**3GPP TSG-RAN WG4 Meeting # 112 R4-2411804**

**Maastricht, Netherlands, 19th – 23rd August, 2024**

**Agenda item:** 5.29.4

**Source:** Moderator (Huawei)

**Title:** Ad-hoc minutes for [112][209] Netw\_Energy\_NR

**Document for:** Information

# Introduction

This topic summary includes RRM core/perf requirements for Rel-18 network energy saving (5.29.1 and 5.29.2).

**Recommended Topics to be treated online (in order of decreasing priority):**

**Issue 1-1-1: Power difference conditions**

**Issue 1-1-5: Intra-band non-contiguous CA**

**Issue 1-1-2: Multiple SSB-less SCells activation**

**Issue 1-1-4: Neighbour cells on carrier of SSB-less SCell**

**Issue 1-1-3: Relation to R15 intra-band SSB-less**

**Issue 1-2-1: When CHO condition is not met anymore**

**Issue 1-2-2: TP to address the difference cases as described in issue 1-2-1**

# Topic #1: Core requirements maintenance

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

NA

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1 SSB-less related

**Issue 1-1-1: Power difference conditions**

*Background*

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| **RAN4#111 R4-2410269**  **Issue 1-1-1: Power difference conditions**  **Agreement:**  Clarify that EPRE difference is based on the EPRE normalized by SCSs of SSB of reference Cell and A-TRS/P-TRS of SSB-less Cell.  Only change [9] dB to [12] dB in this meeting.  Further discuss whether and how to support larger EPRE difference in next meeting:   * Option 1: Clarify that EPRE difference is smaller or equal to [12] dB + |20\*log (f1/f2)| - Margin, where f1 and f2 is the center frequency of reference Cell and SSB-less Cell and the value of Margin is FFS. * Option 2: Further increase [12] dB and the value is FFS * Option 3: Update the requirements with one more P-TRS sample for larger EPRE difference * Other options are no precluded. |

* Proposals
  + Option 1: Clarify that EPRE difference is smaller or equal to [12] dB + |20\*log (f1/f2)| - Margin, where f1 and f2 is the center frequency of reference Cell and SSB-less Cell and the value of Margin is FFS. (Apple, OPPO, Nokia, CMCC, Huawei, ZTE)
  + Option 2: Further increase [12] dB. (Nokia, Vivo, ZTE)
  + Option 3: The power difference condition could be further increased beyond EPRE = 12 dB. In this case one more P-TRS occurrence should be allowed for AGC convergence. Remove [after the compensation for AGC]. (QC, Vivo)
  + Option 4: RAN4 to keep “EPRE after pre-compensation” and “12dB EPRE difference” in the spec text, and no any further change is expected. (Apple, CTC, Ericsson)
* Moderator:
  + 6/10 companies support option 1
  + 3/10 companies support option 2
  + 2/10 companies support option 3.
  + 3/10 companies support option 4.

Though there is majority supporting for option 1, there is also strong objection behind each option based on the discussion in last meeting. Considering that it is already late stage, let’ try to conclude this issue in this meeting.

* Recommended WF:
  + Treat this issue online and try to conclude it in this meeting.

**Issue** **1-1-2: Multiple SSB-less SCells activation**

*Background:*

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| **RAN4#111 R4-2410269**  **Issue 1-1-3: Multiple SSB-less SCells activation**  **Agreements:**   * + Also define requirements for following scenario:     - When all to-be-activated SCells are SSBless on the same band and SCells are contiguous.     - All to-be-activated SCells have same QCL source cell.     - P-TRS is used.       * Option 1: The multiple SCell activation delay requirements are based on TRS with the shortest periodicity. The detailed requirements can be discussed in the CR.       * Option 2: UE activate each to-be-activated SCell based on the TRS on the SCell, and the requirements to be defined accordingly (i.e. single CC delay)     - FFS A-TRS based requirements. |

* Proposals

TRS-based:

* + Option 1: For multiple SSB-less SCell activation with TRS, when all to-be-activated SCells are intra-band contiguous SSB-less SCells and all to-be-activated SCells have same QCL source cell, the multiple SCell activation delay requirements are based on TRS with the shortest periodicity. (Apple, Nokia, CMCC, CTC, ZTE)
  + Option 2: Regarding the minimum requirement of multiple SSB-less SCells activation, the UE should activate each to-be-activated SCell based on the TRS on the SCell, and the requirements to be defined accordingly. (MTK, QC, Huawei)

A-TRS based:

* + Option 1: For multiple SSB-less SCell activation with A-TRS, when all to-be-activated SCells are intra-band contiguous SSB-less SCells and all to-be-activated SCells have same QCL source cell, the multiple SCell activation delay requirements are based on A-TRS on the SCell which has the earliest arrived A-TRS after MAC CE decoding. (Apple, CMCC)
  + Option 2: When all to-be-activated SSB-less SCells are contiguous in same band, the single SSB-less SCell activation delay can be applied to each to-be-activated SSB-less SCell respectively. (Huawei, ZTE)
  + Option 3: No requirements for multiple SSB-less SCell activation should be defined for A-TRS in Rel-18. (QC)

Mixed scenario (TRS-based and A-TRS based):

* + Option 1: For multiple SSB-less SCell activation, when “all to-be-activated SCells are intra-band contiguous SSB-less SCells” and “all to-be-activated SCells have same QCL source cell” and “A-TRS and TRS are configured for different to-be-activated intra-band contiguous SSB-less SCells”, the multiple SCell activation delay requirements are based on A-TRS on the SCell which has the earliest arrived A-TRS after MAC CE decoding. (Apple)
* Moderator:
  + It was agreed in previous meeting to define multiple SCell activation requirements at least for TRS-based case. Option 1 is one step further enhancement compared with option 2. Considering it is already late stage, Companies please check with option 2 can be agreed, and further enhancement can be considered in later release. A-TRS and mixed (TRS and A-TRS), can be discussed after TRS-based case.
* Recommended WF:
  + For TRS-based multiple SSB-less SCell activation, agree on option 2. Further enhancement (e.g. option 1) can be considered in further release.
  + Discuss whether/how to define requirements for A-TRS based and mixed scenario (TRS-based and A-TRS based):

Ad-hoc discussion (Monday):

* Recommended WF:
  + For TRS-based multiple SSB-less SCell activation, single SCell activation requirement applies to each to-be-activated SCells accordingly.
  + FFS whether/how to define requirements for A-TRS based and mixed scenario (TRS-based and A-TRS based).

CMCC: For TRS-based, can compromised to the recommended WF. Same principle can apply to A-TRS and mixed scenarios.

Apple: Though we support option 1, same principle and apply to A-TRS and mixed case.

ZTE:

**Agreement:**

* + For TRS-based multiple SSB-less SCell activation, single SCell activation requirement applies to each to-be-activated SCells accordingly.
  + FFS: For A-TRS and mixed scenario (TRS-based and A-TRS based), single SCell activation requirement applies to each to-be-activated SCells accordingly.

**Issue 1-1-3: Relation to R15 intra-band SSB-less**

* Proposals
  + Option 1: For UE supports both R18 inter-band SSB-less and R15 intra-band contiguous SSB-less SCell operation, if the to-be-activated SSB-less SCell is configured with QCL source to both intra-band contiguous and inter-band Cells, no SCell activation requirement shall be applied, regardless of whether the Rel-18 reference cell indication is configured. (Apple, Nokia, Huawei, ZTE)
    - Option 1a: (Huawei)
    - For UE supports both R18 inter-band SSB-less and R15 intra-band contiguous SSB-less, when R18 reference cell indication is configured, network shall configure QCL source to associate with the inter-band Cell.
    - For UE supports both R18 inter-band SSB-less and R15 intra-band contiguous SSB-less, when R18 reference cell indication is configured, Rel-18 SSB-less requirement is applied.
  + Option 2: When R18 reference cell indication is configured, network configure with QCL source to both intra-band contiguous and inter-band Cells, SSB less activation should follow Rel-15 requirement. (Ericsson)
* Recommended WF:
  + Agree on option 1, which means no spec impacts.

Ad-hoc discussion (Monday):

* Recommended WF:
  + Agree on option 1 (i.e. no requirements when the SSB-less SCell is configured with QCL source to both intra-band contiguous and inter-band Cells), which means no spec impacts.

**Agreement:**

* + No requirements when the SSB-less SCell is configured with QCL source to both intra-band contiguous and inter-band Cells. And no spec impacts expected.

**Issue 1-1-4: Neighbour cells on carrier of SSB-less SCell**

* Proposals
  + Option 1: if neighbor cells on carrier of SSB-less SCell have SSB transmission, the measurement for those neighbor cells shall be treated as inter-frequency measurement without MG as long as the SSBs from those neighbor cells can be contained in the active BWP of SSB-less SCell (Apple, ZTE)
* Recommended WF:
  + Intra-frequency/Inter-frequency: Inter-frequency based on existing definition.
  + With/without gap:
    - Option 1: For UE supporting R18 SSB-less, UE autonomously supports inter-f w/o gap as long as the SSB is within the active BWP.
    - Option 2: Whether UE can support inter-f w/o gap following existing rules (conditions in 9.3.1, e.g supporting of R16 inter-frequency without gap, R17 R18 NeedForGap)

Ad-hoc discussion (Monday):

* Recommended WF:
  + Intra-frequency/Inter-frequency definition:
    - Inter-frequency based on existing definition.
  + With/without gap:
    - For UE supporting R18 SSB-less, UE supports inter-f w/o gap as long as the SSB is within the active BWP of SSB-less SCell.

Vivo: gap or without gap, prefer option 2.

Ericsson:

Apple: gap or without gap, prefer option 2. Should depends on R16/R17 gap related capabilities.

ZTE: gap or without gap, prefer option 1. Not sure whether R16/R17 capability can suit R18 feature.

Nokia: gap or without gap, prefer option 1.

QC: gap or without gap, prefer option 2.

Ericsson:

Intel: Ok with option 2.

**Agreement:**

* + Intra-frequency/Inter-frequency definition:
    - Inter-frequency based on existing definition. No impact to spec about the intra-f and inter-f definition.
  + FFS: With/without gap:
    - Whether UE can support inter-f w/o gap following existing rules (conditions in 9.3.1, e.g supporting of R16 inter-frequency without gap, R17 R18 NeedForGap)

**Issue 1-1-5: Intra-band non-contiguous CA**

* Proposals
  + Option 1: (Apple)
    - The [EPRE] difference at the UE is smaller than or equal to [6] dB, where, [EPRE] difference is the power difference between TRS/A-TRS symbol on the SSB-less SCell and SSB symbol on the reference serving cell [after the compensation for AGC].
    - The RTD between the target SSB-less intra-band NCCA SCell and the collocated reference serving cell is within CP where CP is corresponding to the max SCS between reference cell and target SCell.
  + Option 2: (Nokia, Intel)
    - For FR1 intra-band non-contiguous CA, reuse the SSB-less SCell activation delay requirement defined for FR1 co-located inter-band CA with the same RTD side condition i.e. RTD within CP
  + Option 2a: (Intel)
    - Specify only assuming separate chains and reuse largely the requirements specified for inter-band cases;
    - Specify UE optional capability signalling for intra-band NCCA SSB-less SCell operations in a similar way as for inter-band cases;
    - UE with single chain implementation does not indicate support for intra-band NCCA SSB-less SCell operations and does not need to meet the requirements.
    - Introduce the optional with capability signalling with per FS granularity for UE supporting intra-band NCCA SSB-less SCell operation in Rel-18.
  + Option 3: (ZTE)
    - Two sets of requirements respectively assuming single and separate chains, where the requirements of inter-band case are largely reused for the separate chains assumption, and the requirements of intra-band contiguous case are largely reused for the single chain assumption. Two optional UE capabilities refers to the two cases. If neither of them supported by the UE, then UE does not support the SSB-less SCell activation for intra-band non-contiguous CA.
* Moderator: Considering the late stage, suggest to conclude this issue online in this meeting.
* Recommended WF:
  + Conclude this issue online in this meeting.

### Sub-topic 1-2 NES-based CHO related

**Issue 1-2-1: When CHO condition is not met anymore**

* + Option 1: (Nokia)
    - For FR1 intra-band non-contiguous CA, reuse the SSB-less SCell activation delay requirement defined for FR1 co-located inter-band CA with the same RTD side condition i.e. RTD within CP
    - The NES-based CHO shall be executed only if the condition of NES-based CHO is met when receiving the DCI 2-X command after TEvent\_DU + Tidentify\_intra\_with\_index.
* Recommended WF:
  + Discuss in CR in issue 1-2-2.

**Issue 1-2-2: TP to address the difference cases as described in issue 1-2-1**

* Proposals
  + Option 1: (Nokia R4-2411565)

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| TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until#  - a condition exists at the measurement reference point which will trigger the conditional handover, or   * a condition exists after receiving DCI 2-9 command which will trigger the NES-based conditional handover, provided DCI 2-9 command comes after TEvent\_DU + Tidentify\_intra\_with\_index and the condition of NES-based CHO is met when receiving the DCI 2-9 command, or   - a condition exists at the measurement reference point which will trigger the NES-based conditional handover , otherwise.  For NES-based conditional intra-frequency handover:  - If UE successfully decodes DCI 2-9 command occurs earlier than the time at the end of TEvent\_DU + Tidentify\_intra\_with\_index or TEvent\_DU + Tidentify\_intra\_without\_index, then the measurement time delay equal to Tidentify\_intra\_with\_index or Tidentify\_intra\_without\_index  - If UE successfully decodes DCI 2-9 command occurs later than the time at the end of TEvent\_DU + Tidentify\_intra\_with\_index or TEvent\_DU + Tidentify\_intra\_without\_index, and the condition of NES-based CHO is met when receiving the DCI 2-9 command, then the measurement time delay equals to the time from the end of Tevent\_DU until UE successfully decodes DCI 2-9 command.   * If UE successfully decodes DCI 2-9 command later than the time at the end of TEvent\_DU + Tidentify\_intra\_with\_index or TEvent\_DU + Tidentify\_intra\_without\_index, and the condition of NES-based CHO is not met when receiving the DCI 2-9 command, then the measurement time delay equals to TSSB\_measurement\_period\_intra. |

* + Option 2: (Huawei R4-2412200)

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| TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until  - a condition exists at the measurement reference point which will trigger the conditional handover, or  - UE successfully decodes DCI 2-9 with NES-mode indication.  <<unchanged part>>  6.1.4.2.2 Measurement time  The measurement time delay is defined from the end of TEvent\_DU until UE executes a handover to a target cell and interruption time starts.  For conditional intra-frequency handover, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify intra with index or Tidentify\_intra\_without\_index defined in clause 9.2.5.1 or clause 9.2.6.2.  For conditional inter-frequency handover, the measurement time delay measured without Time To Trigger (TTT) and L3 filtering shall be less than Tidentify\_inter\_with\_index or Tidentify\_inter\_without\_index defined in clause 9.3.4.  For NES-based conditional intra-frequency handover:  - If a condition exists at the measurement reference point which fulfills the conditions for NES-based conditional handover, and it keeps existing for Tidentify\_intra\_with\_index or Tidentify\_intra\_without\_index before UE successfully decodes the DCI 2-9 with NES-mode indication, Tmeasure = 0.  - Otherwise, Tmeasure equal to the time span from the end of TEvent\_DU until a condition keeps existing for Tidentify\_intra\_with\_index or Tidentify\_intra\_without\_index. which can fulfill the NES-based conditional handover. |

* + Option 3: Vivo R4-2412605

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| TEvent\_DU is the delay uncertainty which is the time from when the UE successfully decodes a conditional handover command until  - a condition exists at the measurement reference point which will trigger the conditional handover, or  - a condition exists within 2\*Tidentify\_intra\_with\_index or 2\*Tidentify\_intra\_without\_index before UE successfully decodes DCI 2-9, which will trigger the NES-based conditional intra-frequency handover if NES-based conditional handover applies, or  - a condition exists within 2\*Tidentify\_inter\_with\_index or 2\*Tidentify\_inter\_without\_index before UE successfully decodes DCI 2-9, which will trigger the NES-based conditional inter-frequency handover if NES-based conditional handover applies.  TCHO\_execution is the UE execution preparation time for conditional handover.  For conditional handover, it starts after UE realizes the condition of CHO is met and identity of the target cell is determined.  For NES-based conditional handover:  - It starts after UE realizes the condition of CHO is met and identity of the target cell is determined provided that UE has already successfully decoded DCI 2-9.  - Otherwise, it starts after UE successfully decodes DCI 2-9. |

* Recommended WF:
  + Discuss in the CR in this meeting.

### CR handling

Discuss following CR during the meeting.

**CR for SSB-less operation**

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| **Tdoc** | **Source** | **Changes** | **Recommendation** |
| R4-2412219 | Huawei | Updating for EPRE condition  Updating for multiple SCell activation  Clarification when multiple TRS is configured | Pending on Issue 1-1-1/Issue 1-1-2. |
| R4-2412421 | Intel | Requirements updating for intra-band NCCA | Pending on Issue 1-1-6. |
| R4-2413014 | Ericsson | Updating for EPRE condition | Pending on Issue 1-1-1. |

**CR for NES-based CHO**

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| **Tdoc** | **Source** | **Changes** | **Recommendation** |
| R4-2411565 | Nokia | Updating for NES-based CHO requirements considering condition variation. | Pending on Issue 1-2-2 |
| R4-2412200 | Huawei | Updating for NES-based CHO requirements considering condition variation. | Pending on Issue 1-2-2 |
| R4-2412605 | Vivo | Updating for NES-based CHO requirements considering condition variation. | Pending on Issue 1-2-2 |

# Topic #2: Performance maintenance

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

NA

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 2-1 Performance part related to SSB-less

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 2-1-1: Test case for SSB-less**

* + Option 1: Do not introduce pathloss margin [ΔEPRE] for inter-band SSB-less SCell activation test cases. (Apple)
  + Option 2: (Ericsson)
    - RAN4 to set EPRE difference as 12 dB + ΔPL - margin in the test cases
    - RAN4 to use free space propagation delay difference to compute the ΔPL based on the carrier frequency difference and BW difference.
* Recommended WF:
  + Discuss this issue with core maintenance issue 1-1-1 in this meeting.

**Issue 2-1-2: Test case for NES CHO**

* + Option 1: The test cases where DCI 2-9 command is decoded “after” the RSRP condition of CHO is met needs to be updated considering additional sub-test where CHO condition is not met when receiving DCI 2-9 command. (Nokia)
* Recommended WF:
  + Discuss above option.

**Issue 2-1-3: Test case for Cell DTX**

* + Option 1: For Cell DTX test, UE can be scheduled with PUSCH for L3 reporting during on-duration of Cell DTX. The delay uncertainty for next available PUSCH should be considered in the test requirements. (Huawei)
  + Option 2: For cell DTX test case, the TAT is set to 1280ms, and the UE shall be scheduled with PUSCH at every cell DTX cycle. (Vivo)
  + Option 3: Test 40ms Cell DTX periodicity instead of 640ms. (Vivo)
* Recommended WF:
  + Discuss above option.

### Sub-topic 2-2 CR handling

Discuss following CRs during the meeting.

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| **Tdoc** | **Source** | **Recommendation** |
| R4-2411567 | Nokia | To be checked during the meeting. |
| R4-2412422 | Intel | To be checked during the meeting. |
| R4-2412522 | Vivo | Related to issue 2-1-3. To be checked during the meeting. |
| R4-2413016 | Ericsson | Related to issue 2-1-1. To be checked during the meeting. |