**3GPP TSG-SA5 Meeting #158 *S5-247119***

Orlando, USA, 18 - 22 November 2024 revision of *S5-246667*

**Source: Nokia**

**Title: Rel-19 pCR TR 28.880 Add use case on cell proximity-based energy saving**

**Document for: Approval**

**Agenda Item: 6.19.20**

# 1 Decision/action requested

***The group is requested to discuss and approve the pCR below.***

# 2 References

[1] 3GPP TR 28.880: " Study on energy efficiency and energy saving aspects of 5G networks and services"

# 3 Rationale

This contribution proposes to add a new use case on cell proximity based energy saving.

The inference function has been introduced in TS28.105 and it is agreed that Energy Saving is one use case for which for AI/ML inference functions may be instantiated. This pCR adds the configurable features and requirements for AI/ML-based Energy Saving Functions.

This is key issue related to the following objective that is described in FS\_Energy\_OAM\_Ph3.

* WT-1.3 Study new use cases, requirements and solutions for energy efficiency and energy saving, applying to NG-RAN and/or 5GC and/or network slicing, (including but not limited to intent based, analytics based and AI/ML assisted energy saving)

# 4 Detailed proposal

The following changes are proposed for TR 28.880[1].

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## 3.3 Abbreviations

For the purposes of the present document, the abbreviations given in 3GPP 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 3GPP TR 21.905 [1].

CE Carbon Emission

CEE Carbon Emission Efficiency

CEF Carbon Emission Factor

CPC Cell Proximity Coupling

GST Generic Slice Template

NEST Network Slice Type

P-NEST Private NEST

REF Renewable Energy Factor

S-NEST Standardized NEST

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## 5.A Use case #<A>: Cell proximity-based energy saving

### 5.A.1 Description

#### 5.A.1.1 Overview

TS 28.310 defines a capacity booster cell which can be deactivated when the load is low. For a capacity booster cell to be deactivated, a coverage cell should have adequate overlap with the booster cell to make sure that deactivation of the booster cell does not lead to a coverage hole. A coverage cell may have several capacity booster cells that can be deactivated. An energy saving function, e.g., the "domain-centralized ES function", needs to select the best among the capacity booster cells to be deactivated at a given time. The energy saving function should be enabled to support the selection for and sequencing of deactivation of the capacity booster cells.

#### 5.A.1.2 Cell proximity

To activate or deactivate cells, an energy saving function (be it the Domain-centralized ES or the distributed ES function, see TS 28.310 [12]) computes the degree to which the coverage of cells overlap among each other to ensure that the coverage of a deactivated cell (the capacity booster cell) is compensated by another cell (called the coverage cell). The degree of neighborliness measures and characterizes the degree to which a capacity booster cell overlaps with the coverage cell. The energy saving function can compute or consumes services of another function which computes the degree of neighborliness among the cells. Alternatively, the degree of neighborliness can be obtained by an entity , e.g., the operator and configured onto the energy saving function. As input, the entity computing the degree of neighborliness takes 1) the cell configuration data including transmit powers, applied antennas characteristics and tilts; 2) the propagation characteristics like building information; and 3) performance information like cell handover statistics.

Note 1: the degree of neighborliness is information contained by the energy saving function, it does not need to be defined in the RAN.

#### 5.A.1.3 Cell grouping and categorization

To optimize the selection of cells to be deactivated or reactivated, the energy saving function needs to group the cells that need to be treated togther for energy saving into a group, say called the Energy Saving Cell Group. Within the Energy Saving Cell Group, the cells are categorized into two sets - the coverage cells which are not deactivated and provide primary coverage and capacity booster cells which only enhance capacity and can thus be deactivated when the load is low. The entity computing the cell grouping can inform the operator or an energy saving function about the group of cells that need to be treated together, i.e., the the Energy Saving Cell Group and the categorization of cells either as a coverage or a capacity booster cell., Where the energy saving function does not have the capability to compute the Energy Saving Cell Group, it should be possible to configure the Energy Saving Cell Group and cell categorisations to the energy saving function.

Note 2: the Energy Saving Cell Group is quasi-static information on the energy saving function, when configured it remains uncnahed untill reconfigured.

#### 5.A.1.4 Cell deactivation sequence

When selecting cells to deactivate, the energy saving function considers the load in a set of cells to then decides the most optimal cell(s) to be deactivated and the order in which they can be deactivated. Based on the degree of neighborliness among cells as well as the cell grouping and categorization as coverage or capacity booster cells, the the energy saving function can compute the order in which the cells can be deactivated and reactivated. The energy saving function can inform the e.g., the operator of the cell deactivation order, e.g., by indicating each capacity booster cell’s rank in the deactivation and reativation process. The an Operator can be enabled to request for such a deactivation order. Where the energy saving function does not have the capability to compute the cell deactivation order, another function(e.g. an AIML inference function) can be enabled to configure the cell deactivation order onto the energy saving function.

Given the cell deactivation order, the energy saving function routinely compares the load in the set of cells (the Cell Group load) to the low and high load thresholds to decide if activation or deactivation can be executed. The the Cell Group load needs to be computed for the set of active cells Moreover, an automaton function can be enabled to configure the activation or deactivation load thresholds.

Note 3: the term deactivation is used to represent a total switching off of the cell or any disabling of a part of the cell, e.g., a disabling of the cell's power amplifier.

Note 4: the activation sequence is expected to be the opposite order to the deactivation sequence, but whether extra details are required for the activation sequence will be addressed in the normatve work.

Note 5: For all the input information, the energy saving function may be configured by or based on the output of other automation functions including MDA functions and AIML inferenc efunctions. For example, MDA may derive the cell grouping which is then configured onto the Energy saving function

### 5.A.2 Potential requirements

**REQ-NES-01:** The 3GPP management system should have a capability allowing an authorized MnS consumer to configure an energy saving function with the Cell Proximity Coupling (CPC), describing the degree to which the coverage areas of any candidate neighbour cells overlap with each other.

**REQ-NES-02:** The 3GPP management system should have a capability allowing an authorized MnS consumer to configure an energy saving function with information on the group of cells that need to be treated together (called the Energy Saving Cell Group) when selecting cell to be activated or deactivated.

NOTE REQ-1: Configuration is needed only if the energy saving function cannot compute the Energy Saving Cell Groups.

**REQ-NES-03:** The 3GPP management system should have a capability allowing an authorized MnS consumer to configure an energy saving function with information on the cell categories indicating coverage cells and capacity booster cells.

NOTE REQ-2: Coverage cells are those that provide primary coverage and are not deactivated while capacity booster cells are those which only enhance capacity and can thus be deactivated when the load is low.

**REQ-NES-04:** The 3GPP management system should have a capability allowing an authorized MnS consumer to configure an energy saving function with information on the cell deactivation order which is the capacity booster cell’s rank in the deactivation and reactivation process indicating the order in which the cells in a given area should be deactivated.

NOTE REQ-3: Configuration is needed only if the energy saving function does not compute the cell deactivation order.

**REQ-NES-05:** The 3GPP management system should have a capability allowing an authorized MnS consumer to configure an energy saving function with the deactivation and reactivation load thresholds.

**REQ-AIML-NES-01:** The 3GPP management system should have a capability enabling an MnS producer to provide to an authorized MnS consumer a set of Cell Proximity Couplings (CPC) expressing the degree to which the coverage areas of any candidate neighbour cells overlap with each other.

**REQ-AIML-NES-02:** The 3GPP management system should have a capability enabling an MnS producer to provide to an authorized MnS consumer information on the group of cells that need to be treated together (called the Energy Saving Cell Group) when selecting cell to be activated or deactivated.

**REQ-AIML-NES-03:** The 3GPP management system should have a capability enabling an MnS producer to provide to an authorized MnS consumer information on the categorisation of cells indicating which among them are coverage cells or capacity booster cells.

**REQ-AIML-NES-04:** The 3GPP management system should have a capability enabling an MnS producer to provide to an authorized MnS consumer information on the cell deactivation order which is the capacity booster cell’s rank in the switch off/on process indicating the order in which the cells in a given area should be deactivated.

### 5.A.3 Potential solutions

#### 5.A.3.1 Potential solution #A: AI/ML-assisted Network Energy Saving

##### 5.A.3.1.1 Introduction



Figure 5.A.3.1.1-1: Relation on cell-based energy saving and beam-based energy saving

The required functionality for cell-based energy saving is related to the functionality on beam-based energy saving as illustrated by Figure 5.A.3.1.1-1. MDA computes analytics for beam-based energy saving and provides recommendations t the gNB, e.g. for the sequence in which to deactivate beams. On the other hand, the centralized energy saving function can compute the sequence of deactivation of cells, e.g. with support from AIML inference functions or MDA Mns services. Based on the sequence, the ES function determines the cells to be deactivated at a given time. The deactivation of cells can be executed by the centralized energy saving function while the deactivation of beams is executed by the gNB and only for the cells that are active at the time.The focus of this use case and solution is the configuration and reporting information to the centralized ES function (illustrated by the thick arrow).

##### 5.A.3.1.2 Required Information

In this potential solution, the energy saving function takes 4 pieces of information to derive the point at which specific cells are deactivated for energy saving:

- the degree of neighborliness among cells called the Cell Proximity Coupling (CPC),

- the group of cells that should be considered together for energy saving called the Energy Saving Cell Group

- categorisation of cells within the the Energy Saving Cell Group as either coverage cells or capacity booster cells

- the cell deactivation order which indicates the order in which the cells in a given area should be deactivated, e.g., as a rank of each capacity booster cell in the deactivation and reactivationprocess.

An energy saving function can be configured by the MnS consumer with any of the four pieces of information while the rest may be derived internally by the energy saving function. The energy saving function may also consume the services of one or more AI/ML inference function(s) for energy saving optimization which derives any of the four input information.

The energy saving function may employ an AIML inference function to support the selection for and sequencing of deactivation of the capacity booster cells. In particular,

##### 5.A.3.1.3 Proposed information elements

This potential solution proposes the following:

1) Introduce an IOC representing a group of cells that should be managed together for energy saving purposes. It can be a generic grouping IOC (e.g., GenericCollection) or a specific IOC for an energy saving purpose called EnergySavingCellGroup (derived from GenericCollection IOC).

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- Introduce attributes on the EnergySavingCellGroup IOC representing the set of coverage and capacity booster cells. They can respectively be called coverageCells and capacityBoosterCells.

- Introduce an attribute on the EnergySavingCellGroup representing the recommended cell deactivation order.

3) Enhance the energySavingFunction IOC to add the following attributes:

- the Cell Proximity Coupling for any pair of cells

- the EnergySavingCellGroup

3) Introduce in the inference report of an energy saving optimization AI/ML inference function:

- an attribute for the Cell Proximity Coupling (CPC) for each gNB,

- a list indicating the group of cells that should be considered together for energy saving

- for each entry in the list a flag indicating the categorization of the cell as either a coverage or a capacity booster cell within that group

- for each capacity booster cell in the list an integer indicating the rank of that cell in the cell deactivation order

### 5.A.4 Evaluation of potential solutions

Only one solution in clause 5.A.3.1 is provided for this use case. The solution enables an automation function (e.g., an AIML inference function) to generate any of the four input information for energ saving while also enabling the same to be configured onto the energy saving function. It is thus a feasibe solution and normative work should be pursued following this solution.

Note 6: the use case, requirements and solution are a baseline which can be enhanced or extended in the normative work, e.g. to address support for an activation sequence if different from the deactivation sequence.

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## 6.A Cell proximity-based energy saving

The use case, requirement and solution for Cell proximity-based energy saving is described in clause 5.A. In this use case, four input information for energ saving is described including how the energ saving may be configured with that information. it is also described how an energy saving function may rely on an AIML inference function to obtain the four input information

It is recommended to add this use case and requirement in TS 28.310 [12] and take the solution as baseline for normative work. It is also recommended to add the new attribute proposed in the solution to TS 28.541 [16].

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| **End of change** |