**3GPP TSG-SA5 Meeting #157 *S5-245679***

Hyderabad, India, 14 Oct - 18 Oct 2024

**Source: Samsung, Nokia**

**Title: EE Conclusions**

**Document for: Approval**

**Agenda Item: 6.19.4**

# 1 Decision/action requested

***In this box give a very clear / short /concise statement of what is wanted.***

# 2 References

None

# 3 Rationale

This provides the conclusion for EE related solutions.

# 4 Detailed proposal

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| **First Change** |

## 5.1 Energy efficiency analytics

### 5.1.1 Use case 1: Energy Saving based on throughput requirements

#### 5.1.1.1 Description

Directional beams are formed using multiple antenna elements and directional beams are used in both common channels for initial access and in RRC\_CONNECTED state. Common signals/channels used for UE initial access are transmitted in synchronization signal block (SSB). Each SSB associated with a beam is designed at different directions to cover the intended coverage area of a cell as depicted in Figure 5.1.1.1-1.

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| Figure 5.1.1.1-1: Illustration of SSB beams covering full cell coverage area. | Figure 5.1.1.1-2: Illustration of reduced number of SSB beams covering only hotspot area. |

To reduce energy consumption, SSB beams which are not required based on traffic demand can be modified or deactivated. For example, as depicted in Figure 5.1.1.1-2, if the expected traffic (hotspot area) can be covered by 3 beams, then the remaining beams can be deactivated. This energy saving techniques depend on the accuracy of where the expected traffic demand comes from geographically, so that it can be correlated with SSB beam coverage areas.

This use case considers throughput as main criteria to define the traffic load. It is desirable to use MDA analytics to get throughput prediction for traffic load at the granular level of geographical coordinate. This information can be then used to reduce the coverage of the beam resulting in energy savings.

#### 5.1.1.2 Potential requirements

**REQ-TLM-FUN-01:** MDA capability for energy saving analysis shall include providing the predicted throughput requirements for the area which is the candidate for the energy saving mechanism.

#### 5.1.1.3 Potential solutions

The enabling data for MDAAssistedEnergySaving.EnergySavingAnalysis is defined in TS 28.104 [2]. This solution proposes additional performance metrics into this table to enrich UE throughput and location information so that throughput metrics can be processed with UE location to generate throughput requirement, at the granular level of geographical coordinate, for more accurate energy saving decisions.

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| **Data category** | **Description** | **References** |
| MDT Reports | PDCP Data Volume per UE | PDCP SDU Data volume measurement separately for DL and UL, per DRB per UE by gNB of M4 measurements in TS 32.422 [12] and TS 32.423 [10]. |
| Average UE throughput measurement | Average UE throughput measurement separately for DL and UL, per DRB per UE and per UE for the DL, per DRB per UE and per UE for the UL, by gNB of M5 measurements in TS 32.422 [12] and TS 32.423 [10]. |
| Packet Delay measurement | Packet delay measurement, separately for DL and UL, per DRB per UE by gNB of M6 measurements in TS 32.422 [12] and TS 32.423 [10]. |
| UE location reports | UE location information provided by the LMF services. | The UE location information provided by LMF via service-based interface (see TS 23.273 [7]). The mapping between the UE location and the SSB coverage need to be decided and up to the producer implementation. |

The analytics output for MDAAssistedEnergySaving.EnergySavingAnalysis is defined in TS 28.104 [2]. This solution proposes that throughput information at the granular level of geographical coordinate is added to the analytics output. Additionally the recommendation to activate the SSB is also provided based on the throughput requirements at the granular level of geographical coordinate. This recommendation can be proposed to gNB which can decide to implement the recommendation based on local policies.

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| **Information element** | **Definition** | **Support qualifier** | **Properties** |
| rANenergySavingRecommendationSSB | For ES on NR cell SSBs. It may contain a set of:  - Recommended NRCell SSB to be activated/de-activated.  - Recommended candidate cell SSBs with precedence for taking over the traffic of the ES-Cell.  -  - The load threshold to activate/de-activate the NR Cell SSB. | M | type: EsRecommendationOnNRcellSSB  multiplicity: 1..\*  isOrdered: False  isUnique: True  defaultValue: None  isNullable: False |

#### 5.1.1.4 Evaluation of solutions

The solution proposed in clause 5.1.1.3 satisfies the requirements and this solution is feasible for normative work.

### 5.1.2 Use case 2: Extension of Cell Energy Saving analytics

#### 5.1.2.1 Description

Energy efficiency can be achieved by moving certain cells to energy saving state (see TS 28.104 [2]). When moved to energy saving state, such cells or beams will have different impacts to the neighbour cells or beams depending on how much the coverage of those cells overlap

RAN3 has a use case to configure unified mapping rule for a group of cells. This implies that a mapping rule related to EE are same across a group of cells for a given area. It is desirable to use MDA analytics to get a group of cells that should be managed together for energy saving, computed, or learned depending on their proximity and likely impact on one another.

Then, for the cells in the group, it is desirable to use MDA analytics to get the sequence in which the beams can be activated/de-activated in order to maximize the throughput of the users while minimizing the energy consumption. Note that the sequence in which the activation of beams happen activated are necessarily not in the same sequence as deactivation. The sequence of activation/de-activation of the beams do matter in real time scenarios. For instance, there are 4 beams in a cell serving the same geo area at different directions. To maximize the energy efficiency, if it has been decided to switch two beams off for energy saving purposes, in general the sequence of the deactivation of the beams can be random or all the identified beams can be deactivated together. In both these cases, the sharing of load among the other beams and the handover performances between the beams would not be optimal. If all the identified beams are deactivated at the same time, the remaining beams would have to share the load of the beams those are deactivated at the same time. This would cause call drops and throughput impacts. Alternatively, if a random sequence is followed, the impact and the performance of the beams sharing the load of the deactivated beams would be random as well. To avoid this scenario, it is recommended to follow a sequence in which the beams are activated/deactivated.

RAN3 has identified the need for configuring a unified mapping rule among gNBs. These set of gNBs to which unified mapping rule to be applied form a group of cells that need to be managed together for energy efficiency purposes as shown in the below figure.



**Figure 5.1.2.1-1 Example of Energy Cost exchange between gNBs.**

The enabling data of this use case may include Mobility Management related measurements (clause 5.1.1.6 from TS 28.552 [5]) including intra and inter gNB handovers. These also include handover measurements per beam (in clauses 5.1.1.6.1.12 and 5.1.1.6.1.13 from TS 28.552 [5]) and intra-NR cell SSB beam switch measurements (in clause 5.1.1.21 from TS 28.552 [5]).

#### 5.1.2.2 Potential requirements

**REQ-TLM-FUN-01:** MDA capability for energy saving analysis shall include providing, for a given area, the recommended grouping of cells that should be managed together for energy saving.

**REQ-TLM-FUN-02:** MDA capability for energy saving analysis shall include providing the recommended sequence in which the beams are switched off/on in order to maximize the throughput of the users while minimizing the energy consumption.

#### 5.1.2.3 Potential solutions

This potential solution proposes to extend the existing energy saving analytics for RAN to include the datatype that may contain the groups and the cells in each of the groups. RAN3 has already identified the need for the groups of cells that can be managed together and this recommendation of energy saving analytics proposes the optimal number of groups and the cells in each of those groups. The cells belonging to each group can be identified by the datatype NCGI (clause 5.3.212 from [13]).

The potential solution also proposes to extend the cell energy saving analytics for gNBto indicate the sequence in which the beams may be activated or de-activated. This recommendation can be proposed to gNB which can decide to implement the recommendation based on the local policies. The beams can be identified with the “beamIndex” (clause 4.3.40 from [13]).

#### 5.1.2.4 Evaluation of solution

The solution proposed in clause 5.1.2.3 satisfies the requirements and this solution is feasible for normative work.

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| **Next Change** |

## 6.1 Energy efficiency analytics

The use case, requirements and solution for Energy Saving based on throughput requirements is described in clause 5.1.1. It is recommended to update the inputs and outputs for MDAAssistedEnergySaving.EnergySavingAnalysis as proposed in clause 5.1.1.3.

The use case, requirements and solution for the capability of Extension of Cell Energy Saving analytics is described in clause 5.1.2. It is recommended to update the inputs and outputs for MDAAssistedEnergySaving.EnergySavingAnalysis as proposed in clause 5.1.2.3.

Note: It is assumed that the RAN node would consume the beam level information provided as part of MDAAssistedEnergySaving.EnergySavingAnalysis. RAN Node can manage beams as suggested in analytics output.

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| **Last Change** |