**3GPP TSG-WG SA2 Meeting #162 S2-2405124**

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**Source: Lenovo**

**Title: KI#2,** **New Solution option to Solution #15 on PCF based policy control for UE Energy Consumption**

**Document for: Approval**

**Agenda Item: 19.4**

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*Abstract: This paper proposes a new solution to KI#2 as part of the existing Solution #15.*

# 1. Introduction/Discussion

The Solution #15 describes in the clause 6.15.3.1 enhancements to the MM procedures for energy saving. In this procedure, based on input information from the NWDAF or NEMF, the AMF determines in step 7 to perform access and mobility management procedures for energy saving. Such AM procedures are applicable on per UE basis.

There is an alternative solution possible and explained herewith. After the AM policy association is established for a UE, based on the indication that the UE is subject to energy control (and optionally about the subscribed energy credit, the PCF subscribes for notification the energy collecting NF (e.g. the NEMF or NWDAF). When the PCF is notified that the subscribed energy credit of the UE is exceeded, the PCF may create and send to the AMF an updated AM policy control information. The updated AM policy control information may include lower UE-AMBR, Slice-MBR or other parameters.

# 2. Text Proposal

It is proposed to capture the following changes to TR 23.700-66.

\* \* \* \* First change \* \* \* \*

## 6.15 Solution #15: Enhancements to existing 5GS procedures for energy saving and policy control enforcement

### 6.15.1 Key Issue mapping

This solution addresses Key Issue #3 "5GS enhancements for network energy saving and efficiency" and Key Issue #2 "Subscription and policy control to support energy efficiency and energy saving as service criteria".

### 6.15.2 Functional Description

Existing 5G MM and SM procedures can be enhanced based on the requirements of network energy saving and energy efficiency.

The AMF can decide Access and Mobility parameters related to network energy saving based on AM subscription data, AM policy, UE related analytics (e.g. UE mobility and abnormal behaviour analytics), network energy control information, etc. and provide the parameters to the UE during 5G MM procedures (e.g. Registration and UE Configuration Update procedures).

The SMF can decide Session Management parameters related to network energy saving based on SM subscription data, SM policy, UE related analytics (e.g. UE communication and abnormal behaviour analytics), network energy control information, etc. and provide the parameters for the PDU Session during 5G SM procedures (e.g. PDU Session establishment/modification procedures).

The AM policy and SM policy are created by the PCF taking into account the requirements of network energy saving. The AM and/or SM subscription data can be extended to contain validity conditions (e.g. time/area) for more features/capabilities (e.g. Subscribed UE-AMBR, 5GS Subscribed QoS profile, Subscribed-Session-AMBR, ATSSS information) to facilitate network energy saving (i.e. limiting network energy consumption per UE).

NOTE: The AM and SM subscription data (see clause 5.2.3.3.1 of TS 23.502 [3]) contains already some features/capabilities with validity condition, e.g. CAG and Network Slice with validity time/location information.

The AMF and the SMF may requests network energy control information from the NEMF (Network Energy Management Function), a new 5GC NF introduced for network energy management. The network energy control information contains NF IDs of the 5GC NFs which are put in energy saving states with validity time and area information.

Editor's note: The role of the NEMF and need of NEMF needs to be clarified.

Editor's note: The analytics requires input information that has not been identified.

In one alternative, the PCF may determine AM policy information or SM policy information to achieve energy saving (e.g. by UE service restriction or PDU Session restriction). After the AM policy association is established for a UE or SM policy association is established for a PDU Session, based on the indication that the UE or PDU session is subject to energy control (and optionally about the subscribed EC credit), the PCF may subscribe for notifications from the energy collecting NF (e.g. the NEMF or NWDAF). When the PCF is notified that the subscribed EC credit of the UE (or for an application/session) is exceeded, the PCF creates and sends to the AMF (or SMF) an updated AM policy control information (or SM policy control information) which includes lower UE-AMBR, Slice-MBR or other service restriction parameters and optionally applicability conditions for the service restriction.

### 6.15.3 Procedures

#### 6.15.3.1 Mobility Management procedures enhanced for energy saving



Figure 6.15.3.1-1: Enhanced MM/Registration Procedures for energy saving

1. The UE initiates Registration procedure towards the network as described in step 1, clause 4.2.2.2.2 of TS 23.502 [3].

 The Registration procedure continues as specified in clause 4.2.2.2.2 of TS 23.502 [3], with the following enhancements:

2. In step 14b of Figure 4.2.2.2.2-1 in TS 23.502 [3], the AM subscription data retrieved from the UDM contains validity conditions for one or more subscription parameters (e.g. Subscribed UE-AMBR per time period and/or area) to facilitate network energy saving (i.e. limiting network energy consumption per UE).

3. In step 16 of Figure 4.2.2.2.2-1 in TS 23.502 [3], during AM Policy Association Establishment/Modification procedure, the PCF decides AM policy, e.g. UE-AMBR, List of UE-Slice-MBR, List of allowed TAIs, taking into account network energy related information, and provides the AM policy to the AMF. The PCF may collect the network energy related information by subscribing to energy related notifications from the AMF, SMF and/or UPF, or requesting/subscribing to energy related analytics from the NWDAF. The PCF may decide to reduce the UE-AMBR or UE-Slice-MBR or to expand a list of allowed TAIs, if the network energy related information indicates that the UE is associated with high network energy consumption in an area or for a time period.

4. In step 21 of Figure 4.2.2.2.2-1 in TS 23.502 [3], the AMF provides the parameters e.g. Mobility restrictions, Allowed NSSAI, in Registration Accept message taking into account network energy related information. Also, in the Registration Accept message, one or more network supported features are provided with validity conditions (e.g. support of Control plane CIoT 5GS optimization with validity time and/or validity area). Based on this, the UE decides only to apply functions corresponding to the network supported features under the validity condition, thus saving network energy by avoiding unnecessary information processing (i.e. receiving and rejecting UE requests).

 After the completion of Registration procedure, the AMF may perform the following steps for energy saving:

5. The AMF requests "UE Mobility" analytics and "Abnormal behaviour" analytics from the NWDAF as specified in clauses 6.7.2 and 6.7.5 of TS 23.288 [14].

6. Optionally, the AMF requests network energy control information from the NEMF. The network energy control information contains NF IDs of the 5GC NFs which are put in energy saving states with validity time and area information.

Editor's note: Whether and how the AMF gets network energy control information from the NEMF is FFS.

7. Based on UE subscription data, AM policy, "UE Mobility" analytics and "Abnormal behaviour" analytics, network energy control information (if available), etc, the AMF performs access and mobility management procedures for energy saving, e.g. deregistering the UE with unexpected long-live/large rate flows based on "Abnormal behaviour" analytics if the registration procedure is for mobility registration update or periodic registration update, or forwarding the Registration Request to a target AMF based on the network energy control information (e.g. if the AMF itself is put in Energy Saving state and then a target AMF is selected for the UE based on the network energy control information).

8. The AMF sends energy saving assistance information in N2 message to the NG-RAN. The energy saving assistance information may be part of CN assisted RAN parameters tuning based on UE mobility analytics, e.g. statistics/prediction of UE location and UEs' geographical distribution. Based on this, the NG-RAN performs energy saving operations, e.g. redirecting the UEs to cell(s) with higher energy efficiency.

NOTE 1: Regarding providing the energy saving assistance information to NG-RAN, N2 signalling load should be considered. Non-UE associated N2 signalling can be considered for transmitting the energy saving assistance information, which is up to RAN WG3 to decide.

NOTE 2: How the NG-RAN performs energy saving operations with both OAM configuration and energy saving assistance information from the 5GC is up to implementation.

Editor's note: It is FFS whether the NG-RAN supports performing energy saving operation based on assistance information from the 5GC.

#### 6.15.3.2 AM policy control to achieve energy efficiency and energy saving

This solution describes a procedure for the PCF to create AM policy control information which contributes to restrict the UE service parameters (e.g. based on the reached maximum EC credit) and achieves energy saving.



Figure 6.15.3.2-1: Procedure for the PCF to create AM policy control information achieving energy saving

The detailed description of the steps is provided as follows:

1. The UDM/UDR stores UE subscription data which is enhanced to include *EC-related subscription data* for the UE and may include:

- an indication that the UE is subject to service restrictions when energy needs to be saved.

- a maximum EC credit to be enforced for the UE (e.g. for a time span like day, week, month).

- an alternative QoS level which can be expressed by a reduced bitrate (e.g. reduced UE-AMBR for Non-GBR QoS Flows) to apply when the EC credit is consumed.

- the service or traffic type to which the *EC-related subscription data* applies, e.g. a) to Non-GBR services; b) to any type of non-mission critical services; or c) to all services.

2a. The UE initiates Registration procedure towards the network as described in step 1, clause 4.2.2.2.2 of TS 23.502 [3].

2b, 2c. Similar as step 2 in the Figure 6.15.3.1-1, the AMF retrieves the UE’s subscription data from the UDM. The UDM sends a response message including the UE’s subscription data which may include the *EC-related subscription data*.

3a. The AMF requests the access and mobility (AM) policy association establishment with the PCF. The AMF may indicate that 1) the UE is subject to service restriction due to EC, and/or 2) the subscribed maximum EC credit.

3b. The PCF sends an AM policy association response message to the AMF.

4. The AMF sends Registration Accept to the UE.

5a. The PCF discovers and selects an NF which is responsible to collect the UE EC information (e.g. NEMF, ECF, NWDAF). The PCF subscribes with the NF to be notified when the UE subscribed maximum EC credit is reached, whereby the SUPI identifies the UE.

5b. The PCF is notified of the event that the UE subscribed maximum EC credit is reached. The PCF may be triggered by events from e.g. OAM system (e.g. when Energy Consumption per Network Slice or in an area should be limited), or EC Collection Function on per UE-level (e.g. ECF, which can be collocated with the CHF or NWDAF). Such trigger events may occur when the network has identified that the EC in a specific area, or the EC of a specific service or Network Slice has reached a maximum EC credit. Alternatively, the PCF may be triggered, e.g. by CHF, when the Energy Credit Limit (ECL) for a UE has been reached.

NOTE 1: The ECF is outside the scope of this solution and is described in solution(s) focusing on the collection of the energy related information for KI#1 and KI#2. The PCF can also subscribe with the ECF for notifications when an energy-related event occurs (e.g. when the maximum EC credit or ECL has been reached).

Editor's note: It is FFS whether and how the NEMF/ECF stores the EC information collected during previous the UE registration, if applicable.

5c. The PCF determines to create updated AM policy control information called *EC/EE-related AM restriction policy* which restricts the UE AM service parameters. For example, the AM policy control information may include *alternative reduce UE-AMBR for Non-GBR QoS Flows* or *reduced QoS level* to be applied to the UE.

Optionally, *applicability conditions* may be included which indicate the conditions under which the *alternative reduce UE-AMBR* or *reduced QoS level* applies. For example, the restrictions may apply for 1) non-GBR services; 2) to any type of non-mission critical services; 3) to all services; 4) the time period or 5) the service area (e.g. a list of cells or TAIs).

5d. The PCF sends a Notification message to the AMF to update the AM policy for the UE based on the energy consumption.

6. The AMF stores and enforces the updated EC/EE-related AM policy e.g. towards the (R)AN.

7. This is similar to step 8 from the Figure 6.15.3.1-1 where the AMF sends an N2 message to the (R)AN and includes the EC/EE-related *AM restriction policy* and the associated *applicability conditions*. The EC/EE-related information includes an indication that the NG-RAN may perform energy efficiency operations, reduced QoS level (e.g. UE-AMBR), etc.

 The (R)AN stores the EC/EE-related *AM restriction policy* and the associated *applicability conditions* in the UE context. The (R)AN enforces the *EC/EE-related service restriction policy* for the UE in the service area (defined by list of cells or TAs), the (R)AN applies the restriction parameters (e.g. reduced UE-AMBR) for User Plane data transmissions.

NOTE 2: The reduced UE-AMBR or Slice-MBR contributes to the energy saving because less transmitted data means less energy consumption. According to SA1 requirements, restricting the data rate due to energy restrictions is fine if covered in the SLA.

 The (R)AN notifies the AMF about applied restriction (e.g. duration of EC-related restrictions.

8. The AMF (or PCF) may store the information received from (R)AN in the UE’s context. The AMF may send a Notification message to the PCF or to a CHF in order to inform about the applicability of the EC-related restrictions in order to allow different charging rate during the EC-related restrictions were applied.

#### 6.15.3.3 Session Management procedures enhanced for energy saving



Figure 6.15.3.3-1: Enhanced SM/PDU Session Establishment Procedures for energy saving

1. The UE initiates PDU Session Establishment procedure towards the network as described in step 1, clause 4.3.2.2.1 of TS 23.502 [3].

 The PDU Session Establishment procedure continues as specified in clause 4.3.2.2.1 of TS 23.502 [3], with the following enhancements:

2. In step 4 of Figure 4.3.2.2.1-1 in TS 23.502 [3], the SM subscription data retrieved from the UDM contains validity conditions for one or more subscription parameters (e.g. 5GS Subscribed QoS profile or Subscribed-Session-AMBR per time period and/or area, ATSSS information with validity time and/or area) to facilitate network energy saving (i.e. limiting network energy consumption per UE).

3. In step 7b and 9 of Figure 4.3.2.2-1 in TS 23.502 [3], during SM Policy Association Establishment/Modification procedures, the PCF decides SM policy, e.g. Authorized Session-AMBR, Authorized default 5QI/ARP, taking into account network energy related information (e.g. energy consumption of the network slice for the PDU Session) and energy related application specific parameters (e.g. authorized energy consumption credit per network slice and/or application) provisioned by the AF, and provides the SM policy to the SMF. The PCF may collect the network energy related information by subscribing to energy related notifications from 1) NEMF or 2) other NFs like the AMF, SMF and/or UPF, or requesting/subscribing to energy related analytics from the NWDAF. The PCF may decide to reduce the Authorized Session-AMBR or change the Authorized default 5QI/ARP for the PDU Session, if the network energy related information indicates that the UE is associated with high network energy consumption in an area or for a time period.

 The PCF can also subscribe with the NEMF to obtain energy related information on per service/application level. The PCF determines to trigger an event notification to the SMF (e.g. that the service restriction due to maximum EC are reached).

4. In step 11 of Figure 4.3.2.2-1 in TS 23.502 [3], the SMF provides the parameters in N2 SM information (e.g. QoS Profile(s), Session-AMBR, Maximum Data Rate) and parameters in PDU Session Establishment Accept message (e.g. QoS Flow level QoS parameters, Session-AMBR, Always-on PDU Session Granted, Small Data Rate Control parameters), taking into account network energy related information.

 After the completion of PDU Session establishment procedure, the SMF may perform the following steps for energy saving:

5. The SMF requests "UE Communication" analytics and "Abnormal behaviour" analytics from the NWDAF as specified in clauses 6.7.3 and 6.7.5 of TS 23.288 [14].

6. Optionally, the SMF requests network energy control information from the NEMF.

Editor's note: Whether and how the SMF gets network energy control information from the NEMF is FFS.

7. SMF may perform an SMF initiated SM Policy Association Modification procedure if the Policy Control Request Trigger condition(s) is met as specified in TS 23.502 [3] and TS 23.503 [4]. The PCF may update the SM policy for the PDU Session based on network energy related information, e.g. energy consumption of the PDU Session reaches or goes beyond a predefined threshold.

8. Based on UE subscription data, SM policy, "UE Communication" analytics and "Abnormal behaviour" analytics, network energy control information (if available), etc, the SMF performs Session Management procedures for energy saving, e.g. modifying the QoS parameters for specific applications based on "UE Communication" analytics.

9. The SMF sends energy saving assistance information in N2 message to the NG-RAN. The energy saving assistance information may be part of CN assisted RAN parameters tuning based on UE communication analytics, e.g. statistics/prediction of traffic volume, periodic communication indicator and periodic time for the UE and/or the PDU Session. Based on this, the NG-RAN performs energy saving operations, e.g. redirecting the UEs to cell(s) with higher energy efficiency.

NOTE: How the NG-RAN performs energy saving operations with both OAM configuration and energy saving assistance information from the 5GC is up to implementation.

Editor's note: It is FFS whether the NG-RAN supports performing energy saving operation based on assistance information from the 5GC.

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

**AMF:**

- Performs Access and Mobility Management taking into account network energy saving requirements, based on AM subscription data, AM policy received from PCF, UE related analytics (e.g. UE Mobility analytics and Abnormal behaviour analytics), and/or network energy control information, etc.

- Optionally, obtaining network energy control information from the NEMF.

- Optionally, indicating charging event related to EC/EE-related restrictions to the CHF.

**SMF:**

- Performs Session Management taking into account network energy saving requirements, based on SM subscription data, SM policy, UE related analytics (UE Communication analytics and Abnormal behaviour analytics), network energy control information, etc.

- Optionally, obtaining network energy control information from the NEMF.

**PCF:**

- Collecting network energy related information by subscribing to network energy related notifications using the following option: 1) from the AMF, SMF and/or UPF, or 2) requesting/subscribing to network energy related analytics from the NWDAF, or 3) requesting/subscribing with the NEMF/ECF for notification about reaching the energy credit for a UE or other energy restriction criteria.

- Obtains energy related application specific parameters from the AF (via the NEF/UDM/UDR).

- Creates an updated AM policy and/or SM policy based on network energy consumption related information received from the NEMF/ECF and optionally energy related application specific parameters from the AF.

**AF:**

- Provisions energy related application specific parameters to the PCF (via the NEF/UDM/UDR).

**NEMF (new, optional):**

- Perform network energy management, e.g. providing to other 5GC NFs the network energy control information which contains information of the 5GC NFs in energy saving states with validity time and area information.

**RAN:**

- Performs energy saving operations base on assistance information provided by the 5GC.

\* \* \* \* End of changes \* \* \* \*