3GPP TSG-RAN WG4 Meeting #98-e R4-210xxxx

Electronic Meeting, Jan. 25-Feb. 5, 2021

**Agenda item:** 11.9.1, 11.9.2

**Source:** Moderator (MediaTek inc.)

**Title:** Email discussion summary for [98e][238] NR\_UE\_pow\_sav\_enh

**Document for:** Information

# Introduction

This document is the email discussion summary for UE Power Saving Enhancements (AI 11.9), including the following topics covered

* Topic 1: General and work plan (AI 11.9.1)
* Topic 2: UE measurements relaxation for RLM and/or BFD (AI 11.9.2)

List of candidate target of email discussion for 1st round and 2nd round

* 1st round: Decide on the scope, priority, options and tentative agreement to be discussed in the 2nd round. Conclude issues with strict consensus, if any.
* 2nd round: Conclude the issues identified in the 1st round.

# Topic #1: General and work plan (AI 12.9.1)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2101221**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101221.zip) | MediaTek inc. | *Proposal 1: RAN4 to endorse the RRM work plan for R17 UE powers saving enhancements as presented in this contribution.* |

## Open issues summary

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

### Sub-topic 1-1 Work plan

**Issue 1-1-1: Work plan**

* Background:
  + Revised RRM work plan for R17 UE powers saving enhancements is proposed. (R4-2101221)
* Proposals
  + Option 1: RAN4 to approve the RRM work plan for R17 UE powers saving enhancements as presented in R4-2101221. (MTK)
* Recommended WF:
  + Companies are encouraged to provide views in 1st round.
  + Rapporteur may revise Work plan in 2nd round.

## Companies views’ collection for 1st round

### Open issues

**Issue 1-1-1: Work plan**

|  |  |
| --- | --- |
| **Company** | **Comments** |
|  |  |

### CRs/TPs comments collection

*Moderator’s note: No CRs/TPs in this topic.*

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

**Issue 1-1-1: Work plan**

|  |
| --- |
| **Status summary** |
| *Status:*  *Tentative agreements:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
|  |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
|  |  |

## Discussion on 2nd round (if applicable)

**Issue 1-1-1: Work plan**

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: UE measurements relaxation for RLM and/or BFD (AI 12.9.2)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2100043**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100043.zip) | ZTE Corporation | Observation 1: The mobility status of the UE is known to both the network and the UE in CONNECTED mode.  Proposal 1: Whether UE can determine alone if the low mobility criteria is met depends on the testability of the correct UE behavior.  Proposal 2: The UE can determine alone if the criteria is met and enter the low mobility mode to use a relaxed requirements for RLM and RLF if there will be test cases defined to test the UE behaviors.  Proposal 3: The UE while performing relaxed RLM upon detecting certain number of out-of-sync indications or upon triggering T310 reverts to the normal RLM operation (i.e. without relaxation).  Proposal 4: The UE while performing relaxed BFD upon beam failure detection reverts to the normal BFD operation (i.e. without relaxation).  Observation 2: Whether the UE can relax monitoring PDCCH depends on the data traffic instead of mobility.  Observation 3: Monitoring of PDCCH depends on the DRX cycles, which already takes into account the traffic between UE and network.  Proposal 5: Further discussion whether relaxation on PDCCH monitoring is within the scope of this WI. And whether RAN4 needs to specify anything related to relaxation on PDCCH monitoring.  Proposal 6: For intra-band CA case, the UE should relax only on serving cells where the relaxed criteria is fulfilled.  Proposal 7: Take UE mobility as the major factor into the criteria. |
| [**R4-2100219**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100219.zip) | Apple | Observation: RLM/BFD relaxation achieve higher UE power saving gain with shorter DRX cycle, with up to 19.34% power saving gain is observed.  Proposal 1: RLM/BFD relaxation through scaling on DRX cycle is supported.  Proposal 2: Relaxation factor depends on various factor including DRX cycle configuration, RLM-RS configuration, mobility and channel conditions etc.  Proposal 3: R16 RRM relaxation criterion can be used as baseline for RLM/BFD relaxation.  Proposal 4: UE revert back to normal operation when criterion is not met, or when N310 start to count. |
| [**R4-2100474**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100474.zip) | CATT | Observation 1: for low speed, the relaxation factor can be 4 with no performance degradation for RLM compared to Rel-15.  Observation 2: When speed is 30km/h, the system cannot meet the same performance as that in release 15.  Proposal 1: Use of a scaling factor for defining the relaxed RLM/BM evaluation period. Use low mobility criteria to do RLM relaxation for power saving, and the relaxation factor can be 4 with no performance degradation for RLM compared to Rel-15. |
| [**R4-2100478**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100478.zip) | CATT | *Simulation results* |
| [**R4-2100725**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100725.zip) | Xiaomi | Proposal 1: Extending the measurement interval of RLM/BFD for UE power saving.  Proposal 2：UE skip some measurement samples by increasing the indication interval to a longer interval which is larger than the evaluation period could be an alternative way to save the UE power consumption.  Proposal 3: Low mobility scenario and at-cell-centre scenario could be considered as two possible scenarios for RLM/BFD measurement relaxation.  Proposal 4: The relaxation for the RLM/BFD should be determined by both the network and UE.  Proposal 5: UE is expected to revert to normal RLM operation during T310 is running.  Proposal 6: There might be no benefit to configure conditions for UE reverting to normal BFD.  Proposal 7: RAN4 to define the same measurement relaxation rules for the serving cells in intra-band CA/DC. |
| [**R4-2100821**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100821.zip) | CMCC | *Proposal 1: For relaxation scheme, Option1a (use a scaling factor for defining the relaxed RLM/BM evaluation period and indication intervals) is preferred.*  *Proposal 2: The scaling factor of indication intervals is equal to the scaling factor of evaluation period.*  *Proposal 3: The applicability of DRX cycles for RLM/BFD relaxation should be studied*  *Proposal 4: The evaluation period after relaxation should be within a reasonable range considering periodicity of SSB or CSI-RS resource (Option2b), N factor (Option3) and P factor (Option4) for RLM/BFD relaxation.*  *Proposal 5: “low mobility criteria” should consider both UE velocity and the channel quality variation.*  *Proposal 6: Both UE mobility and serving cell’s quality should be included in the relaxation criteria.* *UE can perform RLM/BFD relaxation if both low mobility and serving cell’s quality requirement are met simultaneously.*  *Proposal 7: Network determine whether UE can perform RLM/BFD relaxation based on relaxation criteria, after indicated by network, UE can further decide whether go into relaxation or not based on the relaxation criteria network indicated.*  *Observation 1: If UE is in relaxation mode, it means the link quality is quite good and stable in most relaxation time.*  *Proposal 8:*   * *Reverting to the normal RLM operation upon detect 1 out-of-sync indication.* * *Reverting to the normal BFD operation upon detect 1 beam failure instance indication.*   *Proposal 9: We prefer relax only on serving cells where the relaxed criteria is fulfilled.* |
| [**R4-2101139**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101139.zip) | Nokia | 1. No power saving gain can be observed in the simulation results when only RLM and BFD measurement relaxation is done. 2. By relaxing RLM/BFD and *also* RRM measurements, significant power saving gain can be observed in the simulation results, when the SMTC window is outside the ON duration. 3. SMTC window offset has a significant impact on the power saving gain that can be achieved with relaxed RLM+BFD+RRM measurements. 4. By relaxing RLF/BFD and *also* RRM measurements, when the SMTC window is inside the ON duration, limited power saving gain can be achieved without WUS, and somewhat larger gain can still be achieved with WUS. 5. Power saving gain can be achieved *only if* also RRM measurements are relaxed, which however is not part of the current WID.   Additionally, we have discussed the enter and exit criteria for the UE entering relaxed measurement mode. Based on the discussion we have made following observations and proposals:   1. If UE is under coverage of a specific cell or beam for certain amount of time or certain observed conditions do not change for a predefined time, the UE could be considered to be in stationary/low mobility state. 2. Consider time associated with a given condition when determining UE mobility state. 3. Robust, UE autonomous mechanism, is needed to determine when UE should change back to normal measurement activity if UE has adapted its activity based on e.g. ‘mobility’ state. 4. If UE RLM/BFD measurement activity adaptation is supported, there should be robust mechanism enabling returning to normal measurement activity in order to avoid negative system impacts. 5. When operating in relaxed RLM/BFD mode, there could be alternate values for related parameters such has values for N310/N311. 6. Observed link quality degradation should cause the UE to revert back to normal measurement operation. |
| [**R4-2101222**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101222.zip) | MediaTek inc. | Observation 1: Ranged from 8% to 27% UE power saving gain can be obtained for scenarios SSB-based RLM/BFD measurement and CSI-RS based RLM/BFD measurement in both FR1 and FR2  Observation 2: Average increased latency in RLF triggering, beam failure detection and the initiation of beam recovery procedure can be controlled by selecting proper minimum SINR threshold for UE to enter the relaxed measurement scheme and proper scaling factor for UE to extend the evaluation period  Observation 3: In FR1, evaluation period for SSB-based RLM/BFD measurement and CSI-RS based RLM/BFD measurement can be extended at least for 4 times when minimum SINR for UE to start relaxed measurement ≥ 4dB and UE speed ≤ 30km/hr  Observation 4: In FR2, evaluation period for CSI-RS based RLM/BFD measurement can be extended at least 2 times when minimum SINR for UE to start relaxed measurement ≥ 8dB and UE speed ≤ 30km/hr  Proposal 1: RAN4 to confirm that from UE power saving gain perspective, it is beneficial to relax SSB-based RLM/BFD measurement and CSI-RS based RLM/BFD measurement in both FR1 and FR2  Proposal 2: RAN4 to confirm that from system impact perspective, SSB-based RLM/BFD and CSI-RS based measurement relaxation in FR1 are feasible for low mobility and high SINR UE  Proposal 3: RAN4 to confirm that from system impact perspective, CSI-RS based RLM/BFD measurement relaxation in FR2 are feasible for low mobility and high SINR UE.  Proposal 4: RAN4 to further study from system impact perspective, the feasibility for SSB-based RLM/BFD measurement relaxation in FR2 for stationary and high SINR UE  Proposal 5: RAN4 to specify that RLM/BFD measurement relaxation when UE speed is low and SINR is high |
| [**R4-2101461**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101461.zip) | vivo, MediaTek | *Updated Simulation assumptions* |
| [**R4-2101462**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101462.zip) | vivo | Observation 1 According to current spec, the UE is required to perform RLM/BFD at least twice per 3 DRX cycles when DRX cycle length is less than or equal to 320ms, no matter what mobility state UE is in and whether UE is in the high/medium SINR.  Observation 2 If a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, and falls back to normal measurement when SINR is below such threshold, then the impact to increased RLF triggering latency with 99%-tile probability can be less than (K-1) × DRX\_cycle, while K is the relaxation factor.  Observation 3 If 40ms DRX cycle is considered and a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, the RLF latency increases no more than only 2.5% when K=2, 7.5% when K=4 and 17.5% when K=8, with 99%-tile probability.  Observation 4 The SINR threshold for relaxation can be set by leaving enough margin to accommodate different mobility scenarios.  Observation 5 The one-shot SINR estimation error mainly impacts low SINR region, and it is still feasible to relax RLM if enough SINR margin is left for the relaxation threshold.  Observation 6 To optimise the case where data packet arrives with interval of around 100ms to 200ms, and 40 ms DRX cycle is considered, relaxation of RLM/BFD may further achieve power saving gain on top of R16 power saving techniques. If PDCCH WUS is configured and relaxing RLM-RS measurements 2x/4x/8x, 15% to 26% additional gain can be achieved.  Observation 7 For intensive eMBB or VoIP traffic, relaxing RLM measurements 2x/4x/8x, can also achieve 10% to 17% power saving gain.  Observation 8 The DRX on-duration offset to the SSB may have impact on power saving gain.  Proposal 1 In the study phase of this WI, RAN4 conclude the exact mobility impact and the exact power saving gain if RLM/BFD are relaxed in low mobility and/or high/medium SINR region.  Proposal 2 RAN4 should further study the impact to oos requirement if the RLM assessment period is allowed to be extended K times when SINR is above a proper threshold.  Proposal 3 RAN4 should strive to identify the scenarios that can achieve power saving gain when RLM/BFD are relaxed.  Proposal 4 The PDCCH monitoring relaxation, if RLM/BFD are relaxed, should be further studied.  Proposal 5 The conclusions to RLM measurement relaxation, if achieved, should also be applicable to BFD, at least in FR1.  Proposal 6 R16 low-mobility criterion should not be directly reused in R17 SINR-based criterion for RLM/BFD relaxation.  Proposal 7 Short DRX cycles, e.g. DRX cycle length <= 80ms, should be considered ONLY in R17 RLM/BFD relaxation.  Proposal 8 For schemes to be studied in RLM/BFD relaxation, at least adopt option 1a & 3, i.e.   * RAN4 to further discuss use of a scaling factor for defining the relaxed RLM/BM evaluation period and indication intervals, and * Reducing the sample number.   Proposal 9 Define a SINR-based network-configured threshold for RLM/BFD relaxation. Such threshold is the same for RLM and BFD.  Proposal 10 The RSs for RLM/BFD, especially the periodicity/bandwidth of these RSs and the relation to RSs for RRM, need careful consideration in R17 RLM/BFD relaxation. |
| [**R4-2101463**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101463.zip) | vivo | *Simulation results*  *Observation 1 If a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, and falls back to normal measurement when SINR is below such threshold, then the impact to increased RLF triggering latency with 99%-tile probability can be less than (K-1) × DRX\_cycle, while K is the relaxation factor.*  *Observation 2 If 40ms DRX cycle is considered and a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, the RLF latency increases no more than only 2.5% when K=2, 7.5% when K=4 and 17.5% when K=8, with 99%-tile probability.*  *Observation 3 The SINR threshold for relaxation can be set by leaving enough margin to accommodate different mobility scenarios.*  *Observation 4 The one-shot SINR estimation error mainly impacts low SINR region, and it is still feasible to relax RLM if enough SINR margin is left for the relaxation threshold.*  *Observation 5 The conclusion of Delta SINR approach is aligned with the increased RLF latency approach. If the increased delta SINR margin is considered as no more than 11dB for K=8, then the same threshold at around 0dB can be obtained for RRM relaxation*  *Observation 6 To optimise the case where data packet arrives with interval of around 100ms to 200ms, and 40 ms DRX cycle is considered, relaxation of RLM/BFD may further achieve power saving gain on top of R16 power saving techniques. If PDCCH WUS is configured and relaxing RLM-RS measurement 2x/4x/8x, 15~ 26% additional gain can be achieved.*  *Observation 7 For intensive eMBB or VoIP traffic, relaxing RLM measurements 2x/4x/8x, can also achieve 10% to 17% power saving gain.*  *Observation 8 The DRX on-duration offset to the SSB may have impact on power saving gain.* |
| [**R4-2101542**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101542.zip) | OPPO | Observation 1: Option 2 or 3 is not feasible for UE power saving in RLM/BFD measurement.  Proposal 1: RAN4 focus on extending evaluation period of RLM/BFD measurement and evaluating the scaling factor to achieve the balance of power saving and measurement performance.  Observation 2: Low mobility criteria in Rel16 can be reused.  Proposal 2: Prefer option 2b as SINR criteria that the measured SINR is above one additional threshold (e.g. SINR > X dB).  Proposal 3: Prefer UE to determine if the criteria for relaxation is fulfilled. |
| [**R4-2101685**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101685.zip) | Huawei, HiSilicon | Observation 1: For the slot where UE needs to perform PDSCH decoding, there is no power saving gain due to skipping RLM/BFD measurement on this slot.  Observation 2: The power saving benefit due to only relaxed RLM/BFD measurements is quite limited.  Observation 3: The relaxed RLM evaluation period will cause RLF triggering latency, and the RLF triggering latency is increased with the lager relaxation coefficient and the higher UE speed. |
| [**R4-2102239**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102239.zip) | Ericsson | *Updated Simulation assumptions* |
| [**R4-2102240**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102240.zip) | Ericsson | **Proposal #1:** RAN4 to discuss whether different relaxation factors can be allowed for FR1 and FR2 based on simulation study.  **Proposal #2:** RAN4 to discuss and agree reference SINR error (that can be tolerated) and the scaling factors is decided based on that. |
| [**R4-2102241**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102241.zip) | Ericsson | • Observation #1: In release 17 UE power saving, it is possible to treat each UE separately by setting the relaxation criteria separately for each UE.  • Proposal #1: Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network, and it is up to the UE whether to apply relaxed RLM/BM requirements when configured.  • Proposal #2: The short DRX periodicity for which relaxation is allowed is decided based on the ongoing simulation study.  • Proposal #3: The UE while performing relaxed RLM upon detecting certain number of out-of-sync indications or upon triggering T310 reverts to the normal RLM operation (i.e. without relaxation).  • Proposal #4: The UE while performing relaxed BM upon beam failure detection reverts to the normal BFD operation (i.e. without relaxation).  • Proposal #5: Relaxed RLM/BFD requirements are defined by extending the legacy evaluation period with a scaling factor.  • Proposal #6: Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on maximum of SSB periodicity and DRX cycle, max(TDRX, TSSB).  • Proposal #7: For intra-band CA/DC scenario, if UE has fulfilled the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it is allowed to operate BFD in relaxed mode in all other serving cells (e.g. SCells).  • Proposal #8: For intra-band CA/DC scenario, if UE has failed to fulfil the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it shall revert to normal BFD operation (i.e. without relaxation) in all other serving cells (SCells).a  • Proposal #9: PDCCH is monitored based on the RLM/BFD relaxation, and adaption of PDCCH monitoring and exact criteria needs further discussion. |
| [**R4-2102587**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102587.zip) | Qualcomm Incorporated | Observation 1: Out-of-sync and Beam Failure indications are based on SINR;  Proposal 1: Introduce RLM/BFD measurement relaxation, using a scaling factor to extend the period length between required measurement instances compared to the current standard operation as indicated in TS 38.133.  Proposal 2: Include a condition based on serving cell SINR in the criteria to be fulfilled for relaxation.  Proposal 3: Include a minimum SINR threshold for RLM/BFD relaxation, to be set based on simulation results and evaluated against the expected performance impact. |

## Open issues summary

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

### Sub-topic 2-1 Evaluation assumption

**Issue 2-1-1: The definition of Delta SINR in R15**

* Background:
  + Companies proposed to revise the definition of Delta SINR in R15.
* Proposals:
  + Option 1 (R4-2102239, Ericsson): Revise the definition of Delta SINR in R15 to be Delta SINR = MAX (ABS(estimated SINR – ideal SINR) CDF=5%), ABS(estimated SINR – ideal SINR) CDF=95%) [dB].
* Recommended WF:
  + May Ericsson clarify the formula, does it mean "CDF=5%/95%" of "ABS (estimated SINR – ideal SINR)" or "ABS" of "CDF=5%/95% of (estimated SINR – ideal SINR)"?

**Issue 2-1-2: Update on simulation assumptions**

* Background:
  + Companies proposed to update the simulation assumptions
* Proposals:
  + Option 1 (vivo, MTK): Approve the simulation assumptions provided in R4-2101461.
  + Option 2 (Huawei): Add UE power consumption modelling for evaluating RLM/BFD relaxation.
* Recommended WF:
  + Companies are encouraged to provide views on whether Option 1 is agreeable or not.

### Sub-topic 2-2 Scenarios for power saving

**Issue 2-2-1: Confirmation on beneficial Scenarios, from UE power saving gain perspective:**

* Background:
  + Companies proposed to confirm and conclude the power saving gain
* Proposals:
  + Option 1 (MTK): RAN4 to confirm that from UE power saving gain perspective, it is beneficial to relax SSB-based RLM/BFD measurement and CSI-RS based RLM/BFD measurement in both FR1 and FR2.
  + Option 2 (Vivo): RAN4 to conclude the exact power saving gain if RLM/BFD are relaxed in low mobility and/or high/medium SINR region.
    - RAN4 should strive to identify the scenarios that can achieve power saving gain when RLM/BFD are relaxed. (Vivo)
    - The RSs for RLM/BFD, especially the periodicity/bandwidth of these RSs and the relation to RSs for RRM, need careful consideration in R17 RLM/BFD relaxation. (Vivo)
  + Option 3 (Huawei): RAN4 to study the power saving gain level at which RLM/BFD measurement relaxation is considered as feasible.
    - When the power saving gain level is higher than the threshold, it is considered that the benefit is big enough to support RLM/BFD measurement relaxation.
    - To study the threshold is useful for RAN4 to identify the feasible scenarios.
* Recommended WF:
  + To capture the summary of simulation results for power saving gain in WF

**Issue 2-2-2: Feasible Scenarios for Power Saving, from system impact perspective:**

* Background:
  + Companies proposed to conclude the feasible scenario for power saving gain, from system/mobility impact perspective
* Proposals:
  + Option 1 (MTK):
    - SSB-based RLM/BFD and CSI-RS based measurement relaxation in FR1 are feasible for low mobility and high SINR UE.
    - CSI-RS based RLM/BFD measurement relaxation in FR2 are feasible for low mobility and high SINR UE
    - FFS the feasibility for SSB-based RLM/BFD measurement relaxation in FR2 for stationary and high SINR UE
  + Option 2: (Vivo)
    - RAN4 to conclude the exact mobility impact if RLM/BFD are relaxed in low mobility and/or high/medium SINR region.
* Recommended WF:
  + Companies to comment whether the merged proposal, as the following, is agreeable or not
  + Option 3: (Moderator)
    - SSB-based RLM/BFD and CSI-RS based measurement relaxation in FR1 are feasible for low mobility and high/medium SINR UE.
    - CSI-RS based RLM/BFD measurement relaxation in FR2 are feasible for low mobility and high/medium SINR UE
    - FFS the feasibility for SSB-based RLM/BFD measurement relaxation in FR2 for stationary and high/medium SINR UE

**Issue 2-2-3: DRX cycle**

* Background:
  + Companies proposed to study the applicability of DRX cycles for RLM/BFD relaxation.
* Proposals:
  + Option 1 (CMCC, Ericsson): The applicability of DRX cycles for RLM/BFD relaxation should be studied and decided based on the ongoing simulation study.
  + Option 2 (VIVO): Short DRX cycles, e.g. DRX cycle length <= 80ms, should be considered ONLY in R17 RLM/BFD relaxation.
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views. Note that the options are not necessary to be mutually exclusive.

### Sub-topic 2-3 Relaxation criteria

**Issue 2-3-1: Criteria which the UE is allowed to relax the RLM/BM requirements**

* Background:
  + RAN4 to further study the criteria which the UE is allowed to relax the RLM/BM requirements, according to UE mobility and/or serving cell’s quality.

* Proposals:
  + Option 1: Take both UE mobility and serving cell's quality as the relaxation criteria. (MTK, CMCC, Xiaomi,vivo)
  + Option 2: Take UE mobility as the major factor into the criteria. (ZTE, CATT)
  + Option 3: Take serving cell SINR as the relaxation criteria. (QC,vivo)
* Recommended WF:
  + Is Option 1 agreeable?

**Issue 2-3-2: UE mobility as relaxation criteria**

* Background:
  + Companies proposed how to consider the UE mobility as relaxation criteria

* Proposals:
  + Option 1: R16 low-mobility criterion should not be directly reused in R17 SINR-based criterion for RLM/BFD relaxation. (VIVO)
  + Option 2: R16 RRM relaxation criterion can be used as baseline for RLM/BFD relaxation. (Apple)
  + Option 3: “low mobility criteria” should consider both UE velocity and the channel quality variation. (CMCC)
  + Option 4: Consider time associated with a given condition when determining UE mobility state. (Nokia)
  + Option 5: Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network (Ericsson).
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views. Note that the options are not necessary to be mutually exclusive.

**Issue 2-3-3: Serving cell’s quality as relaxation criteria**

* Background:
  + Companies proposed how to consider the serving cell’s quality as relaxation criteria

* Proposals:
  + Option 1: based on serving cell RSRP, i.e. at-cell-center criteria in R16 RRM relaxation criterion. (Apple, Xiaomi)
  + Option 2: based on serving cell SINR which is above a certain threshold. (Oppo, QC, vivo).
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views. Note that the options are not necessary to be mutually exclusive.

**Issue 2-3-4: Network or UE to determine if the relaxation criteria is fulfilled**

* Background:

The following options are FFS

* Option 1: Low mobility scenario under which the UE is allowed to relax the RLM/BM requirements is determined by the network.
* Option 2: Low mobility scenario under which the UE is allowed to relax the RLM/BM requirements is determined by the UE.
* Option 3: Low mobility scenario under which the UE is allowed to relax the RLM/BM requirements is determined by both the network and UE.

* Proposals:
  + Option 1: Network determine whether UE can perform RLM/BFD relaxation based on relaxation criteria, after indicated by network, UE can further decide whether go into relaxation or not based on the relaxation criteria network indicated. (CMCC)

Option 1a: Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network, and it is up to the UE whether to apply relaxed RLM/BM requirements when configured. (Ericsson)

* Option 1b: Define a SINR-based network-configured threshold for RLM/BFD relaxation. Such threshold is the same for RLM and BFD. (Vivo)
* Option 2: Prefer UE to determine if the criteria for relaxation is fulfilled. (Oppo)
* Option 3: determined by both the network and UE (Xiaomi)
* Option 4: Whether UE can determine alone if the low mobility criteria is met depends on the testability of the correct UE behavior (ZTE)
  + The UE can determine alone if the criteria is met and enter the low mobility mode to use a relaxed requirements for RLM and RLF if there will be test cases defined to test the UE behaviors. (ZTE)
* Recommended WF: Need more discussion, companies are encouraged to provide views on the following questions
  + Q1: Should it be network or UE to enable/disable this feature?
  + Q2: Should the relaxation criteria be predefined or configurable?
  + Q3: Should it be network or UE to determine the relaxation criteria is fulfilled or not?

### Sub-topic 2-4 Relaxation scheme

**Issue 2-4-1: Scheme of RLM/BFD measurements relaxation**

* Background:
  + At least extending evaluation period of RLM/BFD measurement (Option 1) to be considered as the scheme of RLM/BFD measurements relaxation. FFS other schemes.
* Proposals:
  + Option 1: Use of a scaling factor to extend the RLM/BFD evaluation period (Apple, CATT, Xiaomi, CMCC, QC, Vivo, Oppo, Ericsson)
  + Option 2: Reducing the sample number (Vivo)
  + Option 3: UE skip some measurement samples by increasing the indication interval to a longer interval which is larger than the evaluation period (Xiaomi)
* Recommended WF:
  + Is Option 1 agreeable?

**Issue 2-4-2: relaxation factor definition**

* Background:
  + Companies proposed the definition of the scaling factor.
* Proposals:
  + Option 1 (Ericsson): Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on maximum of SSB periodicity and DRX cycle, max(TDRX, TSSB)
* Recommended WF:
  + Is Option 1 agreeable?

**Issue 2-4-3: relaxation factor determination**

* Background:
  + Companies proposed the considerations to determine the scaling factor.
* Proposals:
  + Option 1 (Apple): Relaxation factor depends on various factor including DRX cycle configuration, RLM-RS configuration, mobility and channel conditions etc.
  + Option 2 (CMCC): The evaluation period after relaxation should be within a reasonable range considering periodicity of SSB or CSI-RS resource (Option2b), N factor (Option3) and P factor (Option4) for RLM/BFD relaxation.
  + Option 3 (Ericsson): RAN4 to discuss and agree reference SINR error (that can be tolerated) and the scaling factors is decided based on that.
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views. Note that the options are not necessary to be mutually exclusive.

**Issue 2-4-4: relaxation factor: different relaxation factor in FR1 and FR2**

* Proposals:
  + Option 1 (Ericsson): RAN4 to discuss whether different relaxation factors can be allowed for FR1 and FR2 based on simulation study.
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-4-5: relaxation between RLM and BFD**

* Proposals:
  + Option 1 (vivo): The conclusions to RLM measurement relaxation, if achieved, should also be applicable to BFD, at least in FR1.
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-4-6: relaxation factor for RLM/BFD indication interval**

* Background:
  + Companies proposed relaxation factor for RLM/BFD indication interval
* Proposals:
  + Option 1 (CMCC): The scaling factor of indication intervals is equal to the scaling factor of evaluation period.
  + Option 2 (vivo): RAN4 should further study the impact to oos requirement if the RLM assessment period is allowed to be extended K times when SINR is above a proper threshold.
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-4-7: N310/N311 in the relaxation mode**

* Background:
  + Companies raised the discussion on N310/N311 in the relaxation mode could be different from normal RLM operation.
* Proposals:
  + Option 1: When operating in relaxed RLM/BFD mode, there could be alternate values for related parameters such has values for N310/N311. (Nokia)
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

### Sub-topic 2-5 Other Aspects

**Issue 2-5-1: Reverting to the normal RLM operation**

* Background:
  + The following options are FFS
    - Option 1: The UE while performing relaxed RLM upon detecting certain number of out-of-sync indications or upon triggering T310 reverts to the normal RLM operation (i.e. without relaxation).
    - Other options are not precluded
* Proposals:
  + Option 1: The UE while performing relaxed RLM upon detecting certain number of out-of-sync indications or upon triggering T310 or upon observed link quality degradation reverts to the normal RLM operation (i.e. without relaxation). (ZTE, Ericsson, Apple, CMCC, Xiaomi, Nokia, vivo)
    - Option 1a: revert when the relaxation criterion is not met (Apple, vivo)
    - Option 1b: revert when N310 starts to count, i.e. 1 out-of-sync indication. (Apple, CMCC)
    - Option 1c: revert when T310 is running, i.e. N310 out-of-sync indication. (Xiaomi)
    - Option 1d: revert when observed link quality degradation. (Nokia)
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-5-2: Reverting to the normal BM operation**

* Background:
  + Companies proposed reverting to the normal BM operation (i.e. without relaxation) upon beam failure detection.
* Proposals:
  + Option 1: Reverting to the normal BFD operation upon detect 1 beam failure instance indication. (CMCC)
  + Option 2: The UE while performing relaxed BM upon beam failure detection reverts to the normal BM operation (i.e. without relaxation). (ZTE, Ericsson)
  + Option 3: There might be no benefit to configure conditions for UE reverting to normal BFD. (Xiaomi)
* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-5-3: Relaxation of BM when not all serving cells in intra-band CA/DC meets relaxation criteria**

* Background:
  + Companies proposed to discuss the relaxation of BM when not all serving cells in intra-band CA/DC meets relaxation criteria.
* Proposals:
  + Option 1: For intra-band CA case, the UE should relax only on serving cells where the relaxed criteria is fulfilled. (ZTE, CMCC)
  + Option 2 (Xiaomi): For intra-band CA case, RAN4 to define the same measurement relaxation rules for the serving cells.
  + Option 3 (Ericsson):
    - For intra-band CA/DC scenario, if UE has fulfilled the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it is allowed to operate BFD in relaxed mode in all other serving cells (e.g. SCells).
    - For intra-band CA/DC scenario, if UE has failed to fulfil the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it shall revert to normal BFD operation (i.e. without relaxation) in all other serving cells (SCells)

* Recommended WF:
  + Need more discussion, companies are encouraged to provide views.

**Issue 2-5-4: Relaxation on PDCCH monitoring**

* Background:
  + Companies proposed to discuss whether relaxation on PDCCH monitoring is within the scope of this WI.
* Proposals:
  + Option 1: Further discussion whether relaxation on PDCCH monitoring is within the scope of this WI. And whether RAN4 needs to specify anything related to relaxation on PDCCH monitoring. (ZTE, Vivo)
  + Option 2: PDCCH is monitored based on the RLM/BFD relaxation, and adaption of PDCCH monitoring and exact criteria needs further discussion (Ericsson)
* Recommended WF:
  + PDCCH monitoring reduction is ongoing discussion in RAN1, need to wait for RAN1's conclusion.

## Companies views’ collection for 1st round

### Open issues

**Issue 2-1-1: The definition of Delta SINR in R15**

…

### CRs/TPs comments collection

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
|  |  |
|  |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

**Issue 2-1-1: The definition of Delta SINR in R15**

*…*

*Recommendations on WF/LS assignment*

Moderator: this WF is to capture all agreements and remaining open issues of this Email thread

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
|  |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
|  |  |

## Discussion on 2nd round (if applicable)

**Issue 2-1-1: The definition of Delta SINR in R15**

…

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
|  |  |