broadcast Service Function

MBSR Mobile Base Station Relay

MBSTF Multicast/Broadcast Service Transport Function

MB-SMF Multicast/Broadcast Session Management Function

MB-UPF Multicast/Broadcast User Plane Function

MEO Medium Earth Orbit

MFAF Messaging Framework Adaptor Function

MCX Mission Critical Service

MDBV Maximum Data Burst Volume

MFBR Maximum Flow Bit Rate

MICO Mobile Initiated Connection Only

MINT Minimization of Service Interruption

ML Machine Learning

MPQUIC Multi-Path QUIC

MPS Multimedia Priority Service

MPTCP Multi-Path TCP Protocol

MTLF Model Training Logical Function

MWAB Mobile gNB with wireless access backhauling

N3IWF Non-3GPP InterWorking Function

N3QAI Non-3GPP QoS Assistance Information

N5CW Non-5G-Capable over WLAN

NAI Network Access Identifier

NAT Network Address Translation

NCR Network Controlled Repeater

NCR-MT NCR Mobile Termination

NEF Network Exposure Function

NF Network Function

NGAP Next Generation Application Protocol

NID Network identifier

NPN Non-Public Network

NR New Radio

NRF Network Repository Function

NS-AoS Network Slice Area of Service

NSAC Network Slice Admission Control

NSACF Network Slice Admission Control Function

NSAG Network Slice AS Group

NSI ID Network Slice Instance Identifier

NSSAA Network Slice-Specific Authentication and Authorization

NSSAAF Network Slice-specific and SNPN Authentication and Authorization Function

NSSAI Network Slice Selection Assistance Information

NSSF Network Slice Selection Function

NSSP Network Slice Selection Policy

NSSRG Network Slice Simultaneous Registration Group

NSWO Non-Seamless WLAN offload

NSWOF Non-Seamless WLAN offload Function

NW-TT Network-side TSN translator

NWDAF Network Data Analytics Function

ONN Onboarding Network

ON-SNPN Onboarding Standalone Non-Public Network

PCF Policy Control Function

PDB Packet Delay Budget

PDR Packet Detection Rule

PDU Protocol Data Unit

PDV Packet Delay Variation

PEGC PIN Element with Gateway Capability

PEI Permanent Equipment Identifier

PEMC PIN Element with Management Capability

PER Packet Error Rate

PFD Packet Flow Description

PIN Personal IoT Network

PINE PIN Element

PLR Packet Loss Rate

PNI-NPN Public Network Integrated Non-Public Network

PPD Paging Policy Differentiation

PPF Paging Proceed Flag

PPI Paging Policy Indicator

PSA PDU Session Anchor

PSDB PDU Set Delay Budget

PSER PDU Set Error Rate

PSIHI PDU Set Integrated Handling Information

PTP Precision Time Protocol

PVS Provisioning Server

QFI QoS Flow Identifier

QMC QoE Measurement Collection

QoE Quality of Experience

RACS Radio Capabilities Signalling optimisation

IAN (Radio) Access Network

RG Residential Gateway

RIM Remote Interference Management

RQA Reflective QoS Attribute

RQI Reflective QoS Indication

RSN Redundancy Sequence Number

RTT Round Trip Time

SA NR Standalone New Radio

SBA Service Based Architecture

SBI Service Based Interface

SCP Service Communication Proxy

SD Slice Differentiator

SEAF Security Anchor Functionality

SEPP Security Edge Protection Proxy

SF Service Function

SFC Service Function Chain

SMF Session Management Function

SMSF Short Message Service Function

SN Sequence Number

SNPN Stand-alone Non-Public Network

S-NSSAI Single Network Slice Selection Assistance Information

SO-SNPN Subscription Owner Standalone Non-Public Network

SSC Session and Service Continuity

SSCMSP Session and Service Continuity Mode Selection Policy

SST Slice/Service Type

SUCI Subscription Concealed Identifier

SUPI Subscription Permanent Identifier

SV Software Version

TA Tracking Area

TAI Tracking Area Identity

TNAN Trusted Non-3GPP Access Network

TNAP Trusted Non-3GPP Access Point

TNGF Trusted Non-3GPP Gateway Function

TNL Transport Network Layer

TNLA Transport Network Layer Association

TSC Time Sensitive Communication

TSCAC TSC Assistance Container

TSCAI Traffic Assistance Information

TSCTSF Time Sensitive Communication and Time Synchronization Function

TSN Time Sensitive Networking

TSN GM TSN Grand Master

TSP Traffic Steering Policy

TSS Timing Synchronization Status

TT TSN Translator

TWIF Trusted WLAN Interworking Function

UAS NF Uncrewed Aerial System Network Function

UCMF UE radio Capability Management Function

UDM Unified Data Management

UDR Unified Data Repository

UDSF Unstructured Data Storage Function

UL Uplink

UL CL Uplink Classifier

UPF User Plane Function

URLLC Ultra Reliable Low Latency Communication

URRP-AMF UE Reachability Request Parameter for AMF

URSP UE Route Selection Policy

VID VLAN Identifier

VLAN Virtual Local Area Network

W-5GAN Wireline 5G Access Network

W-5GBAN Wireline BBF Access Network

W-5GCAN Wireline 5G Cable Access Network

W-AGF Wireline Access Gateway Function

\* \* \* \*Third change (all new text) \* \* \* \*

## 5.X Support of Energy Efficiency and Energy Saving

### 5.X.1 General

The 5GS supports some features aimed at Energy saving described in the following clauses.

### 5.X.2 Energy Consumption Information collection, calculation and exposure

#### 5.X.2.1 General

The Energy Information Function (EIF) is defined to collect the UE related Energy Consumption information, calculate the Energy Consumption information at UE, PDU Session and/or QoS flow granularity, and expose the Energy Consumption information to the authorized consumer NF(s) (AF/NEF or 5GC NF) subject to operator’s policy.

Node level energy consumption is reported PLMN-wide at a configurable period T.

#### 5.X.2.2 Energy Consumption information collection

The Energy Information Function (EIF) collects the UE related Energy Consumption information include Node-level energy consumption information, Node-level data volume from OAM and data volume of the required granularities (i.e., PDU Session and/or QoS flow) from UPF (via SMF).

The serving SMFs are retrieved from the UDM of the UE based on the provided input parameters including the UE ID and (S-NSSAI, DNN).

EIF provides UE ID, DNN/S-NSSAI, IP 5-tuple to retrieve the information from SMF. And the information collected from SMF by EIF, is shown in Table 5.X.2.2-1.

The data volume reporting period from the SMFs is the period T with PLMN-wide configuration.

Table 5.X.2.2-1: Information from SMF for user-plane energy consumption calculation

|  |  |
| --- | --- |
| Information | Description |
| UE IP address | UE IP address. |
| UE ID | SUPI |
| S-NSSAI +DNN | Slice and DNN applicable to a PDU session |
| IP 5-Tuple | IP-5-tuple |
| Data Volume information | The data volume and the associating UPF(s) and gNB(s) serving the UE within the time period.  |
| > UL/DL Data Volume of UPF | The UL/DL Data Volume of a PDU Session identified by (UE-ID, S-NSSAI/DNN) or a QoS flow (UE ID, S-NSSAI, DNN, IP 5-Tuple). |
| > (I-)UPF ID(s) | Identifier of any (I-)UPF(s) associated to a reported data volume used by a PDU Session identified by (UE-ID, S-NSSAI/DNN) or a QoS flow (UE ID, S-NSSAI, DNN, IP 5-Tuple). |
| > gNB serving the UE | The gNB which serving the UE. |
| Time period | Time period of the collected information. |

Table 5.X.2.2-2 provides the list of information received from OAM. EIF requests the OAM information with providing the serving gNB ID(s) and (I-)UPF ID(s), which provided by SMFs. The reporting period from the OAM is the period T which is the same as data volume reporting period from SMFs.

Table 5.X.2.2-2: Information from OAM for user-plane energy consumption calculation

|  |  |
| --- | --- |
| **Information** | **Description** |
| gNB energy consumption | The Energy consumed by a gNB over the configured time period T based on clause 6.7.3.4.2 of TS 28.554[10]. This is reported with an associated Timestamp. |
| gNB data volume | The UL/DL data volume handled by a gNB over the configured time period T based on clause 6.7.1.1 of TS 28.554[10]. This is reported with an associated Timestamp. |
| UPF energy consumption | The Energy consumed by a UPF over the configure time period T based on clause 6.7.3.1 of TS 28.554[10].This is reported with an associated Timestamp. |
| UPF data volume | Data volume consumed at a UPF. This is reported with an associated Timestamp. |

When the gNB and/or the (I-)UPF(s) which serving the UE are changed, the serving gNB ID and UPF ID will be updated to the EIF through SMF(s).

NOTE 1: The Node-level Energy Consumption information received from OAM could be used by EIF for all the UEs serving by the NF Node.

NOTE 2: In this release, only the energy related information of user plane communication is supported, and that of control plane signalling is not supported.

#### 5.X.2.3 Energy Consumption information calculation

EIF calculates the Energy Consumption information of the required granularies (UE, PDU Session and/or QoS flow), based on input parameters from table 5.X.2.2-1 and 5.X.2.2-2 and gets the results. Some example formulas to support the above calculation are described in Annex XX.

#### 5.x.2.4 Energy Consumption information exposure

AF/NEF or 5GC NF subscribes the EIF for Energy consumption information of required granularities (UE, PDU session and/or QoS flow).

* For UE level energy exposure, the consumer NF provides UE ID (SUPI/GPSI).
* For PDU session level exposure, the consumer NF provides UE ID (SUPI/GPSI), DNN/S-NSSAI.
* For QoS flow level exposure, the consumer NF provides UE ID (SUPI/GPSI), DNN/S-NSSAI and Flow description(s).
* The consumer NF may also subscribe the above information exposure with providing reporting period, reporting frequency.

Editor’s NOTE: Whether there are other required parameters for energy consumption information exposure are FFS.

Editor’s NOTE: Whether and how the renewable energy is introduced is FFS and depending on SA5.

Editor’s NOTE: whether and how the AF required services level energy consumption information can be exposed are FFS.

\* \* \* \* Forth change \* \* \* \*

### 6.2.5 NEF

#### 6.2.5.0 NEF functionality

The Network Exposure Function (NEF) supports the following independent functionality:

- Exposure of capabilities and events:

 NF capabilities and events may be securely exposed by NEF for e.g. 3rd party, Application Functions, Edge Computing as described in clause 5.13.

 NEF stores/retrieves information as structured data using a standardized interface (Nudr) to the Unified Data Repository (UDR).

- Secure provision of information from external application to 3GPP network:

 It provides a means for the Application Functions to securely provide information to 3GPP network, e.g. Expected UE Behaviour, 5G-VN group information, time synchronization service information and PDU Set handling service specific information. In that case the NEF may authenticate and authorize and assist in throttling the Application Functions.

- Translation of internal-external information:

 It translates between information exchanged with the AF and information exchanged with the internal network function. For example, it translates between an AF-Service-Identifier and internal 5G Core information such as DNN, S-NSSAI, as described in clause 5.6.7.

 In particular, NEF handles masking of network and user sensitive information to external AF's according to the network policy.

- Redirecting the AF to a more suitable NEF/L-NEF e.g. when serving an AF request for local information exposure and detecting there is a more appropriate NEF instance to serve the AF's request.

- The Network Exposure Function receives information from other network functions (based on exposed capabilities of other network functions). NEF stores the received information as structured data using a standardized interface to a Unified Data Repository (UDR). The stored information can be accessed and "re-exposed" by the NEF to other network functions and Application Functions, and used for other purposes such as analytics.

- A NEF may also support a PFD Function: The PFD Function in the NEF may store and retrieve PFD(s) in the UDR and shall provide PFD(s) to the SMF on the request of SMF (pull mode) or on the request of PFD management from NEF (push mode), as described in TS 23.503 [45].

- A NEF may also support a 5G-VN Group Management Function: The 5G-VN Group Management Function in the NEF may store the 5G-VN group information in the UDR via UDM as described in TS 23.502 [3].

- Support management of ECS Address Information.

- Support management of relationship between DNAI and EAS Address Information.

- Exposure of analytics:

 NWDAF analytics may be securely exposed by NEF for external party, as specified in TS 23.288 [86].

- Retrieval of data from external party by NWDAF:

 Data provided by the external party may be collected by NWDAF via NEF for analytics generation purpose. NEF handles and forwards requests and notifications between NWDAF and AF, as specified in TS 23.288 [86].

- Support of Non-IP Data Delivery:

 NEF provides a means for management of NIDD configuration and delivery of MO/MT unstructured data by exposing the NIDD APIs as described in TS 23.502 [3] on the N33/Nnef reference point. See clause 5.31.5.

- Charging data collection and support of charging interfaces.

- Support of Member UE selection assistance functionality:

- NEF may provide one or more list(s) of candidate UE(s) (among the list of target member UE(s) provided by the AF) and additional information to the AF based on the parameters contained in the request from the AF as described in clause 5.46.2. NEF supports the translation of the member UE selection filtering criteria parameters received from the AF to the corresponding event or analytics filters that can be understood by the 5GC NFs for events or analytics related data collection. NEF interacts with 5GC NFs using existing services in order to collect the corresponding data and then derive the list(s) of candidate UE(s) and other assistance information as described in clause 4.15.13 of TS 23.502 [3].

- Support of Multi-member AF session with required QoS for a set of UEs identified by a list of UE addresses:

- Details are specified in clause 4.15.6.13 of TS 23.502 [3].

- Support of UAS NF functionality:

 Details are defined in TS 23.256 [136].

- Support of EAS deployment functionality:

 Details are defined in TS 23.548 [130].

- Support of SBI-based MO SM transmit for MSISDN-less MO SMS:

 Details are defined in TS 23.540 [142].

- Support PDU Set Handling as defined in clause 5.37.5.

- Support management of common EAS and common DNAI:

 Details are defined in TS 23.548 [130].

- Support request and exposure of energy related information as defined in clause 5.x.A specific NEF instance may support one or more of the functionalities described above and consequently an individual NEF may support a subset of the APIs specified for capability exposure.

NOTE: The NEF can access the UDR located in the same PLMN as the NEF.

The services provided by the NEF are specified in clause 7.2.8.

For external exposure of services related to specific UE(s), the NEF resides in the HPLMN. Depending on operator agreements, the NEF in the HPLMN may have interface(s) with NF(s) in the VPLMN.

When a UE is capable of switching between EPC and 5GC, an SCEF+NEF is used for service exposure. See clause 5.17.5 for a description of the SCEF+NEF.

#### 6.2.5.1 Support for CAPIF

When an NEF is used for external exposure, the CAPIF may be supported. When CAPIF is supported, an NEF that is used for external exposure supports the CAPIF API provider domain functions. The CAPIF and associated API provider domain functions are specified in TS 23.222 [64].

\* \* \* \* Eighth change \* \* \* \*

Annex XX (informative):
Network Energy consumption information calculation

XX.1 General

This Annex provides examples on how EIF calculate the energy consumption for required granularities.

## XX.2 Calculation of Energy Consumption parameters

The energy consumed at a UPF ()or a gNB () is known over a time window T. And the EIF is aware of the data volume *(DV*) consumed at a UPF by a UE (*DVUE,UPF*), UE PDU session (*DVSession,UPF*) and UE QoS flow (*DVFlow,UPF*) over the time interval T. The EIF is aware of the overall data volume at a gNB (), as well as at a UPF () which serving the UE. Then based on the below example fomular, the required granularities Energy consumption information can be obtained.

To derive the of energy consumed at a gNB over a period of time T by a UE, PDU session, QoS flow, the formulas are:

To derive the energy consumed at a UPF over a time period T by a UE, session, QoS flow the formulas are:

To derive the energy consumed in the network in the time interval T by a UE (), Session (), QoS flow () the formula is:

 where are all gNBs used by the UE in an interval T, are all UPFs used by the UE in an interval T.

where are all gNBs used by the PDU Session in an interval T, are all UPFs used by the PDU Session in an interval T.

where are all gNBs used by the QoS Flow in an interval T, are all UPFs used by the QoS Flow in an interval T.