**3GPP TSG-RAN WG4 Meeting # 100-e R4-2115218**

**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 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 3a: Thexit = SINRenter with a hysteresis value (**Xiaomi**)
  + Option 3b: Thexit = SINRenter – 3dB (**Hauwei**)
  + Option 3c: Thexit > Qout (**ZTE**)
    - The threshold can be configured by network with margin.
  + Option 3d: 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. |
| vivo | **Issue 1-1: Relaxation when neither serving cell quality criteria nor low mobility criteria is configured**  **We are OK to option 1.**  The following has been agreed in RAN4 #98e.  “*Network to enable and disable this feature.*”  Note if in issue 3-2, serving cell quality criterion is agreed to be not configurable, our understanding is that, when low mobility criteria are not configured, the feature is disabled,  **Issue 1-2: Whether low mobility criteria is necessary to be configured?**  **Support option 1** but no strong view.  In RAN4 98e-bis, the following was agreed.  “*Whether relaxed RLM/BFD requirements can be applied depends on both the serving cell quality and UE mobility state.*”  Therefore, we see only if low mobility criterion and cell quality criterion are both met, UE is allowed to relax RLM/BFD. This is also our preference so far in R17.  In RAN4 99e, the following is agreed.  “*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.*”  Therefore, we see low mobility can only be determined based on RSRP/SINR variation by the UE, i.e. network-determined low mobility is precluded.  Based on above, if low mobility criteria are not necessarily configured, and if cell quality criterion is not configurable, in our understanding there could be 2 options:  Option 1a: it means UE may not be able to enter the relaxed mode even if it has met the serving cell quality criteria for all serving cells.  Option 1b: it means UE may not be able to enter the relaxed mode even if it has met the serving cell quality criteria for the corresponding serving cell(s)/CG(s) in which low mobility criterion is not configured. **Issue 1-3: Whether good serving cell criteria is necessary to be configured?** This issue is overlapped with issue 3-2. Proabalby RAN4 need to firstly agree on whether serving cell criteria is configuratble.  Therefore, we propose to **focus on issue 3-2 firstly**. **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured** In RAN4 98e-bis, the following was agreed.  “*Whether relaxed RLM/BFD requirements can be applied depends on both the serving cell quality and UE mobility state.*”  Our understanding to this agreement is that, only if both conditions are met, UE is allowed to relax RLM/BFD. **We would like to add option 3:**  **Option 3: In R17, only specify the relaxed requirements for the case that UE has met both low mobility and cell quality conditions.** **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements** No strong view. Either option is ok. Slightly prefer option 1, because the following has been agreed in RAN4 #98e.  “*Network to enable and disable this feature.*”  The dedicated signalling would be more flexible in our view.  **Issue 1-6: When DRX cycles > 80ms**  In previous meeting, the following are agreed:  “Relaxation is applicable for DRX<=80ms.” (in RAN4 98e-bis)  “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.” (in RAN4 99e)  **Based on above agreements, we do not see the necessity to further agree option 1.** |

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| --- | --- |
| QC | **Issue 1-1~1-5**  We suggest to follow R16 condition configuration and applicability, and open to discuss whether the good cell condition should be required.  **Issue 1-6**  Can we come back to this issue after the relaxation factor is finalized? |

|  |  |
| --- | --- |
| Intel | **Issue 1-1:** Option 1 is fine. **Issue 1-3:** Option 1 is fine. **Issue 1-4:** Relaxation happen when both low mobility and good serving quality requirement are met. **Issue 1-6:** Option 1 is fine. |
| **CMCC** | **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?****Issue 1-3: Whether good serving cell criteria criteria is necessary to be configured?** **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**  UE can only enter relaxation mode when both serving cell quality criteria and low mobility criteria are configured by network and fulfilled by UE. Don’t understand the benefits of configuring one of the criteria.  **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements**  Clarification is needed for option 1. When UE receive this dedicated signaling, whether UE need to evaluate the relaxation criteria or not? or whether BS need to configure the relaxation criteria together with this signaling. **Issue 1-6: When DRX cycles > 80ms** Option 1. |
| MTK | **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. Our understanding is Network also has its own evaluation method to predict the UE speed. It is more accurate than the existing Rel-16 low mobility criteria. So it is possible that Network only configures good serving cell criteria when they think UE is moving with very low speed. If good serving cell criteria is not configured, then based on principle provided in option 1 of Issue 1-1, UE is not allowed to enter the power saving mode.  **Reply to Apple** Issue 1-2: Clarification is needed for option 1. When it is not configured, does it mean relaxation is:  1. Up to UE implementation for mobility evaluation and decision for relaxation?  [MTK]: Our understanding is “yes”. UE generally would keep monitoring its own speed because this is a very basic need for the channel estimation. Furthermore, considering that Network might only configure good serving cell quality when they think UE is moving with low speed, whether UE will double check its own speed should have no serious impact. So we think whether low mobility criteria is necessary to be configured can be up to Network implementation. 2. Only good serving cell is needed for evaluation and regardless mobility state? [MTK]: Our understanding is “yes”. The reason is the same with previous one.   **Reply to VIVO**  In RAN4 98e-bis, the following was agreed.  “*Whether relaxed RLM/BFD requirements can be applied depends on both the serving cell quality and UE mobility state.*”  Therefore, we see only if low mobility criterion and cell quality criterion are both met, UE is allowed to relax RLM/BFD. This is also our preference so far in R17.  [MTK]: Our understanding is “RAN4 agreed that both serving cell quality and UE mobility have to be considered”. However, it does not limit that UE mobility can “only” be determined by low mobility criteria. As far as I know, both Network and UE side have their own evaluating methods, which are more accurate than existing options of low mobility criteria.  [vivo] Agree.  In RAN4 99e, the following is agreed.  “*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.*”  Therefore, we see low mobility can only be determined based on RSRP/SINR variation by the UE, i.e. network-determined low mobility is precluded.  [MTK]: Our understanding is “RAN4 limited the candidate of low mobility criteria, but did not say it has to be configured by Network”. Network can still decide whether low mobility criteria is needed. If Network think their own evaluation scheme is precise enough, then there is no need to configure this low mobility criteria.  [vivo] We understand your logic. We are fine to accept your understanding but not sure whether the group share the same understanding. RAN4 better align the common understanding.  Based on above, if low mobility criteria are not necessarily configured, and if cell quality criterion is not configurable, in our understanding there could be 2 options:  Option 1a: it means UE may not be able to enter the relaxed mode even if it has met the serving cell quality criteria for all serving cells.  Option 1b: it means UE may not be able to enter the relaxed mode even if it has met the serving cell quality criteria for the corresponding serving cell(s)/CG(s) in which low mobility criterion is not configured.  [MTK]: Our understanding is “if good serving cell quality is configured, then UE is allowed to  enter power saving mode once good serving cell quality is fulfilled.”  [vivo]: Same comment as above. **Issue 1-3: Whether good serving cell criteria criteria is necessary to be configured?** We don’t have strong view but slightly prefer option 2. We have to firstly clarify that “Network always has flexibility to choose whether to configure good serving cell criteria.” Our understanding for this issue is “when Network thinks UE is allowed to enter power saving mode,” whether good serving cell criteria is necessary to be configured? Unlike low mobility estimation, whether serving cell quality is good enough can only be evaluated on the UE side. We provide 2 cases to explain the necessity   1. It is possible that UE is located in the cell center and moving slowly but its signal is blocked. 2. Even though the UE is moving with low speed, the relaxed RLM/BFD measurement should still not be allowed when it is close to the cell edge.   Above situations can only be reflected by further evaluating the good serving cell quality. If only low mobility criteria is configured, UE will not know what SINR threshold is preferred and acceptable from the Network perspective.  **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**  We share the same understanding with Ericsson. **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements** We share the same view with Apple and prefer option 2. In Rel-16, RAN2 did not introduce dedicated signaling to indicate whether UE is allowed to relax RRM measurement in IDLE mode. If neither serving cell quality criterion nor mobility criterion is configured, then UE is not allowed to relax the measurement. The same principles can be reused in Rel-17. We see no strong need to change the legacy signaling structure. **Issue 1-6: When DRX cycles > 80ms** Option 1 is agreeable. |
| **Huawei** | Issue 1-1: It is related to issue 1-5. If the dedicated signaling to indicate UE is allowed for RLM/BFD relaxation, when both good serving cell quality criteria and low mobility criteria are not configured, then how to perform good serving cell quality criteria and low mobility criteria is up to UE implementation. Issue 1-2: We can agree with option 1. When low mobility criteria is not configured, how to perform low mobility criteria is up to UE implementation.  Issue 1-3: We can agree with option 1. When good serving cell quality criteria is not configured, how to perform serving cell quality criteria is up to UE implementation.  Issue 1-4: Relaxation is allowed when both good serving cell quality criteria and low mobility criteria are satisfied.  Issue 1-6: support option 1. |
| **Xiaomi** | **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?****Issue 1-3: Whether good serving cell criteria criteria is necessary to be configured?** **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**  We think that UE is allowed to relax RLM/BFD only if both low mobility criterion and good serving cell quality criterion are met. **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements**Option 2. We prefer to follow the same principles in Rel-16.**Issue 1-6: When DRX cycles > 80ms**Fine with Option 1. |
| **OPPO** | **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?** Option 2. Per agreement in last meeting, relaxation can be allowed for UE once the conditions of serving cell quality and low mobility are fulfilled. **Issue 1-3: Whether good serving cell criteria is necessary to be configured?** Option 2. Same comment as issue 1-2.  **Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured**  We think that UE is allowed to relax RLM/BFD only if both low mobility criterion and good serving cell quality criterion are met. **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements**Option 2. We prefer to follow the same principles in Rel-16.**Issue 1-6: When DRX cycles > 80ms**Fine with Option 1. |
| **CATT** | **Issue 1-1:** **Option 1 is agreeable** **Issue 1-2 and Issue 1-3 and Issue 1-4:** **In our understanding, UE the RLM/BFD shall enter and exit to relax mode in both low mobility and serving cell quality met the corresponding conditions. Just to confirm we are in the same page. For UE only fulfill the enter condtion of low mobility, UE shall not apply RLM relaxation.** **Issue 1-5: In R16, the dedicated signaling is configured for low mobility criterion or not-at-cell edge criterion or both and corresponding thresholds. If we have the common sense for the relaxation should be both low mobility and serving cell quality , what is the dedicated signaling here in proposal 1?** **Issue 1-6:** **Fine with option 1.** |
| **Nokia** | Issue 1-1: Option 1 is agreeable. Issue 1-2, Issue 1-3 and Issue 1-4: Option 1.  We propose adopting the same principle as in Rel16 RRM measurement relaxation. 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.  Issue 1-5: Option 1.  As the relaxation here applies to RLM/BFD in connected mode, network has more information about the UE situation e.g. data activity. This option provides flexibility for network to trigger the UE entering relaxation for power saving based on other conditions known by the network.  To CMCC: This signaling is to push the UE to relaxation immediately. Even with configured low mobility and serving cell quality criteria, the network can enable/disable allowance of relaxation additionally.  Issue 1-6: Option 1 is agreeable. |

#### Sub-topic 2 Low motility criteria

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| **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. |
| **vivo** | **Issue 2-1: Low mobility criteria**  **Support option 1.**  As discussed in our paper, SINR is not a good metric for low mobility. Moreover, in Redcap WI some agreements regarding stationary criterion in connected mode are achieved in RAN2. RAN4 low mobility criterion should align with RAN2 so that UE implementation can be simpler.  For option 1b, our intention is as follows:   * Since the connected mode DRX cycle length is different from idle, we see potential ping-pong effect would be more significant. But if good TdeltasearchP is configured we do not think there is too much issue. * Whether per-beam level RSRP or per-cell level RSRP needs to be clarified.  **Issue 2-2: Low mobility criteria - additional** Option 1 is not needed  TCI state change is configured by network. This is not aligned with previous agreements:  “*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*”  We do not think it is efficient to re-open discussion. |
| **QC** | **Issue 2-1** Support option 1, comments to other options below:  Comment to option 2a: The analysis is based on a specific trajectory. And the SINR evaluation window covers 10 samples, therefore, the filtering is expected to apply on at least 10 sample window. The filter coefficient also affect the evaluated value, which can vary across UEs. Comment to option 2b: The absolute value of SINR should not be part of low mobility condition. It’s not clear to us what additional information SINR can provide from mobility perspective that RSRP is lack of. |
| **Intel** | **Issue 2-1:** W**e can compromise to option 1** considering that **good serving qualtiy threshold is** designed **based on SINR.** |
| **CMCC** | **Issue 2-1: Low mobility criteria** We support Option2, as we stated in our contribution, the SINR level and variation is more important for RLF/BFD. Option 2a and Option 2b are not conflict options, both are fine for us. Some companies block that SINR variation is not highly related to mobility. If companies insist on cover mobility directly, Option 3 maybe a good compromise. |
| **MTK** | **Issue 2-1: Low mobility criteria**  We prefer option 2, but we can compromise to option 1. Option 1 can’t reflect UE speed precisely, one example we can provide is:  gNB  Rel-16 RSRP attenuation can’t detect the UE moving behaviour  When UE moves around the base station. RSRP value might still be the same, so UE fulfill the Rel-16 low mobility criterion but it is not in a stationary state.  We agree that SINR attenuation also have some drawback. There is no perfect performance metric. So we can compromise to option 1. **Issue 2-2: Low mobility criteria – additional** We are open for the discussion, but based on VIVO’s comment RAN4 has to clarify if this would violate the previous agreement. |
| **Huawei** | Issue 2-1: Support option 2. In R16, RRM measurement relaxation in idle/inactive mode is allowed. So, the metric used for R16 low mobility criterion is same as the metric used for RRM measurements. In R17, RLM/BFD relaxation in connected mode is allowed. Hence, the metric used for low mobility criterion for RLM/BFD relaxation also shall be same the metric used for RLM/BFD measurements. Issue 2-2: prefer not to introduce too complicated UE behavior. |
| **Xiaomi** | **Issue 2-1: Low mobility criteria**  Support Option 2. We can also compromise to option 1 to reuse the R16 methodology. **Issue 2-2: Low mobility criteria – additional** We can further study, but slightly prefer not to add additional low mobility criteria. |
| **OPPO** | **Issue 2-1: Low mobility criteria**  Option 1 is fine. **Issue 2-2: Low mobility criteria – additional** Prefer not. |
| **ZTE** | **Issue 2-1: Low mobility criteria**  Slightly Prefer Option 3, but can compromise to Option 1a. L3 filtering can be introduced but we need to consider the testability (in RRM test cases usually we need to disable L3 filtering). |
| **CATT** | **Issue 2-1:** **Prefer to option 1 and 1a.** **Issue 2-2:** **slightly prefer not.** |
| **Nokia** | Issue 2-1: Option 1 and also Option1a. In addition, we like to clarify that RSRP variation in Rel16 refers to cell level RSRP. When applying the same principle to Rel17 RLM/BFD relaxation, SS-RSRP shall be used as the metric for low mobility evaluation.  As for SINR variation, we think it is not a good metric as its variation may be due to changes in the interference level rather than UE mobility. Thereby it is not a valid criterion to indicate low mobility.  Issue 2-2: Option 1.  This additional criterion was proposed considering the beam-based deployment. While RSRP variation can indicate the UE mobility situation in large scale, it may not reflect the beam change in downlink signal when the UE stays within a specific coverage area. For instance, if there is frequent beam change i.e. TCI change, the UE is expected not to enter relaxation mode for better tracking of the downlink radio quality. This can be used separately or in combination with RSRP variation metric.  The RSRP variation criterion standalone may have limitations as identified by Mediatek (i.e. when the UE has a radial movement its RSRP level may be rather constant despite its mobility). Therefore the RSRP variation criterion can be supplemented by the TCI change metric, which would be able to reflect those radial movements.  To Vivo: We are open to discuss how to define the criteria based on TCI change. One example could be network evaluates the TCI change frequency and signals the UE to enter relaxation when TCI change is not very often. |

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

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| **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.** |
| **vivo** | **Issue 3-1: SINR definition for good serving cell quality criteria** **We support option 1 and option 3.**  Not sure how would UE work if the cell quality threshold is based on RSRP. For example, in some realistic scenarios, the RSRP can be quite high but the SINR is low.  But if option 3 in Issue 3-2 is adopted we think no need to further discuss this. **Issue 3-2: predefined or configured threshold** We support option 3 but also fine with option 1.  The main concern from us is how to configure such threshold. Since the SINR used for RLM/BFD evaluation is not specified in the spec, we do not think indicating absolute SINR thresholds is a good approach.  But if X in issue 3-3-1 and Y in issue 3-3-2 is indicated then we are also fine.  Note that X and Y need to be configured in test case so that UE may know whether it is allowed to be relaxed or not. **Issue 3-3-1: good serving cell quality criteria for RLM** Fine with option 1 if option 1 in issue 3-2 is agreed; **Issue 3-3-2: good serving cell quality criteria for BFD** Fine with option 1 if option 1 in issue 3-2 is agreed;  **Issue 3-4-1: same thresholds for RLM and BFD**  Support option 1 if option 1 in issue 3-2 is agreed. This is good to achieve UE power saving gain. **Issue 3-4-2: different thresholds for FR1 and FR2** Support option 1 if option 1 in issue 3-2 is agreed. For FR2, the UE implementation is different from FR2 and different margin is needed. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** Support option 1 if option 1 in issue 3-2 is agreed. SSB based and CSI-RS based have different symbol number configuration and different RE density. The implementation can be different. It is reasonable to have different thresholds. |
| **QC** | **Issue 3-1** Clarification is needed for option 4, what’s the difference compared to option 1? Network can configured the resource different than RLM resource to measure SINR?  **Issue 3-2**  We would like to understand what conditions network need to consider for this threshold. For all mobility related conditions, low mobility conditions should cover them. What are the factors other than mobility related ones that network needs to consider to design the threshold?  **Issue 3-4-1**  Support option 1. |
| **Intel** | **Issue 3-1:** Support option 1.RLM-RS is used to calculate SINR.  **Issue 3-2:**  Support option 1. If company have concern about the absolute SINR threshold, we are also fine to indicate the extra margin for the threshold.  **Issue 3-3-1:**  Agree with the suggestion by moderator. We can compromise to option 1.  **Issue 3-3-2:**  we can compromise to option 1.  **Issue 3-4-1:**  Needs further discussion. Since Qout threshold is different for RLM and BFD, if we consider that *radio link quality > Qout + X (dB).* did it mean that different margin will be considered? |
| **CMCC** | **Issue 3-1: SINR definition for good serving cell quality criteria** Option 1. **Issue 3-2: predefined or configured threshold** We support Option 1 and Option 1a. **Issue 3-3-1: good serving cell quality criteria for RLM** Ok with the recommended WF. **Issue 3-3-2: good serving cell quality criteria for BFD** Ok with the recommended WF. **Issue 3-4-1: same thresholds for RLM and BFD**  If the threshold can be configured by network, then this issue is invalid. We can first focus on Issue 3-3-1/2. **Issue 3-4-2: different thresholds for FR1 and FR2** Support Option 1. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** We support option 1. |
| **MTK** | **Issue 3-1: SINR definition for good serving cell quality criteria** We support option 1.  **Reply to Apple**  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.  [MTK]: It is possible that Network configure a offset threshold value to Qin/Qout  SINRexit = SINRoffset + Qin/Qout  For each UE, there exist a one-to–one mapping between its estimated SINR value and BLER.   If legacy definition of Qin/Qout can be followed, the Qin/Qout is already determined and UE will   know the threshold SINR based on the given offset value. **Issue 3-2: predefined or configured threshold** We support option 1. **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.  **Reply to Apple**  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.  [MTK]: What we propose is to apply different thresholds, not different relaxation factors for SSB based RLM/BFD and CSI-RS based RLM/BFD. The reason behind is to apply the most suitable threshold for each scenario. |
| **Huawei** | Issue 3-1: We can go with option 1, since option 3 and option 1 share the same understanding. Issue 3-2: We prefer option 2. But we can accept that the network configure an offset value to UE for deriving the threshold.  Issue 3-3-1: We prefer option 1a.  Option 1a could guarantee that the threshold is better than Qin. For option 1, a larger margin will be needed to derive a threshold expressing good cell quality.  Issue 3-3-2: We support option 1.  Issue 3-4-1: If different threshold are used for RLM/BFD, then UE behavior when the same RS is configured for both BFD and RLM need to be discussed. Whether the relaxation is allowed when either RLM criterion or BFD criterion is satisfied, or when both RLM criterion and BFD criterion are satisfied, need to be studied.  Issue 3-4-2: We can accept to use different threshold for FR1 and FR2. But it is suggested to use same principle rules to derive the threshold.  Issue 3-4-3: same comments as issue 3-4-2. |
| **Xiaomi** | **Issue 3-1: SINR definition for good serving cell quality criteria** Support option 1. **Issue 3-2: predefined or configured threshold** Support option 1. **Issue 3-3-1: good serving cell quality criteria for RLM** Support the recommended WF. **Issue 3-3-2: good serving cell quality criteria for BFD** Support the recommended WF. **Issue 3-4-1: same thresholds for RLM and BFD** In our understanding, as the thresholds are configurable by the network, they can be different. **Issue 3-4-2: different thresholds for FR1 and FR2** Support option 1. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** Support option 1. |
| **QC** | **Issue 3-1,2** Agree with MTK’s proposal to address Apple’s comment. In this case, we believe this offset can be a pre-determined value instead of network configured value, since network doesn’t have control of the actual SINR threshold anyways. |
| **OPPO** | **Issue 3-1: SINR definition for good serving cell quality criteria** Fine with option 1 and 3. Prefer option 3 if the concern on L1-SINR or L3-SINR cannot be solved. Once the good serving cell quality criteria is configured for UE, UE can relax RLM/BFD up to implementation. **Issue 3-2: predefined or configured threshold** If agreed to introduce threshold, we prefer predefined value. Otherwise, up to UE implementation. **Issue 3-4-2: different thresholds for FR1 and FR2** Up to network. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** FFS. |
| **ZTE** | **Issue 3-2: predefined or configured threshold**We support option 1, i.e. thresholds are configurable by the network. Pre-defined values may not work since we’re facing many different potential use cases and deployment scenarios. |
| **CATT** | Issue 3-2:  Support option 1.  Issue 3-3-1 and Issue 3-3-2:  support the recommended WF.  Issue 3-4-1:  Prefer not to option 1.  Issue 3-4-2:  Support option 1. |
| **Nokia** | Issue 3-1: We listed Option 1 and Option 2a as feasible solutions in the discussion paper, but prefer Option 1 for simplicity. And if this is agreeable, we think it is better to use existing terminology “downlink radio quality” instead of SINR when capturing the criteria to RAN4 spec.  Issue 3-2:  In our views, this depends on the conclusion of Issue 3-1. If legacy definition of SINR i.e. downlink radio quality is adopted, the threshold could be pre-defined or reusing existing Qin/Qout. Otherwise if SS-SINR/CSI-SINR is used, we prefer leaving the threshold as network configuration.  Issue 3-3-1:  We prefer Option 1a. Probably can change Option 1a to Option 2 to differentiate from option 1.  We’d like to highlight that Qout/Qin does not correspond to a constant value of the downlink radio quality (e.g. SINR), instead, it is defined as the level at which the downlink radio link cannot/can be reliably received. Instead X db is assumed to be a fixed value, which is either pre-defined or based on network configuration. Therefore, it is more reasonable to leave separate options on the table.  As Qin indicates the level at which the downlink radio link can be reliable received, we believe it is safer to enter relaxation mode at least when the radio link quality is above Qin, i.e. in a region with good radio link quality. Similarly, the UE shall exit from the relaxation when radio link quality is worse than Qout. How the UE behaves between Qin and Qout can be further discussed.  Issue 3-3-2:  Same comments as in Issue 3-3-1, and we prefer an explicit option x: *radio link quality > Qin,LR.*  Issue 3-4-1/3-4-2/3-4-3:  These depends on SINR definition in Issue 3-1. We can come to it after conclusion on Issue 3-1. |

#### Sub-topic 4 Exiting Relaxation criteria

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| **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. |
| **vivo** | **Issue 4-1: Exit criteria based regarding the radio link quality**  **Support the recommended WF.**  Option 3 is not needed. For option 1 and option 2a, we think this is related to how UE send oos indications and can be automatically solved if RAN4 can reach consensus in issue 5-4. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** **No strong view. Slightly prefer option 1.** **Issue 4-3: Re-entry to the relaxation mode**  **Can not agree with option 1.**  The motivation for this is to aviod ping-pong effect of UE relax/fallback.  However, we already see the margin to aviod ping-pong for cell quality. The only thing we need is to avoid ping-pong in low-mobility.  For option 1, what would happen if network frequently re-configure DRX cycles. As agreed, if DRX cylce length is conifgured >80ms UE is not allowed to relax. So UE is punished because it has successly received network’s reconfiguration of DRX cycls? **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**  Fine with option 1 in principle. Q\_out,LR should be considered for BFD. |
| **QC** | **Issue 4-1**  Support the recommended WF.  **Issue 4-2**  Need clarification for option 1: if UE moves fast but the SNR is good, can UE still stay in power saving mode? This seems weird to us and defeat the purpose of adding low mobility condition.  **Issue 4-3**  If we reuse R16 low mobility, we have T\_searchdeltap to stay in normal mode for a longer period. Even without low mobility condition configured, UE needs to evaluate SNR for at least 10 DRx cycles to enter the power saving mode. We would like to know why this evaluation period itself is not enough. Note that to declare in coverage, the evaluation time with all the counters/timers is long. Adding these two up, we are wondering why we still need the punish period. |
| **Intel** | **Issue 4-1:**  Support option 3. From our understanding, option 2 are option 3 are different. The threshold in Option 2 is more loose to exit relaxion mode.  We have some concern that it maybe a little late when OOS is used as the exit threshold. We prefer that UE will return back to normal mode before channel quality degrade so much. We can also compromise that it’s left to UE implementation about when/how to exit.  **Issue 4-2:**  depends on issue 2-1.  **Issue 4-3:**  If extra margin to enter relaxation mode is applied, we don’t see the need of a new timer. |
| **CMCC** | **Issue 4-1: Exit criteria based regarding the radio link quality** Fine with recommended WF. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** Option 1. If the low mobility criteria is only based on SINR variation, we think only the exit criteria based on radio link quality is enough. Besides, the punish period after the exit is needed. **Issue 4-3: Re-entry to the relaxation mode**  The motivation of “punish period” is not to punish UE. Instead, in this period, UE will not enter relaxation mode again and avoid Ping-Pong and useless evaluation. Based on our understanding, After UE revert, especially when the exit threshold reuses the Qout, the radio link quality will not fulfill the enter threshold very soon, and the channel may be not stable. In this case, UE do not need to do the enter criteria evaluation. **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**  For RLM relaxation revert criteria, it is natural to reuse Qout or Qout+X or N310(OOS indication) for exit criteria. We just want to check, for BFD relaxation revert criteria, do we use Qout or Qout\_lR? |
| **MTK** | **Issue 4-1: Exit criteria based regarding the radio link quality** We agree that UE will exit relaxation mode when estimated SINR is worse than Qout. Evaluation period will be specified in the spec, as long as measurement accuracy can be met, how many samples that UE adopted is up to UE implementation.  **Reply to Apple** Is option 2 a subset of option 1, i.e., at least one Qout indication, and N310 starts to count? [MTK]: Our understanding is what moderator suggests is to agree option 2, not option 2a. UE will exit relaxation mode when estimated SINR is worse than Qout. Considering that entering SINR threshold is much larger than Qout, UE will leave power saving mode too early so we think option 1 might not be a good choice. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** Support option 1. **Issue 4-3: Re-entry to the relaxation mode**  If exiting threshold is Oout, UE will start the N310 counter. It can solve CMCC’s concern already. No need to introduce an extra timer. **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**  Open to discuss |
| **Huawei** | Issue 4-1: Support option 3. Options 3a/3b/3d are acceptable for us. When radio link quality is worse than Qin, the radio link quality is considered to be not good enough. When radio link quality is worse than Qout, the radio link quality is considered to be bad. Hence, the threshold for good serving cell quality criterion shall be better than Qin.  Issue 4-2: We can go with option 1.  Issue 4-3/4: For good serving cell quality criterion, a hysteresis value is suggested to be used for avoiding ping-ping effect. It seems no need to introduce option 1. |
| **Xiaomi** | **Issue 4-1: Exit criteria based regarding the radio link quality** Prefer Option 3. It would be a robust way to guarantee the connection performance that UE exits relaxed mode before the quality of the serving link is bad.  If most companies support Option 2, we can compromise to option 2. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** This issue is depends on issue 2-1 conclusion. |
| **OPPO** | **Issue 4-1: Exit criteria based regarding the radio link quality** Option 1 is fine. UE follows the control of network’s configuration, which is a simple rule.  For option 3, actually a range of SINR was introduced for relaxation. The SINR\_enter (e.g., SINR\_enter＞Qin)and SINR\_exit(e.g., Qin＞ SINR\_enter＞Qout) should be evaluated together. We can further discuss if threshold was agreed in issue 3-3-1 or 3-3-2. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** This issue depends on issue 2-1 conclusion. |
| **ZTE** | Issue 4-1: Exit criteria based regarding the radio link quality The moderator suggested Option 2 as a baseline. Actually, in our view Option 3c shall be a better baseline since we propose that the threshold shall be larger the Qout. We also indicated that a margin can be allowed which is FFS. So I think maybe we can agree on Option 3c and FFS the exactl value of the margin. |
| **Nokia** | Issue 4-1: Option 2. We think the radio link quality worse than Qout during an evaluation period should be the latest timing at which the UE shall exit the relaxation mode. Otherwise, there would be high probability of radio link failure.  For Option 1, N310 starts to count when OoS is indicated to high layer. As OoS indication needs filtering on a number of occurrences of Qout, this may delay the exit from relaxation mode hence increases the risk of RLF.  Issue 4-2: Option 1.  According to Rel16 low mobility criteria, the UE will exit from relaxation if low mobility criteria is not fulfilled. We may follow the same principle here and no additional condition is required.  Issue 4-3/4-4:  As the enter and exit criteria are already based on the evaluation during a certain evaluation period, this can serve the same purpose as the timer proposed in Option 1. We don’t see the need or benefit to introduce such punish period. |

#### Sub-topic 5 During Relaxation mode

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| **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. |
| **vivo** | **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode** **Support option 2.**  Only UE requirements are specified in RAN4. UE behaviour can be discussed so that the background of the requirenments is clear. **Issue 5-2-1: the formula of relaxed evaluation period** Support the recommended WF in principle.  Firstly we think K = 2 should be agreeable, at least for DRX<40ms in FR1.  Also see the issue behind option 2c: monotonicity. But do not think relaxation is allowed for >80ms. FFS whether and how to keep monotonicity. **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period** No strong view, fine with option 2.  **Issue 5-3-1: different relaxation factors for FR1 and FR2**  Support option 1. This is aligned with our proposal in the tdoc. **Issue 5-3-2: different relaxation factors for SSB and CSI-RS** Support option 1. This is aligned with our analysis in the tdoc. **Issue 5-3-3: different relaxation factors for different SINR regions** No need for this. Do not see the impact on oos/bfi requirements. **Issue 5-3-4: value of relaxation factor**  Support option 3.  Firstly we think K = 2 should be agreeable, at least for DRX < 40ms in FR1. **Issue 5-4: OOS indication during relaxation mode** Support option 1.  For option 2, we see such detail can be up to UE implementation, if the requirement is the same. |
| **QC** | **Issue 5-1:** Support option 2. Option 2 guarantees the timing of first OOS indication and the following RLF declaration, therefore from network perspective, the UE report is exactly the same no matter what measurement behavior UE implementing.  **Issue 5-2-1**  Support recommended WF, legacy lower bound can apply.  **Issue 5-2-2**  We are open to discuss, but type 2 makes more sense since power saving is to prevent UE waking up from DRx, not skipping measurement even when UE is on.  **Issue 5-3-4**  Option 2 is good if option 2 in issue 5-1 is agreed.  **Issue 5-4**  We can support option 1 if option 2 in issue 5-1 is agreed.  **Issue 5-5**  If the additional delay is <= 10-15 DRx cycles, does adjusting T310/N310 necessary? We expect the typical length larger this additional delay. |
| **Intel** | **Issue 5-1:** Fine with option 2.  **Issue 5-2-1:**  Support recommended WF.  **Issue 5-2-2:**  Prefer option 2.  **Issue 5-3-1:**  Fine with option 1. Considering that if Rx beam sweeping is used in FR2 and K is used, the total delay may be too large.  **Issue 5-3-3:**  Needs further discussion. Prefer not to define the requirement too complex.  **Issue 5-3-4:**  Fine with option 2.  **Issue 5-4:**  Needs further discussion. depends on the issue 4-1: Exit criteria based regarding the radio link quality.  We still prefer that OOS is sent out in normal mode or it’s left to UE implementation. |
| **CMCC** | **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode** We support Option 2. **Issue 5-2-1: the formula of relaxed evaluation period** OK with the recommended WF. **Issue 5-2-3: clarification on TDRX** Fine with Option1. **Issue 5-3-1: different relaxation factors for FR1 and FR2** Option 1 is OK. Maybe we should first decide whether the relaxation factors are configured by network or pre-defined. **Issue 5-3-2: different relaxation factors for SSB and CSI-RS** Option 1 is fine for us. Maybe we should first decide whether the relaxation factors are configured by network or pre-defined. **Issue 5-3-3: different relaxation factors for different SINR regions** Maybe we should first decide whether the relaxation factors are configured by network or pre-defined. **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. Whether the L1 indication period need to be extended needs discussion. **Issue 5-5: Additional N310/N311 values for relaxation mode** We think this issue based on whether N310 is used for exiting the relaxation. If yes, the additional N310/N311 values maybe needed to avoid frequent re-configuration. |
| **MTK** | **Issue 5-1: Whether to pecific UE behaviour in the relaxation mode** We support option 2. Different UE implementation should be allowed, as long as evaluation period requirement can be met. **Issue 5-2-1: the formula of relaxed evaluation period** We support option 1. This is to avoid the corner case if CSI-RS periodicity is 5ms, short DRX cycle is also 5ms. Then 5\*30= 150ms. We still need to extend the low bound. **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period** We support option 1. This is to avoid the corner case if CSI-RS periodicity is 5ms, short DRX cycle is also 5ms. Then 5\*30= 150ms. We still need to extend the low bound. **Issue 5-2-3: clarification on TDRX****Issue 5-3-1: different relaxation factors for FR1 and FR2** Support option 1. We also have similar evaluation results **Issue 5-3-2: different relaxation factors for SSB and CSI-RS** Support option 1. **Issue 5-3-3: different relaxation factors for different SINR regions** Support option 1. **Issue 5-3-4: value of relaxation factor**  Support option 2. In Rel-16 scaling factor is also predefined in the spec. It would increase the UE implementation burden, if it is a configured value. **Issue 5-4: OOS indication during relaxation mode** Prefer option 1. However, our understanding is this belongs to the UE implementation issue and it can’t be tested. We prefer to focus on issues that do have spec impact firstly. **Issue 5-5: Additional N310/N311 values for relaxation mode**  Do not see the necessity. |
| **Huawei** | Issue 5-1: Supporting option 2. We suggest to focus on how to define the evaluation period for relaxation. How many samples are used within the evaluation period is up to UE implementation.  Issue 5-2-1: we can agree with the recommended WF. The value of K is no larger than 2.  Since RLM/BFD relaxation is allowed for DRX cycle≤80ms, the evaluation period for relaxation is not applied for DRX cycle >80ms.  Issue 5-2-2: Option 2.  Issue 5-2-3: Need more clarification on the target scenario.  Issue 5-3-1/2: We are open on the value of factor K for deriving the RLM/BFD evaluation period for relaxation.  Issue 5-3-3: We suggest to define fixed evaluation period and the used samples for different SINR regions is up to UE implementation.  Issue 5-3-4: The value of factor K for deriving the RLM/BFD evaluation period is no larger than 2.  Issue 5-4: when the threshold for good serving cell quality is defined as Qin or better than Qin, the UE shall fall back to normal RLM/BFD evaluation before detecting OOS.  Issue 5-5: No need to introduce additional N310/N311 for relaxation mode. |
| **Xiaomi** | **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode** Prefer behaviour 1 in Option 1. **Issue 5-2-1: the formula of relaxed evaluation period** Support the recommended WF. **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period** Prefer option 1. |
| **OPPO** | **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode** Prefer Option 2.  **Issue 5-2-1:**  Support recommended WF.  **Issue 5-2-2:**  Prefer option 2.  **Issue 5-3-1:**  Fine with option 1.  **Issue 5-3-3:**  FFS  **Issue 5-3-4:**  Option 2 is fine. Prefer a unified value for one same FR.  **Issue 5-4:**  Option 1 is fine in general. At least, UE shall be expected to send OOS indication during relaxation mode, otherwise UE may become RLF suddenly but still not exit the relaxation mode. The exit criterion design should consider OOS indication evaluation and SINR\_exit level.  FFS on whether to change minimum separation of L1 indication and the rule of L1 reporting. |
| **CATT** | Issue 5-1:  Support option 2. UE behavior is not defined in spec as long as the requirement of the relaxed evaluation period is met.  Issue 5-2-1:  Agree with Recommended WF.  Issue 5-2-2:  Prefer option 2.  Issue 5-2-3:  Why the note is needed?  Issue 5-3-1:  Support option 1.  Issue 5-3-2 and Issue 5-3-3:  Option 1 is fine to us.  Issue 5-3-4:  In general, option 1a is accepted. From the simulation results, option 2 is fine for us. And detailed values for different cased can be FFS such as 5-3-1 5-3-2 5-3-3. It depends on the aligned simulation results by companies. But firstly, should we achieve the agreement whether this value is network configured or not because some companies think it can be while other companies don’t think so. Then the detailed values can be discussed. |
| **Nokia** | Issue 5-1: Option 1.  We agree how the UE relaxes the RLM/BFD measurements is up to UE implementation. Here the intention is to reach common understanding on the assumed UE relaxation behavour, in order to derive the evaluation period.  Issue 5-2-1: Agree with the recommended WF.  Issue 5-2-2: We like to how likely the lower bound will be used when the evaluation period is relaxed. More analysis is needed.  Issue 5-2-3: Option 1.  Issue 5-3-1/5-3-2/5-3-3/5-3-4:  We believe these depend on the simulation results. From our simulation, we are fine to apply different relaxation factor for FR1 & FR2 in Issue 5-3-1. At least on system level when RRM is also relaxed (though no one mentions it) FR2 is more sensitive to relaxation due to smaller cells, narrower beams, and high propagation loss. As for the other cases, we need further study on the simulation.  Issue 5-4: We support Option 3 and also Option 2.  When the UE is evaluating the channel using relaxed measurements, the OoS evalution is based on less frequent measurements over a long time period which may degrade performance of OoS accuracy. Option 2 filters out the first OoS to ensure the RLF can be triggered with the same performance as in legacy RLM. On the other hand, Option 2 may bring additional RLF delay due to not reporting the first OoS to higher layer. The impact on RLF delay needs to be evaluated.  Issue 5-5: Option 1. |

#### Sub-topic 6 Other Aspects

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| **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. |
| **vivo** | **Issue 6-1: Specification structure**  Fine with option 1  **Issue 6-2-1: Relaxation criteria in intra-band CA**  **Support option 2 and 2a.**  We think companies may have different understanding on the principle of R16 eMIMO requirements. In our understanding the measurement of RLM/BFD should not be more than 1 according to TS 38.133, otherwise there is no requirement.  It is better to be clarified in R16 before we discuss this in R17 PowSav.  **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS**  Support option 4. This is also part of why we propose option 3 in issue 3-1 and 3-2.  But we can compromise to option 1. We support option 1 if configurable X/Y, i.e. SINR for RLM/BFD in issue 3-1 is agreed. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** At least for low mobility criterion, UE may only need to evaluate this in only one of the serving cells. Not sure whether how network configure such low mobility criterion in CA/DC, e.g. whether it is per-UE or per-servingcell.  For cell quality criterion, UE may need to consider to evaluate in each of the serving cell(s) that should be evaluated. But anyway clarification is needed.  For some CA/DC scenario, since co-located deployment is possible, UE should be allowed to relax in another cell if it has fulfilled criterions in one cell. |
| **CMCC** | **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS** Option 2, currently we can go with option 3. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** Share similar view with Ericsson. **Issue 6-3: RRM enhancement with RLM/BFD power saving** In last meeting, we see some companies were interested in this RRM enhancement. If we can achieve consensus for further study this issue, we think this can also be considered in R17 PS with low priority for now. |
| **MTK** | **Issue 6-1: Specification structure** We support option 1. **Issue 6-2-1: Relaxation criteria in intra-band CA** We have no strong view, but slightly prefer option 2. It will simplify the UE implementation.   **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS** We support option 1 & 4, but we can also accept option 3. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** We prefer to prioritize single layer discussion. **Issue 6-3: RRM enhancement with RLM/BFD power saving** Agree the recommended WF **Issue 7-1: LS draft** Agree the recommended WF |
| **Huawei** | Issue 6-1: Except the evaluation period, the other RLM/BFD requirements are same for both normal mode and relaxation mode. We prefer to introduce new table for relaxation evaluation period into the current subsections.  Issue 6-2-1: We support option 2 and 2a.  The existing BFD requirements are applied provided that the UE is required to perform BFD on no more than 1 serving cell per band, which are specified in TS38.133 as follows:   |  | | --- | | Section 8.5.2.1  *The requirements in this clause could not be applicable if UE is required to perform beam failure detection on more than 1 serving cell per band.*  Section 8.5.3.1  *The requirements in this clause apply when UE is required to perform beam failure detection on no more than 1 serving cell per band.* |   Issue 6-2-2: We can go with option 1 or option 2. But how to derive the threshold depends on the discussion for issues 3-3-1 and 4-1.  Issue 6-3: As mentioned by moderator, option 1 is out of scope. |
| **Xiaomi** | **Issue 6-1: Specification structure** Support option 1. **Issue 6-2-1: Relaxation criteria in intra-band CA** Support Option2 to simply UE implementation. **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS** Prefer option 2. We can accept Option 3. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** Support Option1. **Issue 6-3: RRM enhancement with RLM/BFD power saving** Agree the recommended WF **Issue 7-1: LS draft** Agree the recommended WF |
| **QC** | **Issue 6-2-2** We have a question for clarification: how does UE send OOS indication for multiple RLM-RS/BFD-RS? We assume this is not the multiple resource sets for mTRP RLM/BFD. The exit criterion design should consider OOS indication evaluation, and the entering condition design should consider exit criterion. |
| **OPPO** | **Issue 6-2-1 and 6-2-2:** Need more clarification:Regarding RLM/BFD is for per cell/RS resource set, should Relaxation criteria be applied for per UE or per cell? Whether should both RLM and BFD be fulfilled on the same cell or band? |
| **Ericsson** | **To Vivo and Huawei:** **Issue 6-2-1: Relaxation criteria in intra-band CA** Section 8.5.2.1/3 does NOT state that the BFD requirement applies only on SpCell per band. It uses the term serving cell per band. So Section 8.5.2.1/3 means that the UE has to meet requirement on one serving cell / band and that serving cell can be any serving cell i.e. SpCell or any SCell in that band. The UE is NOT required to meet BFD requirements if configured on both SpCell AND on SCell.  RLM is always performed on SpCell. Nowhere it is mentioned in any spec that RLM and BFD have to be done on the same serving cell. As stated above that BFD can be performed on one serving cell per band, which can be very well be SCell. RAN4 should specify the requirements for power saving based on current specification. Hence, we propose to agree on option 1.See below from TS 38.133:  *8.5          Link Recovery Procedures*  *8.5.1         Introduction*  *The UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  as specified in TS 38.213 [3] in order to detect beam failure on:*  *-     PCell in SA, NR-DC, or NE-DC operation mode,*  *-     PSCell in NR-DC and EN-DC operation mode,*  *-     SCell in SA, NR-DC, NE-DC or EN-DC operation mode.*  *The RS resource configurations in the set  on PCell or PSCell can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the set  on SCell shall be periodic CSI-RS.* *8.5.3         Requirements for CSI-RS based beam failure detection**8.5.3.1          Introduction* *The requirements in this clause apply for each CSI-RS resource in the set  of resource configurations for a serving cell, provided that the CSI-RS resource(s) in set for beam failure detection are actually transmitted within the UE active DL BWP during the entire evaluation period specified in clause 8.5.3.2. UE is not expected to perform beam failure detection measurements on the CSI-RS configured for BFD if the CSI-RS is not QCL-ed, with QCL-TypeD when applicable, with the RS in the active TCI state of any CORESET configured in the UE active BWP. The requirements in this clause apply when UE is required to perform beam failure detection on no more than 1 serving cell per band.* |
| **vivo2** | **[to Ericsson] On Issue 6-2-1** We think the core part spec does not mention about the case that RLM and BFD are both configured in the same band. But according to the test cases UE is only tested when RLM and BFD are performed in the same serving cell. |
| **Ericsson** | **[To Vivo] Issue 6-2-1: Relaxation criteria in intra-band CA** To interpret the scope of requirements one should look into the requirements and not the test cases.  RAN4 does not specify test cases to verify requirements for all possible configurations supported by the requirements. Testing all functionalities would increase the cost and amount of test cases and won’t be feasible. This is a common way of working in RAN4 that test cases are designed to verify requirements only for a sub-set of configurations. It does not mean that aspects not tested are not supported in the requirements.  Since RLM is always performed on SpCell, and the highlighted text in earlier comment (copied below) clearly shows that BFD can be configured on SCell with CSI-RS resources, it is very clear and obvious that RLM can be on SpCell and BFD on SCell for CSI-RS.  We have also asked the opponents to show any specification text that forbids configuration addressed in this issue, and we have so far not seen any. Hence, RAN4 should define the rel-17 requirements based on the current specification.  *8.5.1         Introduction*  *The UE shall assess the downlink radio link quality of a serving cell based on the reference signal in the set  as specified in TS 38.213 [3] in order to detect beam failure on:*  *-     PCell in SA, NR-DC, or NE-DC operation mode,*  *-     PSCell in NR-DC and EN-DC operation mode,*  *-     SCell in SA, NR-DC, NE-DC or EN-DC operation mode.*  *The RS resource configurations in the set  on PCell or PSCell can be periodic CSI-RS resources and/or SSBs. RS resource configuration in the set  on SCell shall be periodic CSI-RS.* |
| **Nokia** | Issue 6-1: Option 1. Issue 6-2-1: Need further discussion.  Isue 6-2-2: Option 3.  This can be discussed after concluding on the single RLM/BFD-RS.  Issue 6-2-3:  This seems not in the scope of RAN4. We need define the requirements based on existing spec. According to RAN1/2, RLM is performed on SpCell only. If the UE needs to monitor each serving cell shall be up to RAN1/2 discussion.  Issue 6-3: Agree with the recommended WF.  Issue 7-1: Agree to focus on technical issues above in 1st round.  And in 2nd round, we may work on the LS ”if agreed”. |

### 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.*

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

#### Sub-topic 1 Relaxation applicability

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| **Status summary** |
| **Issue 1-1: Relaxation when neither serving cell quality criteria nor low mobility criteria is configured** *Candidate options:*  Option 1: the network would assume the UE is not performing relaxed RLM/BFD measurements and the existing RLM/BFD requirements shall apply.  *Support level:*   * Option 1: No objection out of 9 companies’ comments * One company suggests to conclude it after Issue 1-5. * One company suggest to follow R16 condition configuration and applicability, and open to discuss whether the good cell condition should be required.   *Recommendations for 2nd round:*  Continue discussion. The concern would occur only when the dedicated signaling to indicate the UE when it is allowed to relax the RLM/BFD measurements. The Recommended WF is suggested as:  *When neither serving cell quality criteria nor low mobility criteria is configured, the existing RLM/BFD requirements shall apply.*   * *Note: It can be revisit if*    + *dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements is agreed, or*   + *good serving cell criteria is agreed to be predefined.*  **Issue 1-2: Whether low mobility criteria is necessary to be configured?** *Candidate options:*   * Option 1: No. It is up to network. * Option 2: Yes.   *Support level:*   * Option 1: in favour by 7 companies * Option 2: in favour by 4 companies   *Recommendations for 2nd round:* Continue discussion, since it has agreed that the variation thresholds for low mobility criteria are configured by the NW.According to the proponent’s clarification, Option 1 is similar to the principle as in Rel16 RRM measurement relaxation, i.e. network can decide to configure which one.**Issue 1-3: Whether good serving cell criteria is necessary to be configured?** *Candidate options:*   * Option 1: No. It is up to network. * Option 2: Yes.   *Support level:*   * No clear consensus   *Recommendations for 2nd round:* Come back after Issue 3-2. This issue is assumed good serving cell criteria can be configured by network.According to the proponent’s clarification, Option 1 is similar to the principle as in Rel16 RRM measurement relaxation, i.e. network can decide to configure which one.**Issue 1-4: Relaxation when both serving cell quality criteria and low mobility criteria are configured** *Candidate options:*   * 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**)   *Support level:*   * Option 1: explicitly proposed by 1 company   *Recommendations for 2nd round:*  Further discuss it under Issue 1-2, 1-3.  Most companies agreed UE shall meet both criteria to perform relaxation, as the RAN4 98e-bis agreement  *“Whether relaxed RLM/BFD requirements can be applied depends on both the serving cell quality and UE mobility state.”*  Whether to follow the R16 principle to configure the criterion separately can be discussed in Issue 1-2, 1-3. Thus, suggest not to further discuss in the 2nd round. **Issue 1-5: Whether to have dedicated signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements** *Candidate options:*   * Option 1: Yes * Option 2: No   *Support level:*   * No clear consensus   *Recommendations for 2nd round:*  Continue discussion, proponent could provide the clarification on companies’ comment. **Issue 1-6: When DRX cycles > 80ms** *Tentative agreement:*   * 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.   *Support level:*   * Option 1: No objection out of 9 companies’ comments * One company suggests no need to explicitly agree it.   *Recommendations for 2nd round:*  *It would be no harm to explicitly agree it, although it would be implicitly observed from the previous agreements. Suggest to capture the Tentative Agreement in the WF, unless company raises strong concerns.* |

#### Sub-topic 2 Low motility criteria

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| **Status summary** |
| **Issue 2-1: Low mobility criteria**  *Candidate options:*   * + Option 1: Reuse R16 low mobility criterion. (CATT, Apple, vivo, Qualcomm, Nokia, MTK, Ericsson, Intel, Xiaomi, oppo, ZTE)   + Option 1a: Low mobility state for operating relaxed RLM/BFD is determined based on RSRP measurement variation.   + Option 2: based on the SINR variation (Huawei, CMCC, MTK)   + Option 3: based on the RSRP variation and SINR variation (ZTE, CMCC)   *Support level:*   * Option 1: No objection out of 11 companies’ comments * Option 2: in favour by 3 companies * Option 3: in favour by 2 companies   *Recommendations for 2nd round:*  *This will be suggested for GTW session. Majority’s view is close to Option 1.*  *Could proponents of Option 2/3 compromise to Option 1?* **Issue 2-2: Low mobility criteria – additional** *Candidate options:*   * 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)   + 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. * 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.   *Support level:*   * No clear consensus   *Recommendations for 2nd round:*  Continue discussion. Do we need to introduce this additionally, or it can be done by network implementation, since this feature can be disable by network’s configuration. |

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

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| **Status summary** |
| **Issue 3-1: SINR definition for good serving cell quality criteria** *Candidate options:*   * + Option 1: reuse the legacy definition of the SINR for radio link quality evaluation of RLM/BFD.   + 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.   *Support level:*   * Option 1: No objection out of 12 companies’ comments * Option 2: explicitly proposed by 1 company   *Recommendations for 2nd round:*  *This will be suggested for GTW session. Majority’s view is close to Option 1.*  *@Apple, please check MTK’s comment to see if it addressed the concern.*  *With the clarification provided in the 1st round, could proponents of Option 2 compromise to Option 1? The exact wording can be done in the WF phase.* **Issue 3-2: predefined or configured threshold** *Candidate options:*   * Option 1: The thresholds are configured to the UE by the network. * Option 2: The thresholds is predefined. * Option 3: The offset values to UE for deriving the threshold are configured to the UE by the network.   *Support level:*   * Option 1: No objection out of 9 companies’ comments * Option 2: in favour by 4 companies * Option 3: new option suggested by company as a compromise solution.   *Recommendations for 2nd round:*  *This will be suggested for GTW session. Suggest to consider Option 3 as a compromise option.* **Issue 3-3-1: good serving cell quality criteria for RLM** *Candidate options:*   * + *The good serving cell quality criteria for RLM is*   + *Option 1: radio link quality > Qout + X (dB). FFS X.*   + *Option 2: radio link quality > Qin + X (dB). FFS X.*   *Support level:*   * Option 1: No objection out of 5 companies’ comments * Option 2: in favour by 2 companies   *Recommendations for 2nd round:*  Continue discussion. The conclusion will be captured in WF. Suggest to discuss the margin of threshold should be based on Qin or Qout, regardless the threshold is configurable or predefined. **Issue 3-3-2: good serving cell quality criteria for BFD** *Candidate options:*   * + *The good serving cell quality criteria for BFD is*   + *Option 1: radio link quality > Qout\_LR + X (dB). FFS Y.*   + *Option 2: radio link quality > Qin\_LR + X (dB). FFS Y.*   *Support level:*   * Option 1: No objection out of 6 companies’ comments * Option 2: in favour by 1 companies   *Recommendations for 2nd round:*  Continue discussion. The conclusion will be captured in WF. Moderator observed that Option 2 may be invalid if Issue 3-1 agrees the radio link quality is based on SINR. **Issue 3-4-1: same thresholds for RLM and BFD**  *Candidate options:*   * Option 1: the same thresholds used for good serving cell quality and low mobility criteria are applied for both RLM relaxation and BFD relaxation * Option 2: different threshold should be allowed.   *Support level:*   * No clear consensus   *Recommendations for 2nd round:*  Continue discussion. It will be captured in WF. It may depend on the outcome of Issue 3-1/3-2. **Issue 3-4-2: different thresholds for FR1 and FR2** *Candidate options:*   * Option 1: Different thresholds for different frequency ranges are allowed   *Support level:*   * Option 1: No objection out of 6 companies’ comments   *Recommendations for 2nd round:*  Continue discussion. It will be captured in WF. **Issue 3-4-3: different thresholds for SSB based and CSI-RS based** *Candidate options:*   * Option 1: Different thresholds for SSB based RLM/BFD and CSI-RS based RLM/BFD are allowed   *Support level:*   * Option 1: No objection out of 5 companies’ comments   *Recommendations for 2nd round:*  Continue discussion. It will be captured in WF. |

#### Sub-topic 4 Exiting Relaxation criteria

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| **Status summary** |
| **Issue 4-1: Exit criteria based regarding the radio link quality**  *Candidate options:*   * 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. * Option 2: Reuse Qout as the radio link quality threshold. Exit relaxation mode when the radio link quality is worse than Qout * Option 3: Introduce a radio link quality threshold higher than Qout. Exit relaxation mode when the radio link quality is worse than a SINR threshold (Thexit ).   + Option 3a: Thexit = SINRenter with a hysteresis value   + Option 3b: Thexit = SINRenter – 3dB   + Option 3c: Thexit > Qout   + Option 3d: Thexit = Qout+7dB or Qin   *Support level:*   * Option 1: in favour by 3 companies * Option 2: in favour by 6 companies * Option 3: in favour by 4 companies   *Recommendations for 2nd round:*  Continue discussion. It will be captured in WF. **Issue 4-2: Whether to additionally specify the exit criterion for low mobility criteria** *Support level:*   * Option 1: No. * Option 2: Yes.   *Support level:*   * Option 1: in favour by 3 companies.   *Recommendations for 2nd round:*  Continue discussion. We may not need new agreement for this. **Issue 4-3: Re-entry to the relaxation mode**  *Support level:*   * Option 1: in favour by 1 companies.   *Recommendations for 2nd round:*  Continue discussion. Proponent please address companies’ comments.  **Issue 4-4: Reuse RLM relaxation revert criteria for BFD**  *Support level:*   * Option 1: in favour by 1 companies.   *Recommendations for 2nd round:*  Continue discussion. Proponent please address companies’ comments. |

#### Sub-topic 5 During Relaxation mode

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| **Status summary** |
| **Issue 5-1: Whether to specificy UE behaviour in the relaxation mode**  *Candidate options:*   * Option 1: Yes. RAN4 to use either of the two options to define the good serving cell quality criteria:   + 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   *Support level:*   * Option 1: in favour by 3 companies. While Behaviour 1 in favour by 2 companies to relax the evaluation period. * Option 2: in favour by 9 companies   *Recommendations for 2nd round:*  Continue discussion. The motivation of Option 1 seems to discuss whether to relax or maintain the evaluation period. However, Behavior 1 under Option 1 is also to specify the new evaluation period and supported by 2 other companies.  Could proponent of Option 1 compromise to Option 2? **Issue 5-2-1: the formula of relaxed evaluation period** *Tentative agreement*   * 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.   *Support level:*   * No objection out of 10 companies’ comments   *Recommendations for 2nd round:*  Work on WF directly. **Issue 5-2-2: whether to apply relaxation factor on lower bound of relaxed evaluation period** *Candidate options:*   * Option 1: Yes, also lower bound of relaxed evaluation period is also relaxed. * Option 2: No.   *Support level:*   * Option 1: in favour by 4 companies * Option 2: in favour by 7 companies   *Recommendations for 2nd round:*  Continue discussion. This is captured in Issue 5-2-1 as FFS point. Proponent would further clarify when the lower bound will be used? E.g. only if RS periodicity is less than 10 ms? **Issue 5-2-3: clarification on TDRX** *Candidate options:*   * 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”.   *Support level:*   * Option 1: in favour by 2 companies   *Recommendations for 2nd round:*  Continue discussion. Proponent would further clarify if this clarification is necessary. **Issue 5-3-1: different relaxation factors for FR1 and FR2****Issue 5-3-2: different relaxation factors for SSB and CSI-RS****Issue 5-3-3: different relaxation factors for different SINR regions****Issue 5-3-4: value of relaxation factor**  *Support level:*   * Option 1 in Issue 5-3-1: in favour by 9 companies * Option 1 in Issue 5-3-2: in favour by 6 companies * Option 1 in Issue 5-3-3: No strong objection observed in the 1st comment, but further study would be need. * Issue 5-3-4: no clear consensus   *Recommendations for 2nd round:*  *Start form the draft WF:*   * + *The following aspects can be considered when specify the relaxation factor:*     - *different relaxation factors for FR1 and FR2*     - *different relaxation factors for SSB and CSI-RS*     - *FFS different relaxation factors for different SINR regions*   + *FFS the exact value of relaxation factors*  **Issue 5-4: OOS indication during relaxation mode** *Candidate options:*   * Option 1: UE indicates OOS during relaxation mode. * Option 2: UE is not required to send the first OOS indication to higher layers during relaxation mode.   *Support level:*   * Option 1: in favour by 7 companies * Option 2: in favour by 3 companies   *Recommendations for 2nd round:*  Work on WF directly. Capture the candidate options in the draft WF.  **Issue 5-5: Additional N310/N311 values for relaxation mode**  *Support level:*   * No clear consensus on Option 1   *Recommendations for 2nd round:*  Moderator’s understanding is the current N310/N311 still applies for the relaxation mode. Option 1 seems to propose a separate value to replace the current N310/N311 and it is specific for the relaxation mode.  Continue discussion. Proponent would further clarify. |

#### Sub-topic 6 Other Aspects

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| **Status summary** |
| **Issue 6-1: Specification structure**  *Candidate options:*   * Option 1: Relaxed RLM/BFD requirements are introduced in new subsections within the existing RLM/BFD sections TS 38.133. * Option 2: introduce new table for relaxation evaluation period into the current subsections.   *Support level:*   * Option 1: in favour by 4 companies * Option 2: in favour by 1 companies   *Recommendations for 2nd round:*  Work on WF directly. Capture the candidate options in the draft WF. **Issue 6-2-1: Relaxation criteria in intra-band CA** *Candidate options:*   * Option 1:   + 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.   *Support level:*   * Option 1: in favour by 1 companies * Option 2: in favour by 4 companies   *Recommendations for 2nd round:*  Continue discussion. Companies please take the provided clarification into account.  Suggest to capture the candidate options in the draft WF. **Issue 6-2-2: Relaxation criteria for multiple RLM-RS/BFD-RS** *Support level:*   * Option 1: in favour by 2 companies * Option 2: in favour by 4 companies * Option 3: in favour by 5 companies * Option 4: in favour by 2 companies   *Recommendations for 2nd round:*  Continue discussion. It may need to revisit after exiting criteria. Not see it can be concluded this meeting.  Suggest to capture the candidate options in the draft WF. **Issue 6-2-3: Relaxation criteria in NR-DC and inter-band CA** *Support level:*   * No clear consensus on supporting Option 1.   *Recommendations for 2nd round:*  Continue discussion. Proponent please provide clarification on companies’ comment.  Moderator understanding is that without this addition specification for means the relaxation on DC and different bands are performed separately. **Issue 6-3: RRM enhancement with RLM/BFD power saving** *Support level:*   * No clear consensus on supporting Option 1.   *Recommendations for 2nd round:*  Not further discuss in the 2nd round. |

#### Sub-topic 7 LS out

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| **Status summary** |
| **Issue 7-1: LS draft**  *Recommendations for 2nd round:*  A separate email sub-thread will be triggered for the LS discussion. |

### CRs/TPs

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

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| **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 RLM/BFD relaxation for UE Power Saving enhancements | MediaTek Inc. |  |
|  |  |  |
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**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2112179 | LS on criteria for RLM/BFD relaxation | vivo, MediaTek Inc. | Revised |  |
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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 |  |
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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)