**3GPP TSG-RAN WG4 Meeting # 100-e R4-211xxxx**

**Electronic Meeting, August 16-27, 2021.**

**Agenda item:** 9.14

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

**Title:** Email discussion summary for [100-e][228] NR\_UE\_pow\_sav\_enh\_RRM

**Document for:** Information

# Introduction

This document is the email discussion summary for UE Power Saving Enhancements (AI 9.14), including the following topics covered

* Topic 1: General and work plan (AI 9.14.1)
* Topic 2: UE measurements relaxation for RLM and/or BFD (AI 9.14.2)

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 9.14.1)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2112179**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112179.zip) | vivo | *LS draft*  *Moderator: LS is to be discussed under Topic 2.* |

## Open issues summary

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

*No open issues (LS discussion is to be discussed under Topic 2)*

# Topic #2: UE measurements relaxation for RLM and/or BFD (AI 9.14.2)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2111959**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2111959.zip) | CATT | **Proposal 1: UE should reuse the SINR for RLM/BFD evaluation when determine whether the serving cell quality criteria is fulfilled or not. The SINR can be SS-SINR or CSI-SINR or both of them.**  **Proposal 2: The thresholds can be configured by networks for RLM and BFD. Do not use a set of discrete values. Leave the flexibility to network implementation.**  **Proposal 3: Reuse RSRP variation in Rel-16.**  **Proposal 4: RAN4 should clarify that whether to consider both low mobility criterion and good serving cell quality criterion can be configured at the same time or not? If so, how to define the enter condition?**  **Proposal 5: The similar definition of RLM/BFD evaluation period in Rel-15 can be reused as Max(T, Ceil([Y] x P x N) x Max(TDRX, TRLM-RS/BFD-RS)). Y can be K \* current Rel-15 samples. For example, K = 2 which results in Y = 30 for SSB based RLM OOS. K can be different values in different cases.** |
| [**R4-2112090**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112090.zip) | Apple | **Proposal 1: L3-SINR, RSRP and/or RSRQ can be used as serving cell quality criteria for RLM/BFD.**  **Proposal 2: The relaxation threshold for RSRP, RSRQ or SINR can be configured by RRC signaling.**  **Proposal 3: Reuse R16 low mobility criterion. The threshold is configured by the network**  **Proposal 4: The UE to evaluate and determine whether the serving cell quality and the low mobility criterion are fulfilled or not.**  **Proposal 5: Exit RLM relaxation mode when any relaxation criterion is not met, or when N310 starts to count. No additional Exit criterion needs to be defined.**  **Proposal 6: Reuse definition of evaluation period to capture the scaling factor as Max(T, Ceil([Y] x P x N) x Max(TDRX,TSSB)).** |
| [**R4-2112180**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112180.zip) | vivo | **Observation 1 According to current spec, 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 According to current spec, UE needs to separate o-o-s indications by at least Tindication\_interval, and UE is required to assess RLM quality once per indication period.**  **Proposal 1 Send LS to RAN2 so as to trigger the discussion on the low mobility criterion in RAN2.**  **Proposal 2 Re-use the R16 RSRP-based low mobility criterion as baseline for R17 RLM/BFD relaxation in RRC\_Connected, while the necessary revisions regarding issues like ping-pong effect, RS type, etc., can be further discussed.**  **Proposal 3 Leave the threshold of entering and exiting cell quality criterion as UE implementation, as long as UE can fall back to normal mode and identify o-o-s timely according to the relaxed requirements.**  **Proposal 4 The UE behaviour on checking the entering/exiting condition of cell quality criterion regarding multiple RLM-RSs/BFD-RSs is not specified.**  **Proposal 5 In the high/medium SINR region, RLM and BFD requirements can be relaxed by allowing longer separation between RLM/BFD measurements.**  **Proposal 6 The minimal separation between o-o-s indications needs not to be increased in R17 PowSav.**  **Proposal 7 In FR1, extending the first out-of-sync evaluation period requirements and the first beam failure evaluation period requirements by a same factor X. X is at least 2 for DRX <= 40ms, and X is at least 1.5 for 40ms <DRX <= 80ms.**  **Proposal 8 In FR2, the scaling factor for extending the first out-of-sync evaluation period requirements and the first beam failure evaluation period requirements can be further discussed.**  **Proposal 9 For the case of intra-band CA, on the band where spCell exists, the baseline assumption is that UE will not perform BFD in the SCell in the same band.**  **Proposal 10 For the case of NR-DC and inter-band CA, further discuss whether UE needs to evaluate the entering/exiting conditions for each serving cell, and whether UE is allowed to relax RLM/BFD if it meets the relaxation criterion in other serving cell.** |
| [**R4-2112179**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112179.zip) | vivo | *LS draft* |
| [**R4-2112204**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112204.zip) | CMCC | ***Proposal 1: Consider the RRM enhancement after finishing the RLM/BFD power saving related issues.***  ***Proposal 2: The definition of the SINR for entering relaxation criterion evaluation is the same with the definition of the SINR for radio link quality evaluation of RLM/BFD.***  ***Proposal 3: Additional RSRP condition is not needed for RLM/BFD serving cell quality criterion.***  ***Proposal 4: The thresholds are configured to the UE by the network based on a set of discrete threshold values.***  ***Proposal 5: The low mobility criterion at least based on SINR variation.***   * ***Define an evaluation period, to check the L3-SINR values always higher than the SINR threshold (the threshold used in serving cell quality criterion).***   ***Proposal 6: No need to define low mobility exit condition. If the UE fulfills any of serving cell quality exit condition, or DRX cycle length is not allowed for relaxation, UE will exit relaxation mode.***  ***Proposal 7: UE continues to observe whether the SINR fulfills the serving cell quality exit condition during the relaxation. The observation period is equal to the SINR evaluation period.***  ***Proposal 8: UE exit the RLM relaxation when certain consecutive OOS indications or 1 OOS indication.***  ***Observation 1: The threshold in Option 1 should be careful evaluated considering the balance of power saving gain and Ping-Pong effect.***  ***Proposal 9: The scheme of BFD relaxation revert criteria can reuse the scheme of RLM relaxation revert criteria on the basis of different thresholds and/or indications.***  ***Observation 2: The case that measured SINR is worse than Qout may be happened even the exiting criteria is defined as a certain value higher than Qout. However, with such exiting criteria, this is not the common case.***  ***Observation 3: Option 1 and Option 3 correspond to same UE behavior.***  ***Proposal 10: We prefer Option 1 and Option 3.***  ***Proposal 11: After reverting, UE couldn’t go into relaxation mode again during a certain punish period, such as when a new timer is active. UE can decide whether go into relaxation mode by relaxation criteria after the timer expires. The timer can be configured by network.***  ***Proposal 12: Option 1 should include the definition of L1 indication period in relaxation mode, which can be Max(10ms, Ceil([Y] x 1.5 × DRX\_cycle\_length, Ceil([Y] x 1.5 × TRLM-RS,M)).***  ***Proposal 13: The maximum value of Y can be derived by simulation under various scenarios. The practical value should be configured by network.***  ***Proposal 14: Either Option 1(revisited) and Option 3 can be used as long as the total evaluation period after relaxation is aligned with simulation results.***  ***Proposal 15: Two options may need to be revisited after we achieving the consensus of exiting criteria.***  ***Proposal 16: The principle of Option 2 is preferred, stricter entering and exiting can guarantee relaxation measurement performance, and reduce the number of reverting behaviors.*** |
| [**R4-2112259**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112259.zip) | Qualcomm, Inc. | **Observation 1: Additional margin on top of Qout in exit SINR threshold can not guarantee the reduction of the additional delay or preventing the additional delay in RLF/BFD declaration.**  **Proposal 1: Exit relaxation mode when the radio link quality is worse than Qout, and the UE is still in the relaxation mode when the radio link quality is better than Qout.**  **Observation 2: In relaxation mode, the SINR variation in the evaluation period is longer, or UE has to reduce the number of samples. Therefore, the OOS indication evaluated in relaxation mode is less reliable.**  **Proposal 2: UE is not required to send the first OOS indication to higher layers. The SINR measurement in relaxation mode is for exiting relaxation mode evaluation. After exiting relaxation mode, UE follows the R15 requirement and sends the first OOS indication after the R15 evaluation period if SNR<Qout.**  **Observation 3: The threshold and number of SINR measurements don’t impact the additional delay of RLM/BFD declaration and system performance as long as the evaluation period for exiting relaxation mode evaluation is specified.**  **Proposal 3: Set the evaluation period for exiting relaxation mode evaluation as the evaluation period for OOS indication in normal mode, and leave the SINR exit threshold and the number of SINR measurements in the evaluation period to UE implementation.**  **Observation 4: With the proposed scheme, the additional delay for RFL declaration is within TEvaluate\_out\_SSB.**  **Proposal 4: If power saving conditions are satisfied, allow TEvaluate\_ps\_out\_SSB for the first OOS indication**   |  |  | | --- | --- | | Configuration | TEvaluate\_ps\_out\_SSB (ms) | | no DRX | Max(200, Ceil(10 × P) × TSSB) | | DRX cycle≤80ms | Max(200, Ceil(30 × P) × Max(TDRX,TSSB)) | | 80ms<DRX cycle≤320ms | Max(200, Ceil(20 × P) × Max(TDRX,TSSB)) | | DRX cycle>320ms | Ceil(10 × P) × TDRX | | NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | |   **Proposal 5: Serving cell quality evaluation uses RLM/BFD SINR measurement without RSRP.**  **Proposal 6: UE enters relaxation mode when RLM SNR is larger than Qout/Qin + margin. The threshold is a pre-defined value.**  **Proposal 7: R16 low mobility condition applies to RLM/BFD relaxation when configured with serving cell quality condition.** |
| [**R4-2112413**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112413.zip) | Xiaomi | **Proposal 1: The SINR that used to compare with the Qout/Qout\_LR would be used for the evaluation of the serving cell quality criteria.**  **Proposal 2: SINR threshold value for RLM / BFD relaxation could be derived from the SINR value corresponding to the Qout / Qout\_LR plus a margin X / Y (dB) respectively.**  **Proposal 3: The margin X and Y could be pre-defined or defined as a set of discrete threshold values by the network**  **Proposal 4: The R17 low mobility criterion could be defined based on the SINR variation.**  **Proposal 5: UE would exit relaxation mode when the radio link quality of the serving cell is worse than the SINRenter with a hysteresis value.**  **Proposal 6: UE would follow the legacy behavior for sending OoS indications when the measured SINR is worse than Qout during the relaxation mode.**  **Proposal 7: The relaxed RLM/BFD evaluation period is to be specified in the way of Option 3.**  **Observation 1: For the case when RLM and BFD not using the same measurement RS, it is potential that RLM performed in PSCell while BFD performed in SCell in the same band.**  **Proposal 8: The current proposal for the issue of entering and exiting relaxation mode in intra-band CA is feasible.** |
| [**R4-2112878**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2112878.zip) | Nokia, Nokia Shanghai Bell | **Observation 1**: SINR error of more than 3dB is observed for scaling factor 8.  Proposal 1: RAN4 to discuss what is the acceptable SINR error to determine the maximum allowed scaling factor (i.e. SINR difference between relaxation and without relaxation)  **Observation 2:** In case the relaxation is obtained by applying the relaxation factor, K, to the out of synch. evaluation period, TEvaluate\_out\_SSB and exiting at first OOS indication, the maximum additional delay introduced in RLF declaration, which is equal to the additional delay of the 1st OoS evaluation, can be given as function of K and Max(TDRX,TSSB) and is equal to **(K-1) x TDRX**.  **Observation 3:** In case the relaxation is obtained by applying the relaxation factor, K, to the out of synch. evaluation period, TEvaluate\_out\_SSB and exiting at first measured SINR < Qout, the maximum additional delay introduced in RLF declaration, which is equal to the delay in observing the first occurrence of SINR < Qout, can be given as function of K and is equal to **K x TDRX**.  **Observation 4:** In case relaxation is obtained by reducing the number of measurement samples collected during an evaluation period with equidistant sampling, while the evaluation period is not changed (i.e. not relaxed), **there is no additional delay in RLF declaration.**  **Observation 5:** In case relaxation is obtained by reducing the number of measurement samples collected during an evaluation period with non-equidistant sampling, while the evaluation period is not changed (i.e. not relaxed), the additional delay depends on where the out-of-sync may be observed and can **in worst case be one half of the evaluation period, i.e. TEvaluate\_out\_SSB.**  **Proposal 2: RAN4 needs to discuss the maximum scaling factor, K, corresponding to the acceptable delay in RLF declaration.**  **Observation 6:** The time the UE spends in outage increases when the relaxation factor for RLM and BFD measurements increases due to the late detection of failure and initiating the recovery procedure. The increase is much more significant if RRM measurements are also relaxed.  **Observation 7:** The percentage of RLF and HOF increases significantly if RRM measurements are also relaxed and the increase is more significant in FR2.  **Proposal 3: RAN4 needs to consider impact on system level performance like time of outage and percentage of RLF and HOF is relaxation of RRM measurements is also allowed.**  **Proposal 4: It is up to network to configure whether only one criterion is used (either low mobility criterion or good serving cell quality criterion) or both criteria are used separately, or both are to be used in combination e.g. to enter relaxation.**  **Proposal 5: If neither of the low mobility and good serving cell quality criteria is configured, the network would assume the UE is not performing relaxed RLM/BFD measurements and the existing RLM/BFD requirements shall apply.**  **Proposal 6: If the UE applies a DRX cycle longer than 80ms, the UE is assumed not to perform relaxed RLM/BFD measurements therefore the existing RLM/BFD requirements would apply.**  **Proposal 7: Clarify the definition of DRX cycle in the evaluation period table by adding a note “TDRX is the DRX cycle length being applied”.**  **Proposal 8: The Rel16 SS-RSRP variation based low mobility criterion can be reused for Rel-17 power saving UEs in connected mode.**  **Proposal 9: RAN4 additionally to define a low mobility criterion based on the number of serving beam changes over time (e.g. TCI state change).**  **Proposal 10: It is up to network to configure if the low mobility criteria is based on SS-RSRP variation or TCI change, or the two in combination.**  **Proposal 11: Allow dedicated signalling to configure the UE when it is allowed to relax the RLM/BFD measurements.**  **Observation 8:** One option of defining the good serving cell quality criteria is to reuse existing evaluation principle i.e. the UE is allowed to perform relaxed measurements if the downlink radio link quality is better than a threshold.  **Observation 9**: Another option of defining the good serving cell quality criteria is to use SS-SINR/CSI-SINR with a network configured threshold i.e. the UE is allowed to perform relaxed measurements if SS-SINR/CSI-SINR is better than XdB.  **Proposal 12: RAN4 to use either of the two options to define the good serving cell quality criteria:**   * **Option 1: reusing current RLM/BFD evaluation principle i.e. downlink radio link quality > threshold** * **Option 2: SS-SINR > XdB, wherein X is configured by network.**   **Proposal 13: UE shall revert to non-relaxed RLM/BFD measurement at e.g. the 1st Qout occurrence based on relaxed RLM/BFD measurements and evaluation period.**  **Proposal 14: RAN4 to discuss the alternative options of relaxed RLM/BFD measurement behaviour:**   * **Option 1: relax the evaluation period while assuming the same number of samples as in normal RLM/BFD** * **Option 2: relax the number of RLM/BFD measurement samples performed during the evaluation period, and maintaining the evaluation period the same as in normal RLM/BFD measurements**   **Proposal 15: RAN4 need discuss if the OoS indication based on the Qin/Qout during relaxed measurements shall be indicated to high layers.**  **Proposal 16: It should be allowed for the network to configure different values of the RLF parameters, e.g. T310/N310/N311, for the relaxed operation to reduce the negative impact to the system performance.** |
| [**R4-2113137**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113137.zip) | Intel Corporation | **Proposal 1: Exit relaxation threshold (Thexit) will be Qout+7dB or simpley Qin, which is higher than Qout.**  **Observation 1: In relative high SNR region, there will not be obvious measurement accuracy degradation with reduced samples.**  **Proposal 2: It’s possible to reduce measurement sample numbers in relaxation mode for power saving.**  **Proposal 3: SINR can be used as threshold since the legacy RLM requirement is designed based on SINR.**  **Proposal 4: Entering relaxation threshold (Thenter) for RLM will be Qin+X2 dB or Thenter= Thexit+Margin if the margin can avoid ping-pong effect.**  **Proposal 5: The thresholds are configured to the UE by the network based on pre-defined values.**  **Proposal 6: The entering threshold(Thenter) for BFD will be *rsrp-ThresholdSSB* +X3dB, where X3 dB is margin, in addition to SINR threshold.**  **Proposal 7: For Rel-17, it’s better to consider the SINR variation for low mobility criteria, which is more relevant to RLM/BFD performance.** |
| [**R4-2113820**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113820.zip) | Huawei, HiSilicon | ***Proposal 1: The SINR used for RLM/BFD relaxation criteria is measured on the configured RS resource over the evaluation period.***  ***Proposal 2: For RLM relaxation, the entering condition for good serving cell quality criterion can be defined as when the radio link quality is better than the threshold (Qin + XdB).***  ***Proposal 3: It is suggested to use SINR variation as the metric for low mobility criterion.***  ***Proposal 4: For RLM relaxation, the entering condition for low mobility criterion can be defined as when the SINR variation does not exceed a threshold which is suggested to be defined as 2dB.***  ***Proposal 5: It is suggested that the same thresholds used for good serving cell quality and low mobility criteria are applied for both RLM relaxation and BFD relaxation.***  ***Proposal 6: For exiting relaxation criteria, the existing condition for serving cell quality criterion can be defined as when the radio link quality is worse than the threshold (Qin + XdB - 3dB).***  ***Proposal 7: For exiting relaxation criteria, the existing condition for low mobility criterion can be defined as when the SINR variation exceeds the entering threshold (i.e. 2dB).***  ***Proposal 8: It is suggested to use Option 1 for defining the relaxed RLM/BFD*** ***evaluation period, and the factor Y used in option 1 can be defined as a fixed value.***   * ***Option 1: The similar definition of RLM/BFD evaluation period in Rel-15 can be reused as Max(T, Ceil([Y] x P x N) x Max(TDRX, TRLM-RS/BFD-RS)).***   ***Proposal 9: It is suggested that RLM/BFD relaxation is not applicable on the SSB resource with 160ms periodicity.***  ***Proposal 10: The RLM/BFD evaluation period in relaxation mode TEvaluate\_relax can be defined as:***   |  |  | | --- | --- | | Configuration | TEvaluate\_relax (ms) | | DRX cycle ≤ 80ms | Max(T, Ceil(Y × P) × Max(TDRX,TSSB/TCSI-RS)) | | Note 1: TSSB is the periodicity of SSB in the set  and no longer than 80ms. TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length.  Note 2: The value of P is as same as the existing definition in legacy mode. | |   ***where, the value of Y used*** ***for defining relaxed RLM/BFD evaluation period can be defined as follow:***   |  |  | | --- | --- | | ***Evaluation Period Type*** | ***Value of Y used for defining relaxed RLM/BFD Measurements*** | | ***SSB based RLM*** | *30* | | ***CSI-RS based RLM*** | *60* | | ***SSB based BFD*** | *15* | | ***CSI-RS based BFD*** | *30* |   ***Proposal 11: For intra-band CA, whether to allow RLM/BFD relaxation depends upon whether both RLM and BFD measurements on SpCell fulfil the relaxation criterion.***  ***Proposal 12: The*** ***relaxation condition of RLM/BFD relaxation for multiple RS resources can be defined as when the radio link quality is better than the entering threshold for any RLM/BFD RS resource.***  ***Proposal 13: The exiting condition of RLM/BFD relaxation for multiple RS resources can be defined as when the radio link quality is worse than the exiting threshold for all the RLM/BFD RS resources.*** |
| [**R4-2113887**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2113887.zip) | ZTE Corporation | **Proposal 1: Negative system level impact due to RLM/BFD relaxation should be minimized.**  Proposal 2: The thresholds are configured to the UE by the network..  **Proposal 3: Use RSRP variation and SINR variation as the variation thresholds for low mobility criterion.**  **Proposal 4: The UE shall exit relaxation mode when the radio link quality of the serving cell is worse than a certain threshold, which is higher than Qout. The threshold can be configured by network with margin.** |
| [**R4-2114081**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114081.zip) | Ericsson | * **Proposal #1:** The good serving cell quality criteria is based on exiting RLM/BFD threshold and expressed as follows:   + radio link quality > Qout + X (dB) for RLM,   + Qout,LR + Y (dB) for BFD relaxation,   + Values of X and Y are predefined and FFS. * **Proposal #2:** Low mobility state for operating relaxed RLM/BFD is determined based on RSRP measurement variation. * **Proposal #3:** UE shall revert to normal RLM operation mode when when X number of out-of-indications are sent to the higher layers (option 4), where X can be e.g. 1. * **Proposal #4:** During relaxation, the UE shall continue evaluate the serving cell quality and send out-of-sync indications when the measured SINR becomes worse than Qout threshold and follow the associated procedures (including N310 counters.), i.e. same as in legacy RLM procedure. * **Proposal #5:** Relaxed evaluation period for RLM/BFD is derived by extending the current RLM/BFD evaluation period with a predefined scaling factor X, where X is TBD. * **Proposal #6:** Relaxed RLM/BFD requirements are introduced in new subsections within the existing RLM/BFD sections TS 38.133. * **Proposal #7:** Relaxation factors are different for FR1 and FR2. * **Proposal #8:** RAN4 shall discuss whether to apply different relaxation factors for SSB and CSI-RS based evaluations in FR2. * **Proposal #9:** RAN4 to discuss applying different relaxation factor for the different SINR regions. * **Proposal #10:**    + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, the UE is allowed the operate in relaxed mode for RLM and/or BFD if UE has fulfilled the relaxation criteria for both RLM and BFD.   + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, if UE has failed to fulfil the relaxation criteria for any of RLM and BFD, then the UE is not allowed to operate in relaxed mode in RLM and BFD in any of the cells. * **Proposal #11:**    + The UE is allowed to operate RLM/BFD in relaxed mode for a certain cell (SpCell or SCell) when the radio link quality is better than the threshold (Qout + X1) for all RLM-RS resource.   + The shall exit the relaxed mode when the radio link quality is worse than the threshold (Qout + X2) for any the RLM-RS resources.   + The values of X1, X2 are FFS. |
| [**R4-2114153**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_100-e/Docs/R4-2114153.zip) | MediaTek inc. | ***Proposal 1: Network to configure an offset threshold level Qoffset to UE as the serving cell quality criterion, which indicates how large the SINR threshold of entering condition should be, and UE is only allowed to enter power saving mode when the estimated SINR value is larger than Qrelax = Qout+ Qoffset***  ***Proposal 2: Rel-16 RSRP attenuation is reused as the low mobility criterion of Rel-17 power saving, it is up to Network implementation on whether the low mobility criterion is necessary to be configured***  ***Proposal 3: RAN4 does not to specify a different exiting conditions in the spec, but UE has to leave power saving mode once entering condition is not fulfilled***  ***Proposal 4: RAN4 does not specify UE RLM/BFD relaxation behavior in the spec, at least we can specify the evaluation time when K=2 is 2\* TRel15\_RLM/BFD\_evaluation, where TRel15\_RLM/BFD\_evaluation is as specified in clause 8.1.2.2 and 8.1.3.2 in TS 38.133***  ***Proposal 5: RAN4 specify the new evaluation period as K1\* TRel15\_RLM/BFD\_evaluation, where TRel15\_RLM/BFD\_evaluation is as specified in clause 8.1.2.2 and 8.1.3.2 in TS 38.133***  ***Proposal 6: Different configurations for SSB based RLM/BFD and CSI-RS based RLM/BFD in different frequency ranges are allowed***  ***Proposal 7: Different relaxation factors for FR1 and FR2 should be allowed, so that we can have better balance between the opportunity for UE to enter the power saving mode and obtained power saving gain*** |

## Open issues summary

### Sub-topic 1 Relaxation applicability

#### **Issue 1-1: Relaxation when neither serving cell quality criteria nor low mobility criteria is configured**

* Proposals
  + Option 1: the network would assume the UE is not performing relaxed RLM/BFD measurements and the existing RLM/BFD requirements shall apply. (**Nokia**)
* Recommended WF: Is Option1 agreeable?

#### **Issue 1-2: Whether low mobility criteria is necessary to be configured?**

* Proposals
  + Option 1: No. It is up to network. (**Nokia**, **MTK**)
  + Option 2: Yes.
* Recommended WF: Discuss the proposal. Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 1-3: Whether good serving cell criteria criteria is necessary to be configured?**

* Proposals
  + Option 1: No. It is up to network. (**Nokia**)
  + Option 2: Yes.
* Recommended WF: Discuss the proposal. Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**

* Proposals
  + Option 1: It is up to network to configure whether only one criterion is used (either low mobility criterion or good serving cell quality criterion) or both criteria are used separately, or both are to be used in combination e.g. to enter relaxation. (**Nokia**)
  + Option 2: FFS how to define the enter condition when both serving cell quality criteria and low mobility criteria are configured. (**CATT**)
* Recommended WF: Discuss the proposal. Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements**

* Proposals
  + Option 1: Yes (**Nokia**)
  + Option 2: No
* Recommended WF: Discuss the proposal. Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 1-6: When DRX cycles > 80ms**

* Proposals
  + Option 1: If the UE applies a DRX cycle longer than 80ms, the UE is assumed not to perform relaxed RLM/BFD measurements and the existing RLM/BFD requirements would apply. (**Nokia, Huawei, CMCC**)
* Recommended WF: Is Option1 agreeable?

### Sub-topic 2 Low motility criteria

* Background: the agreement on **Low mobility criteria** for RLM/BFD relaxation in RAN4 99-e-Bis meeting:
* *UE verifies whether the low mobility criterion is fulfilled or not based on the RSRP variation and/or SINR variation, provided that the variation thresholds are configured by the NW.*
* *FFS the variation thresholds for low mobility criterion*
  + *Option 1: RSRP variation*
  + *Option 2: SINR variation*
  + *Option 3: RSRP variation and SINR variation.*
* *FFS how to calculate the variation*

#### **Issue 2-1: Low mobility criteria**

* Proposals
  + Option 1: Reuse R16 low mobility criterion. (**CATT, Apple, vivo, Qualcomm, Nokia, MTK**)
  + Option 1a: Low mobility state for operating relaxed RLM/BFD is determined based on RSRP measurement variation. (**Ericsson**)
  + Option 1b: FFS the necessity revisions regarding issues like ping-pong effect, RS type, etc. (**vivo**)
  + Option 2: based on the SINR variation (**Xiaomi, Intel, Huawei, CMCC**)
  + Option 2a: The SINR variation does not exceed a threshold which is suggested to be defined as 2dB. (**Huawei**)
  + Option 2b: Define an evaluation period, to check the L3-SINR values always higher than the SINR threshold (the threshold used in serving cell quality criterion) (**CMCC**)
  + Option 3: based on the RSRP variation and SINR variation (**ZTE**)
* Recommended WF: Discuss the proposals. Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 2-2: Low mobility criteria - additional**

* Proposals
* Option 1: RAN4 additionally to define a low mobility criterion based on the number of serving beam changes over time (e.g. TCI state change) (**Nokia**)
  + It is up to network to configure if the low mobility criteria is based on SS-RSRP variation or TCI change, or the two in combination. (**Nokia**)
* Recommended WF: Discuss the proposals.

### Sub-topic 3 Good serving cell quality criteria

* Background: the agreement on **Good serving cell quality criteria** for RLM/BFD relaxation in RAN4 99-e-Bis meeting:
  + *the radio link quality metric for RLM*
    - *UE reuse the SINR for RLM/BFD evaluation when determine whether the serving cell quality criteria is fulfilled or not*
      * *FFS what is the SINR definition*
      * *FFS whether RSRP is also needed for RLM/BFD as additional condition*
  + *predefined or configured threshold*
    - *Option A: The thresholds are configured to the UE by the network*
      * *FFS: based on a set of discrete threshold values.*
    - *Option B: The thresholds can be pre-defined.*

#### **Issue 3-1: SINR definition for good serving cell quality criteria**

* Proposals
  + Option 1: reuse the legacy definition of the SINR for radio link quality evaluation of RLM/BFD. (**CMCC, Qualcomm, Xiaomi, Nokia, Intel**)
  + Option 2: L3-SINR. RSRQ and RSRP can also be used as serving cell quality metric for UE that does not support the optional L3-SINR measurement. (**Apple**)
  + Option 2a: the SINR can be SS-SINR or CSI-SINR (Nokia, CATT)
  + Option 3: leave to UE implementation (**vivo**).
  + Option 4: The SINR used for RLM/BFD relaxation criteria is measured on the configured RS resource over the evaluation period (**Huawei**)
* Recommended WF: Discuss the proposals.

#### **Issue 3-2: predefined or configured threshold**

* Proposals
  + Option 1: The thresholds are configured to the UE by the network. (**ZTE,** **CATT**, **Qualcomm**, **Apple, CMCC, Xiaomi, MTK, Intel**)
    - Option 1a: defined as a set of discrete values (**CMCC, Xiaomi, Intel**)
    - Option 1b: Do not define a set of discrete values in RAN4. (**CATT**)
  + Option 2: The thresholds is predefined. (**Qualcomm**)
  + Option 3: leave to UE implementation (**vivo**).
    - Option 2a: as long as UE can fall back to normal mode and identify o-o-s or beam failure timely according to the relaxed requirement (**vivo**)
* Recommended WF: Is Option 1 agreeable? Encourage company to provide views on this, because it has potential singling impact.

#### **Issue 3-3-1: good serving cell quality criteria for RLM**

* Proposals:
* Option 1: (**Xiaomi**, **Ericsson**, **Qualcomm, MTK**)
  + radio link quality > Qout + X (dB) for RLM. FFS X.
* Option 1a: radio link quality > Qin + X (dB) for RLM (**Intel, Huawei**)
* Recommended WF: In moderator’s understanding, Option 1 and Option 1a seems no difference, since margin X is FFS. Suggest to agree on
  + *The good serving cell quality criteria for RLM is*
  + *radio link quality > Qout + X (dB). FFS X.*

#### **Issue 3-3-2: good serving cell quality criteria for BFD**

* Proposals
  + Option 1: radio link quality > Qout,LR + Y (dB) for BFD. FFS Y. (**Xiaomi**, **Ericsson**, **MTK, Huawei, CMCC, Qualcomm**)
  + Option 2: radio link quality *>* *rsrp-ThresholdSSB* +Y (dB), where Y dB is margin (**Intel**)
* Recommended WF: Suggest to agree on
  + *The good serving cell quality criteria for BFD is*
    - *radio link quality > Qout,LR + Y (dB). FFS Y*.

#### **Issue 3-4-1: same thresholds for RLM and BFD**

* Proposals
  + Option 1: the same thresholds used for good serving cell quality and low mobility criteria are applied for both RLM relaxation and BFD relaxation (**Huawei**)
* Recommended WF: Discuss the proposals.

#### **Issue 3-4-2: different thresholds for FR1 and FR2**

* Proposals
  + Option 1: Different thresholds for different frequency ranges are allowed (**MTK**)
* Recommended WF: Discuss the proposals.

#### **Issue 3-4-3: different thresholds for SSB based and CSI-RS based**

* Proposals
  + Option 1: Different thresholds for SSB based RLM/BFD and CSI-RS based RLM/BFD are allowed (**MTK**)
* Recommended WF: Discuss the proposals.

### Sub-topic 4 Exiting Relaxation criteria

* Background:
* the agreement in RAN4 98-e-Bis meeting:
* *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 or mobility state change reverts to the normal RLM operation (i.e. without relaxation).*
* the agreement in RAN4 99-e-Bis meeting:
* *If the UE fulfills any of serving cell quality exit condition or low mobility exit condition, or DRX cycle length is NOT allowed for relaxation, UE will exit relaxation mode.*
  + *Note1: Whether the exit condition for serving cell quality is explicitly specified or not is up to issue 2-3-2.*
  + *Note2: FFS the details of the exit condition of low mobility’*
* *FFS the observation period for the exiting criteria*
* *FFS the following options, which have been discussed in this meeting.*
  + *Option 1: exit relaxation mode when the radio link quality of the serving cell is worse than a certain threshold, which is higher than Qout.*
    - *Option 1a: a hysteresis value could be used to avoid ping-ping effect, e.g. SINRexit = SINRenter - 3dB*
    - *Option 1b: SINRexit = Qout + 7dB*
    - *Option 1c: SINRexit = Qout +Margin or SINRexit = Qin*
    - *Option 1d: The threshold can be configured by network with margin*
  + *Option 2: exit relaxation mode when the radio link quality is worse than Qout, and the UE is still in the relaxation mode when the radio link quality is better than Qout.* 
    - *Option 2b: UE shall revert to non-relaxed RLM/BFD measurement and evaluation period at the 1st Qout based on relaxed RLM/BFD measurements and evaluation period.*
  + *Option 3: Leave the fall back mechanism as UE implementation, as long as UE makes sure it has already fallen back to normal measurement if it has identified one out-of-sync indication.*
  + *Option 4: exit when certain consecutive out-of-sync indications*

#### **Issue 4-1: Exit criteria based regarding the radio link quality**

* Proposals:
* Option 1: Exit RLM relaxation mode when any relaxation criterion is not met, or when N310 starts to count. No additional exit criterion needs to be defined. **(Apple, MTK)**
* Option 2: Reuse Qout as the radio link quality threshold. Exit relaxation mode when the radio link quality is worse than Qout (**Ericsson, Apple, CMCC, Nokia, Qualcomm**)
  + Option 2a: (**Qualcomm**)
    - The SINR measurement in relaxation mode is for exiting relaxation mode evaluation. After exiting relaxation mode, UE follows the R15 requirement and sends the first OOS indication after the R15 evaluation period if SNR<Qout.
    - Set the evaluation period for exiting relaxation mode evaluation as the evaluation period for OOS indication in normal mode, and leave the SINR exit threshold and the number of SINR measurements in the evaluation period to UE implementation.
* Option 3: Introduce a radio link quality threshold rather than Qout. Exit relaxation mode when the radio link quality is worse than a SINR threshold (Thexit ) (**Xiaomi, Huawei, ZTE, Intel**)
  + Option 2a: Thexit = SINRenter with a hysteresis value (**Xiaomi**)
  + Option 2b: Thexit = SINRenter – 3dB (**Hauwei**)
  + Option 2c: Thexit > Qout (**ZTE**)
    - The threshold can be configured by network with margin.
  + Option 2d: Thexit = Qout+7dB or Qin (**Intel**)
* Recommended WF: Moderator’s understanding is that if Option 2 is met, then Option 1 or 3 is also met automatically. Suggest to agree at least on Option 2. FFS whether to additional consider Option 1 or 3.

#### **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria**

* Proposals:
* Option 1: No. (**CMCC**)
  + Option 1a: No need to define low mobility exit condition. If the UE fulfills any of serving cell quality exit condition, or DRX cycle length is not allowed for relaxation, UE will exit relaxation mode. (**CMCC**)
* Option 2: Yes. (**Huawei**)
  + Option 2b: For exiting relaxation criteria, the existing condition for low mobility criterion can be defined as when the SINR variation exceeds the entering threshold (i.e. 2dB) (**Huawei**)
* Recommended WF: Discuss the proposal

#### **Issue 4-3: Re-entry to the relaxation mode**

* Proposals:
* Option 1: (**CMCC**)
  + After reverting, UE couldn’t go into relaxation mode again during a certain punish period, such as when a new timer is active. UE can decide whether go into relaxation mode by relaxation criteria after the timer expires. The timer can be configured by network.
* Recommended WF: Discuss the proposal.

#### **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**

* Proposals:
* Option 1 (**CMCC**): The scheme of BFD relaxation revert criteria can reuse the scheme of RLM relaxation revert criteria on the basis of different thresholds and/or indications.
* Recommended WF: Discuss the proposal.

### Sub-topic 5 During Relaxation mode

* Background
* *Use of a scaling factor to extend the RLM/BFD evaluation period. (Agreement in RAN4 98-e, R4-2103670).*
* *Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on max(TDRX, TSSB). (Agreement in RAN4 98-e-Bis, R4-2105797)*

#### **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode**

* Proposals:
* Option 1: Yes. RAN4 to use either of the two options to define the good serving cell quality criteria: (**Nokia**)
  + Behaviour 1: relax the evaluation period while assuming the same number of samples as in normal RLM/BFD
  + Behaviour 2: reduce the number of RLM/BFD measurement samples performed during the evaluation period, and maintaining the evaluation period the same as in normal RLM/BFD measurement**s**
* Option 2: No. RAN4 does not specify UE RLM/BFD relaxation behavior in the spec but to specify the new evaluation period during for relaxation (**MTK**)
* Recommended WF: Discuss the proposals.

#### **Issue 5-2-1: the formula of relaxed evaluation period**

* Proposals:
* Option 1: RAN4 specify the relaxed evaluation period as K\* TRel15\_RLM/BFD\_evaluation (**Ericsson, MTK, vivo, Xiaomi)**
* where TRel15\_RLM/BFD\_evaluation is the current RLM/BFD evaluation period
* where K is a predefined value.
* Option 2: RAN4 specify the relaxed evaluation period based on Max(T, Ceil([Y] x P x N) x Max(TDRX, TRLM-RS/BFD-RS)) (**CATT, Apple, Huawei, Qualcomm**)
  + - Option 2a: Y = K \* current Rel-15 samples (**CATT)**
    - Option 2b: Y is FFS (**Apple**)
    - Option 2c: If power saving conditions are satisfied, allow TEvaluate\_ps\_out\_SSB for the first OOS indication: (**Qualcomm**)

|  |  |
| --- | --- |
| Configuration | TEvaluate\_ps\_out\_SSB (ms) |
| no DRX | Max(200, Ceil(10 × P) × TSSB) |
| DRX cycle≤80ms | Max(200, Ceil(30 × P) × Max(TDRX,TSSB)) |
| 80ms<DRX cycle≤320ms | Max(200, Ceil(20 × P) × Max(TDRX,TSSB)) |
| DRX cycle>320ms | Ceil(10 × P) × TDRX |
| NOTE: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length. | |

Option 2d: (**Huawei**)

* **The RLM/BFD evaluation period in relaxation mode TEvaluate\_relax can be defined as:**

|  |  |
| --- | --- |
| Configuration | TEvaluate\_relax (ms) |
| DRX cycle ≤ 80ms | Max(T, Ceil(Y × P) × Max(TDRX,TSSB/TCSI-RS)) |
| Note 1: TSSB is the periodicity of SSB in the set  and no longer than 80ms. TCSI-RS is the periodicity of CSI-RS resource in the set . TDRX is the DRX cycle length.  Note 2: The value of P is as same as the existing definition in legacy mode. | |

* **where, the value of Y used** **for defining relaxed RLM/BFD evaluation period can be defined as follow:**

|  |  |
| --- | --- |
| **Evaluation Period Type** | **Value of Y used for defining relaxed RLM/BFD Measurements** |
| **SSB based RLM** | 30 |
| **CSI-RS based RLM** | 60 |
| **SSB based BFD** | 15 |
| **CSI-RS based BFD** | 30 |

Recommended WF: Moderator’s understanding on the main difference between Option 1 and Option 2 is whether to apply scaling factor on the low bound of evaluation period or note. Suggest to discuss lower bound issue in Issue 5-2-2 and agree on the high level principle as below:

* RAN4 specify the new evaluation period based on Max(T, Ceil([Y] x P x N) x Max(TDRX, TRLM-RS/BFD-RS))
  + where T is the lower bound of relaxed evaluation period. FFS whether the relaxation factor to apply on T.
  + where Y is K \* current Rel-15 samples, and K is the predefined relaxation factor. FFS the value of K.

#### **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period**

* Background: Two types of relaxed evaluation period are observed, given the relaxation factor is K:
  + Type 1: K \* Max(T, Ceil(Y0 x P x N) x Max(TDRX, TRLM-RS/BFD-RS)).
  + Type 2: Max(T, Ceil( K x Y0 x P x N) x Max(TDRX, TRLM-RS/BFD-RS)).
  + The main difference is whether the lower bound, i.e. T, is relaxed or not.
* Proposal:
  + Option 1: Yes, also lower bound of relaxed evaluation period is also relaxed.
  + Option 2: No.
* Recommended WF: Discuss the proposal

#### **Issue 5-2-3: clarification on TDRX**

* Proposal:
  + Option 1: Clarify the definition of DRX cycle in the evaluation period table by adding a note “TDRX is the DRX cycle length being applied”. (**Nokia**)
* Recommended WF: Discuss the proposal

#### **Issue 5-3-1: different relaxation factors for FR1 and FR2**

* Proposals
  + Option 1: Relaxation factors are allowed to be different for FR1 and FR2. (**Ericsson, MTK**)
* Recommended WF: Discuss the proposal

#### **Issue 5-3-2: different relaxation factors for SSB and CSI-RS**

* Proposals
  + Option 1: RAN4 shall discuss whether to apply different relaxation factors for SSB and CSI-RS based evaluations in FR2. (**Ericsson**)
* Recommended WF: Discuss the proposal

#### **Issue 5-3-3: different relaxation factors for different SINR regions**

* Proposals
  + Option 1: RAN4 to discuss applying different relaxation factor for the different SINR regions. (**Ericsson**)
* Recommended WF: Discuss the proposal

#### **Issue 5-3-4: value of relaxation factor**

* Proposals
  + Option 1a (**Nokia**):
  + RAN4 to discuss what is the acceptable SINR error to determine the maximum allowed scaling factor (i.e. SINR difference between relaxation and without relaxation)
  + RAN4 needs to discuss the maximum scaling factor, K, corresponding to the acceptable delay in RLF declaration
  + RAN4 needs to consider impact on system level performance like time of outage and percentage of RLF and HOF is relaxation of RRM measurements is also allowed.
  + Option 1b: Negative system level impact due to RLM/BFD relaxation should be minimized. (**ZTE**)
  + Option 2: at least 2. (**MTK**)
  + Option 3: (**vivo**)
  + FR1: at least 2 for DRX <= 40ms, and at least 1.5 for 40ms <DRX <= 80ms (**vivo**)
  + FR2: FFS
* Recommended WF: Discuss the proposal

#### **Issue 5-4: OOS indication during relaxation mode**

* Proposals:
* Option 1: UE indicates OOS during relaxation mode.(**CMCC, Xiaomi, Ericsson, vivo**)
  + Option 1a: the UE shall continue evaluate the serving cell quality and send out-of-sync indications when the measured SINR becomes worse than Qout threshold and follow the associated procedures (including N310 counters.), i.e. same as in legacy RLM procedure (**Ericsson, Xiaomi**)
  + Option 1b: The minimal separation between o-o-s indications needs not to be increased in R17 PowSav. Allowing longer separation between RLM/BFD measurements (**vivo**)
  + Option 1c: L1 indication period in relaxation mode can be Max(10ms, Ceil([Y] x 1.5 × DRX\_cycle\_length, Ceil([Y] x 1.5 × TRLM-RS,M)). (**CMCC**)
* Option 2: UE is not required to send the first OOS indication to higher layers during relaxation mode. (**Qualcomm**)
  + The SINR measurement in relaxation mode is for exiting relaxation mode evaluation. After exiting relaxation mode, UE follows the R15 requirement and sends the first OOS indication after the R15 evaluation period if SNR<Qout. (**Qualcomm**)
* Option 3: RAN4 need discuss if the OoS indication based on the Qin/Qout during relaxed measurements shall be indicated to high layers. (**Nokia**)
* Recommended WF: Discuss the proposal.

#### **Issue 5-5: Additional N310/N311 values for relaxation mode**

* Proposals
* Option 1: It should be allowed for the network to configure different values of the RLF parameters, e.g. T310/N310/N311, for the relaxed operation to reduce the negative impact to the system performance (**Nokia**)
* Recommended WF: Discuss the proposals.

### Sub-topic 6 Other Aspects

#### **Issue 6-1: Specification structure**

* Proposal:
  + Option 1: Relaxed RLM/BFD requirements are introduced in new subsections within the existing RLM/BFD sections TS 38.133. (**Ericsson**)
* Recommended WF: Discuss the proposals.

#### **Issue 6-2-1: Relaxation criteria in intra-band CA**

* Background: *The following is FFS:*
* *For intra-band CA with CSI-RS based RLM/BFD, if UE has fulfilled the criterion for operating RLM/BFD in relaxed mode in all serving cells, then it is allowed to operate RLM/BFD in relaxed mode in all other serving cells if same type of RS (CSI-RS) are used for RLM/BFD in the serving cell and other serving cells.*
* *For intra-band CA with CSI-RS based RLM/BFD, if UE meets the conditions of reverting to the normal RLM/BFD in any of the serving cells, it exists the relaxation mode in all other serving cell(s) if same type of RS (CSI-RS )are used for RLM/BFD in the serving cell and other serving cells.*
* Proposal:
* Option 1: (**Ericsson**)
  + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, the UE is allowed the operate in relaxed mode for RLM and/or BFD if UE has fulfilled the relaxation criteria for both RLM and BFD.
  + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, if UE has failed to fulfil the relaxation criteria for any of RLM and BFD, then the UE is not allowed to operate in relaxed mode in RLM and BFD in any of the cells.
* Option 2: For intra-band CA, whether to allow RLM/BFD relaxation depends upon whether both RLM and BFD measurements on SpCell fulfil the relaxation criterion. (**Huawei, vivo**)
  + Option 2a: For CA, on the band where spCell exists, the baseline assumption is that UE will not perform BFD in the SCells in this band (**vivo**)
* Recommended WF: Discuss the proposals.

#### **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS**

* Proposal:
  + Option 1 (**Huawei**)
    - The relaxation condition of RLM/BFD relaxation for multiple RS resources can be defined as when the radio link quality is better than the entering threshold for **any** RLM/BFD RS resource.
    - The exiting condition of RLM/BFD relaxation for multiple RS resources can be defined as when the radio link quality is worse than the exiting threshold for **all** the RLM/BFD RS resources.
  + Option 2 (**Ericsson, CMCC**)
    - The UE is allowed to operate RLM/BFD in relaxed mode for a certain cell (SpCell or SCell) when the radio link quality is better than the threshold (Qout + X1) for **all** RLM-RS resource.
    - The shall exit the relaxed mode when the radio link quality is worse than the threshold (Qout + X2) for **any** the RLM-RS resources.
  + Option 3 (**CMCC**)
    - revisit after exiting criteria.
  + Option 4: The UE behaviour on checking the entering/exiting condition of cell quality criterion regarding multiple RLM-RSs/BFD-RSs is not specified. (**Vivo**)
* Recommended WF: Discuss the proposals.

#### **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA**

* Proposal:
  + Option 1: For the case of NR-DC and inter-band CA, further discuss whether UE needs to evaluate the entering/exiting conditions for each serving cell, and whether UE is allowed to relax RLM/BFD if it meets the relaxation criterion in other serving cell. (**vivo**)
* Recommended WF: Discuss the proposals.

#### **Issue 6-3: RRM enhancement with RLM/BFD power saving**

* Proposal:
  + Option 1: Consider the RRM enhancement after finishing the RLM/BFD power saving related issues. (CMCC)
* Recommended WF: The option 1 seems out of this WI scope and it would not be RAN4 discussion. Proponent could clarify.

### Sub-topic 7 LS out

#### **Issue 7-1: LS draft**

* Background: according to the agreed work plan (R4-21033669), LS initial RRC parameters to RAN2 would be needed.
* 3GPP RAN4 #100e meeting (August, 2021, **Work phase**)
  + Discuss and specify, if agreed:
    - Relaxation method and the corresponding criteria and scenarios for RLM/BFD
    - LS initial RRC parameters to RAN2, if needed
* 2 companies proposed LS drafts this meeting
* Recommended WF:
  + 1st round: focus on technical issues above
  + 2nd round: work on the LS.

## Companies views’ collection for 1st round

### Open issues

#### Sub-topic 1 Relaxation applicability

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 1-1: Relaxation when neither serving cell quality criteria nor low mobility criteria is configured** Option 1 is agreeable. **Issue 1-2: Whether low mobility criteria is necessary to be configured?** We support option 1, i.e. the low mobility criteria configuration is up to the network **Issue 1-3: Whether good serving cell criteria criteria is necessary to be configured?** We support option 1, i.e. the configuration of good serving cell criteria is up to the network.  **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**  According to earlier discussions and agreements, the relaxed requirements apply when UE has fulfilled both low mobility criterion and good serving cell quality criterion. If UE fulfills only one of then, then it should not enter the relaxation mode. So this is already discussed and agreed earlier. **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements** Option 1 is agreeable to us. **Issue 1-6: When DRX cycles > 80ms** Option 1 is agreeable. |
| **Apple** | Issue 1-1: Option 1 is agreeable.Issue 1-2: Clarification is needed for option 1. When it is not configured, does it mean relaxation:  1. Up to UE implementation for mobility evaluation and decision for relaxation? 2. Only good serving cell is needed for evaluation and regardless mobility state?   Issue 1-3: Same clarification needed as issue 1-2.  Issue 1-4: Have the same understanding as Ericsson’s comment on earlier agreement.  Issue 1-5: Support SIB based signaling. Not clear why UE specific dedicated signaling is needed. Does this proposal imply each UE can potentially has different criterion for RLM relaxation?  Issue 1-6: OK with the proposal. |

#### Sub-topic 2 Low motility criteria

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 2-1: Low mobility criteria**  Option 1 and 1a are very similar and can be merged. We can compromise to option 1. **Issue 2-2: Low mobility criteria – additional** We understand the motivation of option 1, however it needs some further improvement. For example, the condition based on TCI change is not enough, e.g. if the UE is close to the BS and moving along the BS. We support a modified version of option 1 as follows:  Option 1a: Relaxed mode operation for RLM/BFD is allowed if UE has not done any beam failure detection over last X (e.g. X=1) evaluation period. |
| **Apple** | **Issue 2-1: support option 1.**  Issue 2-2: Need further discussion. Do not recall any result in the SI on the number of TCI state switching along UE movement and RLF. |

#### Sub-topic 3 Good serving cell quality criteria

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 3-1: SINR definition for good serving cell quality criteria** We support option 1. **Issue 3-2: predefined or configured threshold** We support option 1, i.e. thresholds are configurable by the network. **Issue 3-3-1: good serving cell quality criteria for RLM** Recommended way forward is agreeable. **Issue 3-3-2: good serving cell quality criteria for BFD** Recommended way forward is agreeable. **Issue 3-4-1: same thresholds for RLM and BFD**  Our view is to have the thresholds configurable by the network and it should also be possible to have separate configurations, i.e. the thesholds can be different. Thus option 1 is not agreeable to us. **Issue 3-4-2: different thresholds for FR1 and FR2** We support option 1. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** We support option 1. |
| **Apple** | **Issue 3-1: We support option 2 and option 2a, where SS-SINR and CSI-SINR are used for L3-SINR.**  We would like to clarify option 1. Qin and Qout is defined by hypothetical BLER, and SINR is used in test case to trigger different Qin/Qout. It is up to UE implementation to map the received RLM-RS to BLER by PHY abstraction.  Since UE need to measure certain RS and compared to the criterion, clear definition of SINR is needed. Therefore, we should reuse SS-SINR or CSI-SINR defined in 38.215 is clearer.  Does option 1 propose that UE should reuse the RLM-RS to measure L1-SINR? Seems option 4 is proposing average of SINR of RLM-RS over evaluation window, which is a new definition of L3-SINR?  In general, we have concern to use L1 measurement as criterion to relax higher layer procedures.  **Issue 3-2: Option 1.**  **Issue 3-3-1: depends on 3-1 and 3-2. Not sure whether the proposals here only apply to L1-SINR based on RLM-RS, and only pre-defined threshold. If the threshold is RRC configured, does the discussion X here only for test cases?**  **Issue 3-3-2: Same comments as 3-3-1.**  **Issue 3-4-1: Open for different threshold for RLM/BFD relaxation.**  **Issue 3-4-2: Open for different threshold for FR1 and FR2.**  **Issue 3-4-3: Need further justification. Different Rx beam scaling factor for SSB versus CSI-RS based RLM/BFD. However same mobility and serving cell criterion can be used, while relaxation factor can be different due to N value.** |

#### Sub-topic 4 Exiting Relaxation criteria

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 4-1: Exit criteria based regarding the radio link quality** We are fine with moderator’s suggestion to agree on option 2. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** This issue is already covered by previous issue (issue 4-1). No needed to discuss this separately. **Issue 4-3: Re-entry to the relaxation mode**  After exiting the relaxed mode, the UE shall not enter the relaxed mode immediately. Instead it shall re-evaluate the criteria which takes some time (evaluation period) and this time may correspond to the “punish period” as mentioned in option 1. Thus option 1 is already covered in the condition for entering or re-entering the relaxed mode. **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**  After exiting the relaxed mode, the UE shall not enter the relaxed mode immediately. Instead it shall re-evaluate the criteria which takes some time (evaluation period) and this time may correspond to the “punish period” as mentioned in option 1. Thus option 1 is already covered in the condition for entering or re-entering the relaxed mode. |
| **Apple** | **Issue 4-1:** we would like to clarify whether the understanding is correct for option 2:Is option 2 a subset of option 1, i.e., at least one Qout indication, and N310 starts to count? Issue 4-2: option 1.  Issue 4-3: do not see the need if L3-SINR is used as criterion.  Issue 4-4: Similar to 4-3. |
|  |  |

#### Sub-topic 5 During Relaxation mode

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 5-1: Whether to pecific UE behaviour in the relaxation mode** We support behavior 1 in option 1 where only the evaluation period is extended. **Issue 5-2-1: the formula of relaxed evaluation period** We are fine with the recommended WF. However, we think the formula is entirely correct. For example, assuming DRX cycle=10 ms, SSB periodicity = 10 ms, P=1 gives an evaluation period of 30\*10=300. This mean the lower bound is never used. **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period** With the current formula, unless lower bound is modified, it will not be used. Consider an example with DRX cycle=10 ms, SSB periodiocity = 10 ms, P=1 which gives an evaluation period 30\*10=300. This means the current value of T=200 is never selected. Then option 2 becomes same as option 1 in issue 5-2-1. **Issue 5-2-3: clarification on TDRX****Issue 5-3-1: different relaxation factors for FR1 and FR2** Different performance was observed in the simulation results between FR1 and FR2, thus we support option 1. **Issue 5-3-2: different relaxation factors for SSB and CSI-RS** If the relaxation factors are going to be configurable, then we think it is reasonable to have the option to config differently for SSB and CSI-RS because the RS configuration could be different. Thus we support option 1. **Issue 5-3-3: different relaxation factors for different SINR regions** Different performance (PDCCH error) was observed in the simulation results for different SINR region. Thus it should be beneficial to have allow different level of relaxation for the different SINR region, e.g. more relaxation (higher scaling factor) when SINR is high and less relaxation (lower scaling factor) when SINR is low. Thus we support option 1. However, we are open to hear the views from other companies on this issue. **Issue 5-3-4: value of relaxation factor**  If the scaling factors are configurable by the network, then there is no need to discuss the method for deriving the scaling factor. **Issue 5-4: OOS indication during relaxation mode** We support option 1 where the UE is still required to send out-of-sync indications when the radio link quality degrades. The impact on applying the relaxation is only to the extended evaluation period, and the UE behavior for triggering the OOS/IS should be similar to legacy behavior. **Issue 5-5: Additional N310/N311 values for relaxation mode**  Out understanding is that these RLF parameters are already configurable and going to be configurable also when operating under relaxed mode. We would like to confirm this understanding. |
| **Apple** | **Issue 5-1:** Support option 2. Clarification is needed on option 1/behavior 1, “the same number of samples as in normal RLM/BFD”. Is this proposal intend to specify how the evaluation period is defined, as listed in issue 5-2-1? Issue 5-2-1: option 2.  Issue 5-2-2: option 2. Lower bound will not be selected anyway.  Issue 5-2-3: Unclear the motivation.  Issue 5-3-1: Open to discuss different relaxation factors for FR1 and FR2.  Issue 5-3-2: Open to discuss different relaxation factors for SSB and CSI-RS.  Issue 5-3-3: Open to discuss different relaxation factors for different SINR regions.  Issue 5-3-4: Support different relaxation factors for different DRX cycles.  Overall, for issues on 5-3, maybe we can add a discussion point that the relaxation factor can be configured by network together with relaxation criterions.  Issue 5-4: Option 1a and 1b.  Issue 5-5: Do not see the need. |

#### Sub-topic 6 Other Aspects

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Ericsson** | **Issue 6-1: Specification structure** We support option 1. This gives better structure as well as convenience specification reading. Also note that the release 16 UE power saving requirements were also introduced in separate section. **Issue 6-2-1: Relaxation criteria in intra-band CA** We support option 1. It is important to note that the option 1 is related to a scenario where the UE is configured to perform CSI-RS based RLM on SpCell and CSI-RS based BFD on Scell on the same band (intra-band CA). It has been argued by some companies that such configuration is not supported. This is not correct understanding. In fact, there is no specification text (neither RAN1 or RAN4 specification) that prohibits such network configuration. If such configuration is prohibited, then we would like to see the corresponding specification text.  It is up to the network to configure the RLM and BFD resources and the UE is required to RLM and BFD using the configured resources. For example, if the network has configured the UE with CSI-RS based BFD-RS resources on a SCell, then it is required to perform BFD using those resources. Similarly, if the network has configured the UE with CSI-RS based RLM-RS resources on a SpCell (e.g. PCell), then the UE is required to perform RLM using those resources.   **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS** We support option 2, but we can also accept option 3 which states that the issue shall be discussed after the discussions on exiting criteria is concluded which makes sense in our view. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** For inter-band and DC scenario, the measurement characteristics might be different from one cell to another. Thus UE may have to evaluate the criteria for entering/exiting separately for each cell. **Issue 7-1: LS draft** Our view is to continue the technical discussions in the 1st round. LS can be discussed in the 2nd round. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## 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.*

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Ericsson | Santhan Thangarasa | santhan.thangarasa@ericsson.com |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)