**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-21XXXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.9

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

**Title:** Email discussion summary for [98-bis-e][224] NR\_UE\_pow\_sav\_enh

**Document for:** Information

# Introduction

This document is the email discussion summary for UE Power Saving Enhancements (AI 8.9), including the following topics covered

* Topic 1: General and work plan (AI 8.9.1)
* Topic 2: UE measurements relaxation for RLM and/or BFD (AI 8.9.2)

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

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

# Topic #1: General and work plan (AI 8.9.1)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2107082**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107082.zip) | vivo | *Moderator: Some content can be discussed one by one in 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.*

### Sub-topic 1-1 General

**Issue 1-1: Issues to be further discussed in the work phase**

* Proposals
	+ Option 1: In the work phase, RAN4 should continue to work on the following (R4-2107082, vivo)
		- Applicable DRX cycles for relaxation
		- The threshold value and/or margins based on further evaluations
		- Relaxation factor determination
		- Relaxation of BM when not all serving cells in intra-band CA/DC meets relaxation criteria
		- Other options, if RAN4 spec impacts are identified, are not precluded.
* Recommended WF
	+ Companies to discuss the proposal.

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 1-1 General**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Issue 1-1: Issues to be further discussed in the work phaseThe list of issue is based the status report for the last RAN plenary.Based on this list of issues, work split between RAN2 and RAN4 is further recommended.Therefore, in issue 2-2-8, companies can further discuss whether LS to RAN2 is needed in this meeting. |
| Apple | Agree with the list to be further discussed. All open issues in 2.2 should be included in the list.  |
| Xiaomi | Issue 1-1: Agree Option 1. |
| CMCC | Issue 1-1: We agree all the bullets above. Besides, we think the revert criteria should be captured as a candidate. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic #1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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)

# Topic #2: UE measurements relaxation for RLM and/or BFD (AI 8.9.2)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104605**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104605.zip) | CMCC | ***Proposal 1: Take serving cell’s quality variation into account as a part of relaxation criteria. It can be included in low mobility rule.******Proposal 2: If SINR drift rate is under a threshold during a certain estimation period, then the UE can be considered to fulfill the serving cell’s quality variation rule.******Proposal 3: Consider the serving cell’s quality based on SINR.******Proposal 4: R16 low-mobility criterion should not be directly reused in R17 SINR-based criterion for RLM/BFD relaxation. The SINR (value and variation) can be used for low-mobility criterion.*** ***Proposal 5: We support the configurable relaxation criteria, the configurable parameters include the parameters in low mobility rule and serving cell’s quality rule, and the relaxation factor.*** ***Proposal 6: UE determine whether the relaxation criteria can be fulfilled or not.******Proposal 7: the determination of scaling factor should consider:**** ***RLM/BFD performance after relaxation***
* ***The evaluation period after relaxation, which should be smaller or equal to a threshold***

***Proposal 8: Different relaxation factors should be allowed for FR1 and FR2 at least when the RLM/BFD-RS is SSB.*** ***Proposal 9:*** * ***Alt1: Revert after several consecutive out-of-sync indications, the specific value is configured by network, a*** ***new Counter may be needed in order to give more flexibility to network.***
* ***Alt2: Revert when T310 is running, i.e. after X out-of-sync indication, the X can be a new Counter and configured by network in order to avoid frequent counter(N310) reconfiguration.***

***Proposal 10:******If UE revert to normal RLM operation, and the T310 is not starting. UE can go back to relaxation mode after receiving several in-sync indications. The number of in-sync indications can be configured by network, such as configure a new counter.******Proposal 11:******If UE stop the T310 because receiving N311 in-sync indication, UE couldn’t go into relaxation mode again during a certain 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 is configured by network.******Proposal 12:*** * ***Alt1: Revert after BFI\_COUNTER add to the value of a new counter or a new parameter, the new counter or the new parameter is configured by network.***
* ***Alt2: Revert when UE trigger the RLF, i.e. after BFI\_COUNTER add to a new parameter, the new parameter which is used in relaxation mode is configured by network.***

***Proposal 13:******If ALT1 is used in proposal 12, then after the beamFailureDetetionTimerT310 expires, UE could not go back to relaxation mode before the punish time ends, the punish time can be a timer by network configuration.*** ***Proposal 14:******If ALT2 is used in proposal 12, then when UE trigger the RLF, UE could not go back to relaxation mode before the new timer expires. The new timer is configured by network, and this timer start right after UE perform revert.******Proposal 15: For intra-band CA case, the UE should relax only on serving cells where the relaxed criteria is fulfilled.******Proposal 16: The relaxation criteria and K factor should be configurable. SpCells and SCells can use different RLM/BFD measurement relaxation criteria.*** |
| [**R4-2104693**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104693.zip) | Xiaomi | **Proposal 1: The evaluation of serving cell quality based on BLER of hypothetical PDCCH can be considered as the RLM/BFD measurement relaxation criteria.****Proposal 2: Rel-16 RRM relaxation criterion can be used as baseline for RLM/BFD relaxation for low mobility scenario.****Proposal 3: The relaxation criteria should be predefined by the NW and it could be determined by UE whether the relaxation criteria is fulfilled or not.****Proposal 4: The evaluation period should be extended based on the legacy RLM/BFD requirements by considering the scaling factors, e.g. N factor, P factor, RS type, FR1 or FR2.****Proposal 5:** **UE is expected to revert to normal RLM operation during T310 is running.****Proposal 6: There is no need to configure conditions for UE reverting to normal BFD operation.****Observation 1:** **The measurement results of CCs in intra-band CA/DC would be quite similar.****Proposal 7: For intra-band CA/DC, if UE fulfils the relaxed criterion for RLM/BFD in one serving cell, it is expected that the relaxation operations are applied to the other serving cell(s).****Proposal 8:** **For intra-band CA/DC, if UE meets the conditions of reverting to the normal RLM/BFD in one serving cell, it is expected the reversion operations are applied to other serving cell(s).** |
| [**R4-2104756**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104756.zip) | CATT | **Proposal 1: SSB-based and CSI-RS based RLM/BFD measurement relaxation in FR1 and FR2 for low mobility and high/medium SINR UE.****Proposal 2: It is feasible to do the relaxation for both DRX=20ms or DRX=40ms RLM/BFD measurement.****Proposal 3: Consider serving cell’s quality as relaxation criteria when radio link quality > Qout + X (dB) for RLM and Qout,LR + Y (dB) for BFD relaxation.****Proposal 4: UE need to fulfil the low mobility and radio link quality is good than a threshold to make sure the link quality is good enough to do the relaxation.****Proposal 5: The similar definition of RLM/BFD evaluation period in Rel-15 can be reused as Max(T, Ceil([Y] × P ×N) × Max(TDRX,TSSB))****Proposal 6: For intra-band CA/DC, UE shouldn’t relax RLM for the cells which UE hasn’t fulfilled the relaxation condition.****Proposal 7: Revert to normal RLM/BFD operation when the relaxation criterion is not met.** |
| [**R4-2104757**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104757.zip) | CATT | *Simulation results are provided* |
| [**R4-2104850**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104850.zip) | Apple | **Observation 1: With R16 UE baseline, with 160ms DRX cycle, up to 7.42% UE power saving gain is observed with 4x RLM/BFD relaxation. With 40ms DRX cycle, up to 19.34% UE power saving gain is observed with 8x RLM/BFD relaxation.** **Observation 2: With R17 DCI based adaptation for UE power saving, with 160ms DRX cycle, up to 10.32% UE power saving gain is observed with 4x RLM/BFD relaxation. With 40ms DRX cycle, up to 21.47% UE power saving gain is observed with 8x RLM/BFD relaxation.** **Proposal 1: RLM/BFD relaxation through scaling on DRX cycle is supported.****Proposal 2: Relaxation factor depends on various factor including DRX cycle configuration, RLM-RS configuration, mobility and channel conditions etc.** **Proposal 3: RLM/BFD relaxation criterion include both mobility criterion and serving cell quality criterion. Relaxation criterion can be configured by the network and determined by the UE whether relaxation criterion is fulfilled.** **Proposal 4: UE revert back to normal operation when criterion is not met, or when N310 start to count.**  |
| [**R4-2104908**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104908.zip) | Qualcomm, Inc. | **Proposal 1: Prioritize SSB-based RLM/BFD in FR1 scenario for power saving RLM/BFD measurement relaxation study.****Proposal 2: Relaxation for longer DRx cycle measurement requirement should be considered to maintain the monotonicity of measurement/evaluation time w.r.t. DRx cycle length.****Observation 1: When serving SINR is above 6dB, the neighboring cell is not detectable.****Observation 2: The UEs with a better performance lose power saving opportunities if we force UEs to take the same number of samples as specified in RAN4 spec in the evaluation assumptions.****Proposal 3: Do not to set assumptions on other RRM measurement procedures when evaluating the power saving gain from RLM/BFD measurement relaxation.****Proposal 4: R16 low mobility condition applies to RLM/BFD relaxation when configured together with serving cell quality condition.****Proposal 5: Set different cell quality conditions for entering and exiting power saving mode.** **Proposal 6: Serving cell quality evaluation uses RLM/BFD SINR measurement.****Proposal 7: UE enters power saving mode when RLM SNR is larger than Qout/Qin + margin.****Observation 3: Low mobility condition is violated in the system level simulation submitted in the previous meetings. Therefore, these simulations are not appropriate for deriving SINR margin.****Proposal 8: If R16 low mobility condition is adapted, RAN4 derives SINR distribution for margin derivation from link level simulation without mobility and with small scale fading.** **Proposal 9: If power saving conditions are satisfied, allow TEvaluate\_ps\_out\_SSB for the first OOS indication and the original TEvaluate\_out\_SSB doesn’t apply. After the first OOS indication, the original TEvaluate\_out\_SSB applies to UE.**

|  |  |
| --- | --- |
| **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. |

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| [**R4-2106461**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106461.zip) | Intel Corporation | **Observation 1: Estimated SINR value varies with time, if a fixed SINR threshold is used as relaxation criteria, estimated SINR value may be up or below the threshold frequently.****Proposal 1: Since SINR value varies with time, a more robust criteria based on SINR is expected to be discussed.****Observation 2: SINR fluctuation will be reduced with more averaged samples.****Proposal 2: SINR will be evaluated during a time window to check if it satisfies the criteria of relaxation or not. The exact window length and how to process SINR value during the window for relaxing RLM/BFD can be further studied.** **Proposal 3: SINR threshold for start relaxing RLM needs to consider SINR fluctuation.****Observation 3: If high SINR is used as the relaxation threshold, there will some problems if out-of-sync is used as the reverting back criteria.****Proposal 4: Relaxation criteria and reverting back criteria should be designed jointly.****Proposal 5: SINR threshold for reverting back needs to consider SINR fluctuation or simply use Qin as threshold.****Observation 4: The low mobility criteria of Rel-16 reflects the low fluctuation of filtered RSRP and is not directly relevant to the RLM/BFD performance.****Proposal 6: R16 low-mobility relaxation criterion is not suitable to be re-used in Rel-17.****Proposal 7: For Rel-17, it’s better to consider the “low fluctuation of SINR”, which is more relevant to RLM/BFD performance. How to define “low fluctuation of SINR” can be further discussed.****Observation 5: For RLM, In-Sync means that SINR is higher than Qin threshold. Different from RLM, the criteria for CBD in BM satisfied that the measured L1-RSRP is equal to or better than the threshold Qin\_LR, which is indicated by higher layer parameter *rsrp-ThresholdSSB*.****Proposal 8: BFD should be relaxed at least better than CBD condition. Whether RSRP is also needed to be considered for relaxation criteria of BFD needs further discussion.****Proposal 9: Relaxation and reverting back criteria for RLM and BFD are different.** |
| [**R4-2106539**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106539.zip) | OPPO | **Proposal 1: It is up to UE implementation to use less L1 samples for RRM measurements if RRM measurement procedure and performance requirements were satisfied for UE.****Proposal 2: Reuse “Low mobility” as relaxation criteria which is determined and configured to UE by the network.****Proposal 3: Define SINR threshold or range as relaxation criteria for RLM/BFD based on evaluation of the scenario serving cell’s SINR is larger than Qout.****Proposal 4: Some margin of SINR should be considered for relaxation criteria due to different UE implementation.****Proposal 5: Suggest scaling factor can be different for different SINR range, for FR1 and FR2, and UE speed level.****Proposal 6: For intra-band CA/DC with collocated deployment,** **if UE has fulfilled the criterion for operating RLM/BFD relaxation in any serving cell, the same relaxation is allowed in all other serving cells of the intra-band pair.** **Otherwise, if UE has failed to fulfil the criterion for operating RLM/BFD relaxation in all serving cells, then it shall revert to normal RLM/BFD operation without relaxation.**  |
| [**R4-2106540**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106540.zip) | OPPO | **Observation 1: Average SINR as relaxation criteria should be at least higher than Qout to ensure RLF will not be triggered.****Observation 2: From simulation results, if delta SINR of max（95%, 5%）can be tolerated within ±2.0dB, the scaling factors for RLM/BFD relaxation could be** * **DRX cycle 20ms: K=4,**
* **DRX cycle 40ms: K=2**

**Observation 3: At least other parameters (e.g., DRX cycle, FR1/FR2) can be considered for defining different relaxation factor.** |
| [**R4-2106581**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106581.zip) | Nokia, Nokia Shanghai Bell | *Simulation results are provided* |
| [**R4-2106582**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106582.zip) | Nokia, Nokia Shanghai Bell | 1. Remove Option 2 (How many L1 samples UE applies for RRM measurements is up to UE implementation) from the list of scenarios to be studied for the UE power saving enhancements WI.
2. There are multiple ways to calculate delta SINR, and the simulation results depend on the chosen scenario.
3. The time the UE spends in outage increases significantly when the relaxation factor for RLM and BFD measurements increases due to the late detection of failure and initiating the recovery procedure.
4. Negative system level impact due to RLM/BFD relaxation should be minimized e.g. by studying the time of outage with different relaxation factors.
5. Based on our simulations, there is no power saving gain in FR1 when only RLM and BFD measurements are relaxed by extending the evaluation period.
6. In FR2, power saving gain of less than 3 % can be achieved by relaxing RLM and BFD measurements by extending the evaluation period in our simulations.
7. Use SINR as the quality measure for serving cell quality. FFS the exact metric.
8. If UE is under coverage of a specific cell or beam for certain amount of time or certain observed conditions do not change for a predefined time, the UE could be considered to be in stationary/low mobility state.
9. Consider time associated with a given condition when determining UE mobility state.
10. Robust, UE autonomous mechanism, is needed to determine when UE should change back to normal measurement activity if UE has adapted its activity based on e.g. ‘mobility’ state.
11. When operating in relaxed RLM/BFD mode, there could be alternate values for related parameters such has values for N310/N311.
12. Observed link quality degradation should cause the UE to revert back to normal measurement operation.
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| [**R4-2106851**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106851.zip) | Ericsson | *Simulation results are provided* |
| [**R4-2106852**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106852.zip) | Ericsson | * **Observation #1:** No specification impact to RRM measurement procedure requirements and performance due to RRM measurement relaxation.
* **Observation #2:** In release 17 UE power saving, it is possible to treat each UE separately by setting the relaxation criteria separately for each UE.
* **Observation #3:** Assuming high SINR threshold for entering the relaxed mode, no significant impact on latency for triggering RLF.
* **Proposal #1:** After RAN1 has agreed on the PDCCH relaxation methods, RAN4 shall assess the interaction between PDCCH relaxation and RLM/BM relaxation from power consumption perspective.
* **Proposal #2:** Allow RLM/BFD relaxation for DRX cycle lengths ≤ 80 ms when serving cell SNR > K, where K=FFS.
* **Proposal #3:** Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network, and it is up to the UE whether to apply relaxed RLM/BM requirements when configured.
* **Proposal #4:** The relaxation criteria includes the serving cell quality expressed as follows:
	+ radio link quality > Qout + X (dB) for RLM,
	+ Qout,LR + Y (dB) for BFD relaxation,
	+ X and Y are FFS.
* **Proposal #5:** Scaling factor defining the relaxed RLM/BFD evaluation period is defined based onmax(TDRX, TSSB).
* **Proposal #6:** RAN4 to discuss whether certain number of out-of-indications upon which UE shall revert back to normal mode can be expressed using N310 or whether it shall be predefined.
* **Proposal #7:** The UE while performing relaxed BM upon beam failure detection (e.g. 1st indication) reverts to the normal BFD operation (i.e. without relaxation).
* **Proposal #8:** The legacy requirement on UE performing BFD on all PCell, PSCell and all configured SCells apply for BFD relaxation.
* **Proposal #9:** For intra-band CA/DC scenario, if UE has fulfilled the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it is allowed to operate BFD in relaxed mode in all other serving cells (e.g. SCells).
* **Proposal #10:** For intra-band CA/DC scenario, if UE has failed to fulfil the criterion for operating BFD in relaxed mode in one serving cell (SpCell), then it shall revert to normal BFD operation (i.e. without relaxation) in all other serving cells (SCells).
* **Proposal #11:** For intra-band CA case, RAN4 to use the same RLM/BFD measurement relaxation criteria for the serving cells.
* **Proposal #12:**
	+ Up to 3 km/h and at high SINR (in-sync), relaxation by factor 4 can be allowed for FR1.
	+ Up to 3 km/h at low SINR (out-of-sync), relaxation if allowed should be smaller than factor 2 for FR1.
* **Proposal #13:**
	+ Up to 30 km/h and at high SINR (e.g. in-sync), relaxation if allowed should be smaller than factor 2 FR1.
	+ Up to 30 km/h at low SINR (e.g. out-of-sync), no relaxation shall be allowed for FR1.
* **Proposal #14:**
	+ Up to 3 km/h at higher SINR (e.g. in-sync), relaxation if allowed should be smaller than factor 2 for FR2.
	+ Up to 30 km/h, no relaxation should be allowed for FR2.
* **Proposal #15:** Relaxation factors used are different for FR1 and FR2, for the different SINR levels.
* **Proposal #16:** Low mobility state for allowing RLM/BM relaxation corresponds to 3 km/h.
* **Proposal #17:** Relaxation factors are different for FR1 and FR2.
* **Proposal #18:** RAN4 shall discuss whether to apply different relaxation factors for SSB and CSI-RS based evaluations in FR2.
* **Proposal #19:** RAN4 to discuss applying different relaxation factor for the different SINR regions.
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| [**R4-2106915**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106915.zip) | ZTE Corporation | **Observation 1:** The mobility status of the UE is known to both the network and the UE in CONNECTED mode.**Proposal 1: The relaxation criteria shall be configured by the network to the UE. If the threshold (criteria) is not configured, it means the UE cannot go into relaxation mode.****Proposal 2: The UE can determine alone if the criteria (configured by the network) is met and enter the low mobility mode to use a relaxed requirements for RLM and RLF if there will be test cases defined to test the UE behaviors.****Proposal 3: The UE while performing relaxed RLM shall revert to the normal RLM operation (i.e. without relaxation) if the relaxation criterion is not met or N310 starts to count (1 out-of-sync indication).****Proposal 4: The UE shall revert to the normal BFD operation upon detect 1 beam failure instance indication.****Proposal 5: For intra-band CA case, the UE should relax only on serving cells where the relaxed criteria is fulfilled.****Proposal 6: Take UE mobility as the major factor into the criteria.** |
| [**R4-2106942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106942.zip) | Huawei, HiSilicon | ***Observation 1: If the assumed measurement sample number in R15 was reduced in R17, the system and the measurement performance could not be guaranteed to be same as in R15.******Proposal 1: In relaxing RLM/BFD evaluation, the measurement sample numbers for both RLM/BFD measurements and RRM measurements need to be kept as same as Rel-15 assumptions.******Proposal 2: In relaxing RLM/BFD evaluation, the measurement sample number and measurement interval for RRM measurements need to be kept as same as Rel-15 assumptions.******Observation 2: For SSB based RLM/BFD in FR1, there is no power saving benefit due to relaxed RLM/BFD measurements.******Proposal 3: It is suggested not to perform SSB based RLM/BFD relaxation in FR1.******Proposal 4: It is suggested not to perform CSI-RS based RLM/BFD relaxation in FR1 when CSI-RS resource configured for RLM/BFD is within SMTC window.******Observation 3: For CSI-RS based RLM/BFD in FR1, the power saving benefit due to relaxed RLM/BFD measurements is quite limited when CSI-RS is within DRX onDuration time and WUS is not used.******Observation 4: For CSI-RS based RLM/BFD in FR1, the power saving benefit due to relaxed RLM/BFD measurements is observed (4%~7%) for a UE with light traffic when CSI-RS is outside DRX onDuration time or WUS is used.******Proposal 5: It is suggested not to perform CSI-RS based RLM/BFD relaxation in FR1 when the CSI-RS resource configured for RLM/BFD is within DRX onDuration time and WUS is used.******Proposal 6: RAN4 needs to study whether the beneficial scenario is a reasonable case for network configuration.******Proposal 7: It is suggested not to perform RLM/BFD relaxation in FR1 when the RS resource for RLM/BFD is also configured for L1-RSRP measurements.******Proposal 8: Due to UE beam sweeping, it is suggested not to perform SSB based RLM/BFD relaxation in FR2.******Proposal 9: The RLM/BFD relaxation criteria needs to combine both serving cell quality and UE mobility state.**** ***Entering conditions: both good serving cell quality and low UE mobility are satisfied.***
* ***Leaving conditions: either good serving cell quality or low UE mobility is not satisfied***

***Observation 5: The UE is not required to perform SSB/CSI-RS based RLM measurements on more than one serving cells in the same bands.******Observation 6: The UE is not required to perform SSB/CSI-RS based BFD measurements on more than one serving cells in the same bands.*** |
| [**R4-2106943**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2106943.zip) | Huawei, HiSilicon | *Simulation results are provided* |
| [**R4-2107083**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107083.zip) | vivo | **Observation 0 According to current spec, the UE is required to perform RLM/BFD at least twice per 3 DRX cycles when DRX cycle length is less than or equal to 320ms, no matter what mobility state UE is in and whether UE is in the high/medium SINR.****Observation 1 If a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, and falls back to normal measurement when SINR is below such threshold, then the impact to increased RLF triggering latency with 99%-tile probability can be less than (K-1) × DRX\_cycle, while K is the relaxation factor.****Observation 2 If 40ms DRX cycle is considered and a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, the RLF latency increases no more than only 2.5% when K=2, 7.5% when K=4 and 17.5% when K=8, with 99%-tile probability.****Observation 3 The SINR threshold for relaxation can be set by leaving enough margin to accommodate low mobility scenarios.****Observation 4 For FR1 SSB based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 3.6dB for K=8 when UE speed is less than 30km/h with 95% probability.****Observation 5 For FR1 SSB based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 7.5dB for K=8 when UE speed is less than 30km/h with 99% probability.****Observation 6 For FR2, compared to UE movement, UE rotation plays more important role in mobility impact analysis.****Observation 7 For FR2 UE rotation, elevation plane rotation would have more impact to mobility than horizontal rotation.****Observation 8 For FR2 CSI-RS based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 4.9dB for K=2 when UE rotation is less than 5r/min with 95% probability.****Observation 9 To optimise the case where data packet arrives with interval of around 100ms to 200ms, and 40 ms DRX cycle is considered, relaxation of RLM/BFD may further achieve power saving gain on top of R16 power saving techniques. If PDCCH WUS is configured and relaxing RLM-RS measurements 2x/4x/8x, 15~ 26% additional gain can be achieved.****Observation 10 For intensive eMBB or VoIP traffic, relaxing RLM measurements 2x/4x/8x, can also achieve 10% to 17% power saving gain.****Observation 11 The DRX on-duration offset to the SSB may have impact on power saving gain.****Observation 12 The packet delay is highly related to the DRX cycle length, and RLM and BFD relaxation will not impact the packet delay.****Observation 13 The one-shot SINR estimation error is less than 1.2dB with 95% probability when the actual SINR is above 8dB.****Proposal 1 In the study phase of this WI, RAN4 conclude the feasibility of R17 power saving, i.e. exact mobility impact and the exact power saving gain if RLM/BFD are relaxed in low mobility and/or high/medium SINR region.****Proposal 2 In the study phase of this WI, RAN4 conclude the potential spec impact of R17 power saving.****Proposal 3 RAN4 conclude the increased latency as observation 2, if number of measured samples are reduced (K=8) when SINR is above a proper threshold in the study phase of WI.****Proposal 4 RAN4 conclude the delta SINR for FR1 as observation 4 and 5, if number of measured samples are reduced (K=8) when SINR is above a proper threshold in the study phase of WI.****Proposal 5 Further update the evaluation assumptions to encourage companies to consider UE rotation in FR2.****Proposal 6 RAN4 conclude the delta SINR for FR2 CSI-RS based RLM as observation 8 and 9, if number of measured samples are reduced (K=2) when SINR is above a proper threshold in the study phase of WI.****Proposal 7 The conclusions to RLM measurement relaxation, if achieved, should also be applicable to BFD in FR1.****Proposal 8 RAN4 conclude the power saving gain and capture observation 6 and 7 in the study phase of the WI.****Proposal 9 For R17 RLM and BFD relaxation, measurement accuracy for RLM, BFD and RRM reuses R15 requirements.** **Proposal 10 For R17 RLM BFD relaxation, the range of applicable DRX cycles is <= Xms, and X=80 is preferred.****Proposal 11 Low mobility cell can be configured by network in RRC without any thresholds, e.g. for indoor cells.****Proposal 12 Define network-configured thresholds reflecting different SINR regions for RLM and BFD relaxation. Such threshold is the same for RLM and BFD.****Proposal 13 Two SINR thresholds, i.e. Thenter and Thquit, should be defined for R17 RLM and BFD relaxation.****Proposal 14 RAN4 further discuss and agree on the link level evaluation assumptions to collect results on the SINR estimation error based on Y samples, while Y=1 is the baseline.****Proposal 15 UE falls back to normal mode if either the averaged SINR based on reduced number of samples is below Thquit, or the one-shot SINR is below Qout.****Proposal 16 Different relaxation factor and different thresholds for relaxation can be considered for SSB based RLM/BFD and CSI-RS based RLM/BFD.****Proposal 17 UE relaxation behaviour for BFD should be the same in all cells in a CG in the same band.****Proposal 18 The PDCCH monitoring relaxation is in RAN1 scope, and should be further studied in RAN1.****Proposal 19 Send LS to RAN2 in this meeting, in order to inform RAN2 on the progress that RAN4 has made.** |
| [**R4-2107084**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107084.zip) | vivo | **Observation 1 If a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, and falls back to normal measurement when SINR is below such threshold, then the impact to increased RLF triggering latency with 99%-tile probability can be less than (K-1) × DRX\_cycle, while K is the relaxation factor.****Observation 2 If 40ms DRX cycle is considered and a UE is only allowed to relax RLM when SINR is above a proper SINR threshold, the RLF latency increases no more than only 2.5% when K=2, 7.5% when K=4 and 17.5% when K=8, with 99%-tile probability.****Observation 3 The SINR threshold for relaxation can be set by leaving enough margin to accommodate low mobility scenarios.****Observation 4 For FR1 SSB based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 3.6dB for K=8 when UE speed is less than 30km/h with 95% probability.****Observation 5 For FR1 SSB based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 7.5dB for K=8 when UE speed is less than 30km/h with 99% probability.****Observation 6 For FR2, compared to UE movement, UE rotation plays more important role in mobility impact analysis.****Observation 7 For FR2 UE rotation, elevation plane rotation would have more impact to mobility than horizontal rotation.****Observation 8 For FR2 CSI-RS based RLM, if proper threshold for RLM/BFD relaxation is considered, the delta SINR can be less than 4.9dB for K=2 when UE rotation is less than 5r/min with 95% probability.****Observation 9 To optimise the case where data packet arrives with interval of around 100ms to 200ms, and 40 ms DRX cycle is considered, relaxation of RLM/BFD may further achieve power saving gain on top of R16 power saving techniques. If PDCCH WUS is configured and relaxing RLM-RS measurements 2x/4x/8x, 15~ 26% additional gain can be achieved.****Observation 10 For intensive eMBB or VoIP traffic, relaxing RLM measurements 2x/4x/8x, can also achieve 10% to 17% power saving gain.****Observation 11 The DRX on-duration offset to the SSB may have impact on power saving gain.****Observation 12 The packet delay is highly related to the DRX cycle length, and RLM and BFD relaxation will not impact the packet delay.****Observation 13 The one-shot SINR estimation error is less than 1.2dB with 95% probability when the actual SINR is above 8dB.** |
| [**R4-2107085**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107085.zip) | vivo | Updated evaluation assumptions |
| [**R4-2107124**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107124.zip) | MediaTek inc. | ***Observation 1: UE can meet RRM measurement procedure requirements and measurement performance requirements when UE speed is lower than 30km/hr and SNR is higher than 0dB.******Observation 2: Probability of RLF triggering and the corresponding averaged increased latency when UE performs RLM/BFD measurement relaxation can be well controlled by setting a sufficient high SINR criterion.******Observation 3: Ranged from 8.62% to 20.34% UE power saving gain can be obtained for scenarios SSB-based and CSI-RS based RLM/BFD measurement in FR1******Observation 4: Ranged from 14.55% to 28.63% UE power saving gain can be obtained for scenario CSI-RS based RLM/BFD measurement in FR2******Observation 5: In FR1, evaluation period for SSB based and CSI-RS based RLM/BFD measurement can be extended at least by 4 times when SINR ≥ 4dB and UE speed ≤ 30km/hr******Observation 6: In FR2, evaluation period for CSI-RS based RLM/BFD measurement can be extended at least by 2 times when SINR ≥ 8dB and UE speed ≤ 30km/hr***And we propose***Proposal 1: RAN4 to confirm that from UE power saving gain perspective, it is beneficial to relax SSB-based and CSI-RS based RLM/BFD measurement in FR1, and it is beneficial to relax CSI-RS based RLM/BFD measurement in FR2******Proposal 2: RAN4 to confirm that from system impact perspective, SSB based and CSI-RS based RLM/BFD measurement relaxation in FR1 and CSI-RS based RLM/BFD measurement relaxation in FR2 are feasible for low mobility and high SINR UE.******Proposal 3: RAN4 to specify that requirement of Rel-17 connected mode power saving at least for the following scenarios: 1) SSB based and CSI-RS based RLM/BFD measurement relaxation in FR1, and 2) CSI-RS based RLM/BFD measurement relaxation in FR2******Proposal 4: RAN4 to specify BLER (or SINR) threshold for UE to enter the relaxation mode******Proposal 5: RAN4 to specify BLER (or SINR) threshold for UE to exit the relaxation mode******Proposal 6: For future study whether to specify 2 different threshold values for UE to enter and exit the relaxation mode******Proposal 7: RAN4 to study the necessity of mobility criterion for Rel-17 power saving*** |

## Open issues summary

### Sub-topic 2-1 Evaluation assumption

**Issue 2-1-1: Evaluation assumption update**

* Background:
	+ Evaluation assumption update is proposed in R4-2107085 (vivo) and discussed in R4-2107083 (vivo).
* Proposals:
	+ Option 1 (vivo):
		- Further update the evaluation assumptions to encourage companies to consider UE rotation in FR2.
		- RAN4 further discuss and agree on the link level evaluation assumptions to collect results on the SINR estimation error based on Y samples, while Y=1 is the baseline.
* Recommended WF:
	+ Companies are encouraged to provide views in the 1st round.
	+ Responsible company may provide revision in the 2nd round.

**Issue 2-1-2: assumption on other RRM measurement**

* Background:
	+ Further evaluate UE power saving gains for the following UE implementations:
		- UE meets Rel-15 RRM measurement period and accuracy requirements
		- Option 1:
			* UE uses all L1 samples for RRM measurements based on Rel-15 assumptions
		- Option 2:
			* How many L1 samples UE applies for RRM measurements is up to UE implementation (e.g. UE can use lower number of measurement samples for RRM measurements)
			* Further discuss how many samples to use for evaluations
			* Companies shall evaluate RRM measurements accuracy for the proposed number of samples.
		- FFS whether Option 2 can be considered for requirements definition
* Proposals:
	+ Option 1: (Nokia, Huawei, Ericsson)
		- UE uses all L1 samples for RRM measurements based on Rel-15 assumptions.
	+ Option 2: (Oppo, Qualcomm)
		- How many L1 samples UE applies for RRM measurements is up to UE implementation. (e.g. UE can use lower number of measurement samples for RRM measurements)
* Recommended WF:
	+ Companies are encouraged to provide views in the 1st round.

**Issue 2-1-3: Impact on PDCCH monitoring**

* Background: Further assess impact on PDCCH monitoring due to relax UE measurements for RLM/BFD
* Proposals:
	+ Option 1: (Ericsson)
		- After RAN1 has agreed on the PDCCH relaxation methods, RAN4 shall assess the interaction between PDCCH relaxation and RLM/BM relaxation from power consumption perspective.
	+ Option 2: (vivo)
		- The PDCCH monitoring relaxation is in RAN1 scope, and should be further studied in RAN1.
* Recommended WF:
	+ Do not discuss this issue until RAN1’s conclusion.

### Sub-topic 2-2 Feasible scenarios for relaxation

**Issue 2-2-1: Observations on the simulation results of power saving gain**

* Proposals
	+ Option 1: (vivo)
	+ In the study phase of this WI, RAN4 conclude the feasibility of R17 power saving, i.e. exact mobility impact and the exact power saving gain if RLM/BFD are relaxed in low mobility and/or high/medium SINR region.
	+ RAN4 conclude the power saving gain and capture observation 6 and 7 in the study phase of the WI.
* Recommended WF:
	+ The observation should be made based on the simulation result.
	+ Encourage companies to update on the simulation result in the 1st round.
	+ The observations of the simulation result will be captured in the 2nd round.

**Issue 2-2-2: Observations on the simulation results of delta SINR**

* Proposals
	+ Option 1: (vivo)
	+ RAN4 conclude the delta SINR for FR1 as observation 4 and 5, if number of measured samples are reduced (K=8) when SINR is above a proper threshold in the study phase of WI.
	+ RAN4 conclude the delta SINR for FR2 CSI-RS based RLM as observation 8 and 9, if number of measured samples are reduced (K=2) when SINR is above a proper threshold in the study phase of WI.
* Recommended WF:
	+ The observation should be made based on the simulation result.
	+ Encourage companies to update on the simulation result in the 1st round.
	+ The observations of the simulation result will be captured in the 2nd round.

**Issue 2-2-3: Observations on the simulation results of increased latency**

* Proposals
	+ Option 1: (vivo)
		- RAN4 conclude the increased latency as observation 2, if number of measured samples are reduced (K=8) when SINR is above a proper threshold in the study phase of WI.
* Recommended WF:
	+ The observation should be made based on the simulation result.
	+ Encourage companies to update on the simulation result in the 1st round.
	+ The observations of the simulation result will be captured in the 2nd round.

**Issue 2-2-4: Feasible Scenarios from both power Saving gain and system impact**

* Background: FFS the feasibility of following scenarios from system level perspective:
	+ SSB-based and CSI-RS based RLM/BFD measurement relaxation in FR1 for low mobility and high/medium SINR UE.
	+ CSI-RS based RLM/BFD measurement relaxation in FR2 for low mobility and high/medium SINR UE
	+ SSB-based RLM/BFD measurement relaxation in FR2 for stationary and high/medium SINR UE
* Proposals: feasible relaxation scenarios:
	+ Case 1: SSB based RLM/BFD measurement relaxation in FR1
		- Option 1: Yes (MTK, CATT, Qualcomm, vivo, Ericsson)
		- Option 2: No (Huawei)
	+ Case 2: CSI-RS based RLM/BFD measurement relaxation in FR1
		- Option 1: Yes (MTK, CATT, Qualcomm, vivo)
		- Option 2: No with the conditions when (Huawei)
			* The CSI-RS resource configured for RLM/BFD is within SMTC window
			* The CSI-RS resource configured for RLM/BFD is within DRX onDuration time and WUS is used
			* The RS resource for RLM/BFD is also configured for L1-RSRP measurements.
	+ Case 3: CSI-RS based RLM/BFD measurement relaxation in FR2
		- Option 1: Yes (MTK, CATT, vivo)
	+ Case 4: SSB based RLM/BFD measurement relaxation in FR2
		- Option 1: Yes (CATTEricsson)
		- Option 2: No (Huawei)

Recommended WF:

* + Focus on the observations in issue 2-1-1, 2-1-2, and 2-1-3.
	+ Companies are still encouraged to provide comments in the first round.
	+ Target to capture the feasible relaxation scenarios in the 2nd round.

**Issue 2-2-5: Considerations on the feasibility study**

* Proposals:
	+ Option 1: Negative system level impact due to RLM/BFD relaxation should be minimized e.g. by studying the time of outage with different relaxation factors. (Nokia)
	+ Option 2: RAN4 needs to study whether the beneficial scenario is a reasonable case for network configuration. (Huawei)
* Recommended WF: Discuss the proposals

**Issue 2-2-6: DRX cycle applicability**

* Background:
	+ The applicability of DRX cycles for RLM/BFD relaxation should be studied and decided based on the ongoing simulation study.
		- FFS DRX cycle length <= 80 ms
* Proposals
	+ Option 1: relaxation is applicable for DRX=20ms or DRX=40ms. (CATT)
	+ Option 2: relaxation is applicable for DRX <= 80 ms. (Ericsson, vivo)
		- Option 2a: relaxation is applicable for DRX <= 80 ms, but adjustment to other DRx cycles is needed to keep the monotonicity of DRx cycles w.r.t. evaluation time (QC)
* Recommended WF
	+ Is Option 2 agreeable? Note that the relaxation criteria should be also satisfied to enable the relaxation.

**Issue 2-2-7: Potential spec impact**

* Proposals
	+ Option 1: In the study phase of this WI, RAN4 conclude the potential spec impact of R17 power saving. (vivo)
* Recommended WF: Discuss the proposals

**Issue 2-2-8: LS to RAN2 on the study phase conclusion**

* Proposals:
	+ Option 1: Send LS to RAN2 in this meeting, in order to inform RAN2 on the progress that RAN4 has made. (vivo)
	+ Option 2: LS is not needed.
* Recommended WF
	+ Companies are encouraged to provide views on whether to send the LS.

### Sub-topic 2-3 Relaxation criteria

* Background: the relaxation criteria of RLM/BFD relaxation has been discussed in the last meeting as follows.
	+ At least take UE mobility into account as the relaxation criteria.
	+ also take serving cell’s quality into account
	+ FFS whether and how to take other aspects into account

**Issue 2-3-1: Criteria of RLM/BFD relaxation - General**

* Proposals
	+ Option 1: The RLM/BFD relaxation criteria needs to combine both serving cell quality and UE mobility state. (Huawei, Apple, CATT, Qualcomm, Intel)
		- Entering conditions: both good serving cell quality and low UE mobility are satisfied.
	+ Option 2: Take UE mobility as the major factor into the criteria. (ZTE)
	+ Option 3: RAN4 to study the necessity of mobility criterion for Rel-17 power saving. (MTK,vivo)
* Recommended WF: Discuss the proposals

**Issue 2-3-2: Good serving cell quality criteria of RLM/BFD relaxation**

* Proposals
	+ Option 1: radio link quality is better than a threshold. (CATT, Qualcomm, Ericsson, Oppo, MTK)
		- radio link quality > Qout + X (dB) for RLM
		- radio link quality > Qout,LR + Y (dB) for BFD relaxation.
		- FFS X, Y
	+ Option 1a: Define network-configured thresholds reflecting SINR regions for RLM and BFD relaxation. Such threshold is the same for RLM and BFD. (vivo)
* Recommended WF: Is Option 1 (i.e. radio link quality is better than a threshold) agreeable?

**Issue 2-3-3: what is the radio link quality in Issue 2-3-2**

* Proposals
	+ Option 1: based on SINR. (CMCC, Qualcomm, Intel, Nokia, Oppo, MTK)
		- Option 1a: (Intel)
			* Since SINR value varies with time, a more robust criteria based on SINR is expected to be discussed.
			* SINR will be evaluated during a time window to check if it satisfies the criteria of relaxation or not. The exact window length and how to process SINR value during the window for relaxing RLM/BFD can be further studied.
	+ Option 2: based on BLER of hypothetical PDCCH. (Xiaomi, MTK)
	+ Option 3: BFD should be relaxed at least better than CBD condition. Whether RSRP is also needed to be considered for relaxation criteria of BFD needs further discussion. (Intel)
* Recommended WF: Is Option 1 agreeable for RLM?

**Issue 2-3-4: different threshold for SSB based and CSI-RS based RLM/BFD**

* Proposals
	+ Option 1: different threshold for SSB based and CSI-RS based RLM/BFD is allowed (vivo)
* Recommended WF: Is Option 1 agreeable?

**Issue 2-3-5: Low mobility criteria of RLM/BFD relaxation**

* Proposals
	+ Option 1: R16 low mobility condition applies to RLM/BFD relaxation. (Qualcomm)
		- If R16 low mobility condition is adapted, RAN4 derives SINR distribution for margin derivation from link level simulation without mobility and with small scale fading.
	+ Option 2: R16 RRM relaxation criterion can NOT be directly used. (CMCC, Intel)
		- Option 2a (CMCC):
			* The SINR (value and variation) of serving cell can be used for low-mobility criterion.
			* If SINR drift rate is under a threshold during a certain estimation period, then the UE can be considered to fulfill the serving cell’s quality variation rule.
	+ Option 3: RAN4 to study the necessity of mobility criterion for Rel-17 power saving. (MTK,vivo)
	+ Option 4: Consider time associated with a given condition when determining UE mobility state. (Nokia)
	+ Option 5: Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network, and it is up to the UE whether to apply relaxed RLM/BM requirements when configured. (Ericsson)
* Recommended WF: Discuss the proposals.

**Issue 2-3-6: Exiting criteria of RLM relaxation**

* Background:
	+ 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).
* Proposals
	+ Option 1: exit relaxation mode when any relaxation criterion is not met (CATT, Apple, ZTE, Huawei)
	+ Option 2: exit relaxation mode when the radio link quality is worse than a certain threshold.
		- Option 2a: set different radio link quality threshold for entering and exiting the relaxation (CMCC, Vivo, MTK, Intel, Oppo)
		- Option 2b: UE falls back to normal mode if either the averaged SINR based on reduced number of samples is below Thquit, or the one-shot SINR is below Qout. (vivo)
	+ Option 3: exit relaxation mode based on out-of-sync indication. (Apple, , ZTE, Xiaomi, CMCC, Nokia)
		- Option 3a: exit when N310 starts to count, i.e. 1 out-of-sync indication. (Apple, , ZTE)
		- Option 3b: exit when T310 is running (Xiaomi, CMCC)
		- Option 3c: exit when certain number of out-of-indications (Ericsson)
		- Option 3d: exit when certain consecutive out-of-sync indications (CMCC)
	+ Option 4 (QC) : Additional time is allowed for UE to evaluate first OOS indication when UE is in power saving mode. UE is in normal mode after first OOS indication. The additional delay for RLF declaration is guaranteed to be within OOS evaluation time (TEvaluate\_out\_SSB) in normal mode. Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “first OOS indication” requirement has to be satisfied.

|  |  |
| --- | --- |
| 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. |

* Recommended WF: Discuss the proposals. Target to down-select or merge proposals.

**Issue 2-3-7: Exiting criteria of BFD relaxation**

* Proposals
	+ Option 1: exit relaxation mode when any relaxation criterion is not met (CATT, Apple, Huawei)
	+ Option 2: exit relaxation mode when the radio link quality is worse than a certain threshold.
		- Option 2a: set different radio link quality threshold for entering and exiting the relaxation (CMCC, vivo, MTK, Intel, Oppo)
		- Option 2b: UE falls back to normal mode if either the averaged SINR based on reduced number of samples is below Thquit, or the one-shot SINR is below Qout. (vivo)
	+ Option 3: exit relaxation mode upon detect 1 beam failure instance indication. (Ericsson, ZTE)
	+ Option 4: exit relaxation mode after BFI\_COUNTER add to the value of a new counter or a new parameter, the new counter or the new parameter is configured by network. (CMCC)
	+ Option 5: exit relaxation modeupon RLF (CMCC)
	+ Option 6: no need for the exiting criteria for BFD relaxation. (Xiaomi)
* Recommended WF: Discuss the proposals. Target to down-select or merge proposals.

**Issue 2-3-8: Alternative N310/N311 values in relaxation mode**

* Proposals
	+ Option 1: When operating in relaxed RLM/BFD mode, there could be alternate values for related parameters such has values for N310/N311. (Nokia, CMCC)
* Recommended WF: Discuss the proposals

**Issue 2-3-9: Re-entry to the RLM relaxation mode**

* Proposals
	+ Option 1 (CMCC):
		- If UE revert to normal RLM operation, and the T310 is not starting. UE can go back to relaxation mode after receiving several in-sync indications. The number of in-sync indications can be configured by network, such as configure a new counter.
		- If UE stop the T310 because receiving N311 in-sync indication, UE couldn’t go into relaxation mode again during a certain 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 is configured by network.
* Recommended WF: Discuss the proposals

**Issue 2-3-10: Re-entry to the BFD relaxation mode**

* Proposals
	+ Option 1 (CMCC):
		- If Option 4 in Issue 2-3-7 is agreed, then after the beamFailureDetetionTimerT310 expires, UE could not go back to relaxation mode before the punish time ends, the punish time can be a timer by network configuration.
		- If Option 5 in Issue 2-3-7 is agreed, then when UE trigger the RLF, UE could not go back to relaxation mode before the new timer expires. The new timer is configured by network, and this timer start right after UE perform revert.
* Recommended WF: Discuss the proposals

### Sub-topic 2-4 Relaxation scheme

**Issue 2-4-1: Relaxed evaluation period of RLM/BFD**

* Background
	+ Use of a scaling factor to extend the RLM/BFD evaluation period.
* Proposals
	+ Option 1: Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on max(TDRX, TSSB). (Ericsson, Apple, CATT, Qualcomm)
		- Option 1a: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,TSSB))
		- Option 1b: If power saving conditions are satisfied, allow TEvaluate\_ps\_out\_SSB for the first OOS indication and the original TEvaluate\_out\_SSB doesn’t apply. (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. |

* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-2: Are the parameters of relaxation criteria predefined or configurable**

* Background
* Network to enable and disable this feature.
	+ FFS Should the relaxation criteria be predefined or configurable?
	+ FFS Should it be network or UE to determine the relaxation criteria is fulfilled or not?
* Proposals
	+ Option 1: The parameters of relaxation criteria should be predefined. (Xiaomi)
	+ Option 2: The parameters of relaxation criteria can be configured by the network. (Apple, ZTE, Oppo, CMCC, vivo, Ericsson)
	+ Option 3: No parameter for low mobility criteria
		- Option 3a: Low mobility cell can be configured by network in RRC without any thresholds, e.g. for indoor cells. (vivo)
		- Option 3b: Low mobility scenario under which the UE is allowed to apply the RLM/BM requirements is determined and configured to UE by the network, and it is up to the UE whether to apply relaxed RLM/BM requirements when configured.(Ericsson)
	+ Option 4 (QC): The parameters of relaxation criterion of low mobility and entering condition of good cell quality can be configured by the network. Exit condition of good cell quality is up to UE implementation, as long as the additional delay for RLF declaration is guaranteed to be within OOS evaluation time (TEvaluate\_out\_SSB) in normal mode
* Recommended WF: Is Option 2 agreeable?

**Issue 2-4-3: network or UE to determine the relaxation criteria is fulfilled or not**

* Proposals
	+ Option 1: UE determines whether the relaxation criteria can be fulfilled or not. (CMCC, Xiaomi, Apple, QC)
	+ Option 1a: The UE can determine alone if the criteria (configured by the network) is met and enter the low mobility mode to use a relaxed requirements for RLM and RLF if there will be test cases defined to test the UE behaviors. (ZTE)
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4a: Different Relaxation factors between FR1 and FR2**

* Proposals
	+ Option 1: Different Relaxation factors are allowed for FR1 and FR2. (Oppo, CMCC, Xiaomi, Ericsson)
	+ Option 2: Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “additional delay for first OOS indication” requirement has to be satisfied (QC).
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4b: Different Relaxation factors for different SINR range**

* Proposals
	+ Option 1: Different Relaxation factors are allowed for different SINR range (oppo, Ericsson, Apple)
	+ Option 2: Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “additional delay for first OOS indication” requirement has to be satisfied (QC).
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4c: Different Relaxation factors for different UE speed**

* Proposals
	+ Option 1: Different Relaxation factors are allowed for different UE speed (oppo)
	+ Option 2: Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “additional delay for first OOS indication” requirement has to be satisfied (QC).
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4d: Different Relaxation factors for SSB and CSI-RS**

* Proposals
	+ Option 1: different relaxation factors are allowed for SSB and CSI-RS (vivo, Xiaomi, Apple)
	+ Option 2: FFS whether different relaxation factors are allowed for SSB and CSI-RS in FR2 (Ericsson)
	+ Option 3: Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “additional delay for first OOS indication” requirement has to be satisfied (QC).
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4e: Different Relaxation factors for different DRX cycle**

* Proposals
	+ Option 1: Different Relaxation factors are allowed for different DRX cycle (apple)
	+ Option 2: Different “additional delay for first OOS indication” requirement for different DRx cycles (QC)
* Recommended WF: Is Option 1 agreeable?

**Issue 2-4-4f: Other consideration on Relaxation factors**

* Proposals
	+ Option 1: The evaluation period should be extended based on the legacy RLM/BFD requirements by considering the scaling factors, e.g. N factor, P factor (Xiaomi)
	+ Option 2: Relaxation for longer DRx cycle measurement requirement should be considered to maintain the monotonicity of measurement/evaluation time w.r.t. DRx cycle length (Qualcomm)
	+ Option 3 (CMCC):
		- RLM/BFD performance after relaxation
		- The evaluation period after relaxation, which should be smaller or equal to a threshold
	+ Option 4 (Ericsson):
		- Up to 3 km/h and at high SINR (in-sync), relaxation by factor 4 can be allowed for FR1.
		- Up to 3 km/h at low SINR (out-of-sync), relaxation if allowed should be smaller than factor 2 for FR1.
		- Up to 30 km/h and at high SINR (e.g. in-sync), relaxation if allowed should be smaller than factor 2 FR1.
		- Up to 30 km/h at low SINR (e.g. out-of-sync), no relaxation shall be allowed for FR1.
		- Up to 3 km/h at higher SINR (e.g. in-sync), relaxation if allowed should be smaller than factor 2 for FR2.
		- Up to 30 km/h, no relaxation should be allowed for FR2.
* Recommended WF: Suggest to discuss the principle first in Issue 2-4-4a~e.

**Issue 2-4-5: Measurement accuracy**

* Proposals
	+ Option 1: For R17 RLM and BFD relaxation, measurement accuracy for RLM, BFD and RRM reuses R15 requirements. (vivo)
* Recommended WF: Discuss the proposals

### Sub-topic 2-5 Others

**Issue 2-5-1: Entering relaxation mode in intra-band CA/DC**

* Proposals
	+ Option 1: For intra-band CA/DC, the UE should relax only on serving cells where the relaxed criteria is fulfilled. (CMCC, CATT, ZTE)
	+ Option 2: For intra-band CA/DC, if UE has fulfilled the criterion for operating BFD in relaxed mode in one serving cell, then it is allowed to operate BFD in relaxed mode in all other serving cells (Oppo, Ericsson, Xiaomi)
* Recommended WF: Discuss the proposals

**Issue 2-5-2: Exiting relaxation mode in intra-band CA/DC**

* Proposals
	+ Option 1: For intra-band CA/DC, if UE meets the conditions of reverting to the normal RLM/BFD in one serving cell, it is expected the reversion operations are applied to other serving cell(s). (Xiaomi, Ericsson)
	+ Option 2: For intra-band CA/DC, if UE has failed to fulfil the criterion for operating RLM/BFD relaxation in all serving cells, then it shall revert to normal RLM/BFD operation without relaxation. (Oppo)
* Recommended WF: Is option 1 agreeable?

**Issue 2-5-3: Relaxation criteria in intra-band CA/DC**

* Proposals
	+ Option 1: For intra-band CA case, RAN4 to use the same RLM/BFD measurement relaxation criteria for the serving cells. (Ericsson, vivo)
		- Option 1a: UE relaxation behaviour for BFD should be the same in all cells in a CG in the same band (vivo)
	+ Option 2: The relaxation criteria and K factor should be configurable. SpCells and SCells can use different RLM/BFD measurement relaxation criteria.
* Recommended WF: Discuss the proposals

**Issue 2-5-4: Applicability for BFD relaxation requirement**

* Proposals
	+ Option 1: As the legacy BFD requirement, the BFD relaxation requirement is applicable for PCell, PSCell and all configured SCells. (Ericsson)
* Recommended WF: Discuss the proposals.

## Companies views’ collection for 1st round

### Open issues

**Sub-topic 2-1 Evaluation assumption**

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| **Company** | **Comments** |
| vivo | Issue 2-1-1: **Evaluation assumption update**As discussed in RAN plenary, the number of samples for RLM/BFD/RRM measurements is up to UE implementation, as long as UE can meet the accuracy requirements. As agreed in last RAN4 meeting, the relaxation for RLM and BFD is only conducted in low mobility and good cell quality condition, it is important to identify the UE measurement performance based on reduced number of samples, when the actual SINR is not as bad as the side condition. This is also important for the purposed of identifying the necessary margin and potential configuration options for the details of the cell quality condition.Issue 2-1-2: **assumption on other RRM measurement**This issue is already discussed in the RAN Plenary and the conclusion from RAN P is “*For Rel-17 WI of UE power saving enhancements for NR, no specification impact to RRM measurement procedure requirements and measurement performance requirements is expected.*”Based on above conclusion, the FFS bullet under option 2 for last meeting can be removed or can be revised to “FFS whether Option 2 can be considered for RLM/BFD requirements definition” to avoid any collision or confusion.Moreover, the above RAN Plenary guidance implies that the number of samples UE used is up to UE implementation, as the wording “sample number” was not included in the plenary guidance. Therefore, we are fine to list option 1 as one option for evaluation, if option 2 in last meeting is not removed.We also prefer option 2 and we think it is better to agree and capture option 2 in this meeting, as proposed in our contribution R4-2107082.Issue 2-1-3: **Impact on PDCCH monitoring**We support the moderator’s recommended WF. Impact on/from PDCCH monitoring is not precluded, and can be further discussed after RAN1 have conclusions. |
| QC | Issue 2-1-2 assumption on other RRM measurement:Support option 2. As we pointed out in our contribution, under good serving cell quality condition, the side condition for neighboring cell measurement is mostly violated and the neighboring cell measurement requirement is not relevant. Therefore, we don’t have to consider other RRM measurement, leaving to UE implementation for power saving gain evaluation. Note that this doesn’t change the requirement, since the requirement doesn’t apply when side condition is violated. |
| Apple | Issue 2-1-2: Option 2. The number of L1 samples used for measurement is up to UE implementation as long as requirement is met. Issue 2-1-3: RAN1 R17 PDCCH monitoring adaptation can reduce UE power used for PDCCH monitoring. In this case, UE spend a larger portion of power for RLM/BFD. RLM/BFD relaxation on top of R17 PDCCH based adaption scheme provides higher UE power saving gain, as shown in our simulation results.  |
| CMCC | Issue 2-1-2: assumption on other RRM measurementFor power saving gain evaluation, we think Option1 and Option2 are both OK. If we use Option2 as a starting point, we should further down-select a specific value for aligned simulation assumption. In real network, how to do the RRM measurements is up to UE implementation as long as UE fulfill the related requirements.Issue 2-1-3: Impact on PDCCH monitoringWe support the recommended WF. |

**Sub-topic 2-2 Feasible scenarios for relaxation**

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| **Company** | **Comments** |
| vivo | Issue 2-2-1: **Observations on the simulation results of power saving gain**Suggest to come back to this issue after the results are collected, since it is mainly about the wording. It is further discussed in the WF.Issue 2-2-2: **Observations on the simulation results of delta SINR**Suggest to come back to this issue after the results are collected, since it is mainly about the wording.. It is further discussed in the WF.Moreover, it is proposed to not to capture the results from some company, in case the results are deviated from all other companies.Issue 2-2-3: **Observations on the simulation results of increased latency**Suggest to come back to this issue after the results are collected, since it is mainly about the wording.. It is further discussed in the WF.Issue 2-2-4: **Feasible Scenarios from both power Saving gain and system impact**Based on the contributions from companies, we identify that the companies having concerns on the feasible scenarios are mainly on whether number of samples for RRM can be reduced, in case the RRM requirements are not impacted. As is discussed for many times, this should be up to UE implementation. Therefore, we suggest to agree on option 1 for at least case 1, 2 and 3.Issue 2-2-5: **Considerations on the feasibility study**For proposal 2, we understand the motivation, but the baseline assumption for such negative system impact needs to be considered. As agreed in evaluation assumptions, the T310 value is stated as 1000ms. This is copied from the in-sync test case, and we think it is an reasonable value for realistic deployment. Considering this value, the UE would be maintained in out-of-sync condition for at least 1000ms before RLF triggers. Only after RLF triggers, UE can start reestablishment, or other recovery procedure.For proposal 3, we are fine to have further discussion. For example, L1-RSRP reporting is not a typical configuration for FR1, at least in our understanding. Even if it is configured, as agreed in TR 38.840, it should not be more frequent than once per 160ms. For the MO configuration, based on our understanding, the only thing matters would be the intra-frequency measurement for the PCC frequency layer, which is defined to have CSSF=1 if CSI-RS layer is not configured. Therefore, it is reasonable to reduce the sample for serving cell and not to measure the neighbor cells if the serving cell SNR is high enough.Issue 2-2-6: **DRX cycle applicability**We support option 2.Option 2a can be further discussed. This is related to what is defined for the relaxed requirement. Issue 2-2-7: **Potential spec impact**At least the restriction for UE to perform RLM once per indication period can be removed in TS 38.214.The indication period specified in clause 38.133 can be extended when UE meets the relaxation criteria.Moreover, the evaluation for the oos evaluation period can be extended based on reasonable UE behavior assumption. Issue 2-2-8: **LS to RAN2 on the study phase conclusion**We prefer option 1.As listed in the status report, the remaining open issues for this topic are quite many. In our view it is reasonable to trigger RAN2 discussion earlier than the work plan stated. For example, the criteria are normally captured in RAN2 spec.In our view, the following topics are better discussed in RAN2.* + Criteria which the UE is allowed to relax the RLM/BM requirements, including both serving cell quality and/or UE mobility criteria
	+ Criteria/mechanism which UE falls back to normal RLM/BM operation
	+ Network or UE to determine if the criteria for relaxation is fulfilled
	+ RRC signaling design

We are open to hear other views. |
| QC | **Issue 2-2-4: Feasible Scenarios from both power Saving gain and system impact**We suggest prioritizing SSB-based based RLM/BFD measurement relaxation in FR1 for low mobility and high/medium SINR UE. In this scenario, largest gain is observed in most of evaluation results. Our option toward different cases:Case 1: prioritizedCase 2: open to discussCase 3/4: can evaluate after RAN4 is done with specifying FR1 power saving**Issue 2-2-6: DRX cycle applicability**We support option 2a, because the monotonicity of DRx cycles w.r.t. evaluation time should be kept.**Issue 2-2-8: LS to RAN2 on the study phase conclusion**It is preferred to send LS when RAN4 reaches concrete conclusion. |
| Apple | Issue 2-2-1: Agree with WF. UE power saving gain highly related to the two options in 2-1-2. Issue 2-2-4: For feasible relaxation scenarios, we also favor option 1 of case 1 and case 2. Issue 2-2-6: Option 2b. Maximum relaxation factor should be related to DRX cycle. Example 1: max relaxation factor is 8 for 40ms DRX cycle, 4 for 80ms DRX cycle, 2 for 160ms DRX cycle. Example 2: max relaxation factor is 4 for 40ms DRX cycle, 2 for 80ms DRX cycle, no relaxation for 160ms DRX cycle. Issue 2-2-7: Spec impact should be discussed in phase II. Issue 2-2-8: Option 2. Do not see the need to send LS on study phase conclusion.   |

**Sub-topic 2-3 Relaxation criteria**

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| **Company** | **Comments** |
| vivo | Issue 2-3-1: **Criteria of RLM/BFD relaxation – General**We support both option 1 and option 3. These two options are compatible.As discussed in issue 2-4-2, our view is that such low mobility condition does not necessarily need to be configured as some thresholds. If network indicates that UE can relax when it meets the cell quality threshold, then UE can relax when it actually meets such threshold. Network only configure the cell quality threshold when UE’s mobility is limited, e.g. indoor cell. If no thresholds are configured, it means such cell is some high mobility cell. Issue 2-3-2: **Good serving cell quality criteria of RLM/BFD relaxation**Option 1 is fine. We also prefer option 1a because if UE only relax RLM but not BFD, while both are configured, then the power saving gain would be lost.Issue 2-3-3: **what is the radio link quality in Issue 2-3-2**We support both option 1 and option 2. Down-selection between option 1 and option 2 can be FFS. In our view this is the issue for signaling design and can be further discussed in WI phase.Regarding option 3, we do not see the necessity to link relaxation of BFD with CBD. If UE exits from BFD relaxation, it does not necessarily mean BF happens. However, we are fine to have further study on option 3.Issue 2-3-4: **different threshold for SSB based and CSI-RS based RLM/BFD**We think option 1 is reasonable because different resources are considered. Issue 2-3-5: **Low mobility criteria of RLM/BFD relaxation**We prefer option option 2, 3, and 5. These options are compatible. However, for option 1, we also see it can be re-used in some scenarios.As discussed in issue 2-4-2, our view is that such low mobility condition does not necessarily need to be configured as some thresholds. If network indicates that UE can relax when it meets the cell quality threshold, then UE can relax when it actually meets such threshold. Network only configure the cell quality threshold when UE’s mobility is limited, e.g. indoor cell. If no thresholds are configured, it means such cell is some high mobility cell. Such details can be further discussed. In our view, RAN2 can be a better place.Issue 2-3-6: **Exiting criteria of RLM relaxation**We support option 2, 2a, 2b. We think at least option 2 and 2a can be agreeable.Option 1,3 can be regarded as special cases for option 2.Option 4 can be regarded as details for option 2, which is not precluded and can be further discussed.Option 2b is to ensure timely fall back when the SINR gets a sharp fall.Issue 2-3-7: **Exiting criteria of BFD relaxation**We support option 2, 2a, 2b. We think at least option 2 and 2a can be agreeable.Option 1,3,4,5 can be regarded as special cases for option 2.Option 2b is to ensure timely fall back when the SINR gets a sharp fall.Issue 2-3-8: **Alternative N310/N311 values in relaxation mode**This can be further discussed in WI phase, after we have conclusion in 2-3-6.Issue 2-3-9: **Re-entry to the RLM relaxation mode**FFSIssue 2-3-10: **Re-entry to the BFD relaxation mode**FFS |
| QC | **Issue 2-3-1: Criteria of RLM/BFD relaxation – General**Support option 1**Issue 2-3-2: Good serving cell quality criteria of RLM/BFD relaxation**Support option 1**Issue 2-3-3: what is the radio link quality in Issue 2-3-2**Support option 1, with the condition that SINR is the one derived for RLM/BFD evaluation.**Issue 2-3-4: different threshold for SSB based and CSI-RS based RLM/BFD**OK with option 1, but in our opinion, SSB based should be prioritized for discussion**Issue 2-3-5: Low mobility criteria of RLM/BFD relaxation**We support option 1.For option 2, the SINR from RLM/BFD is heavily filtered, which can not reflect the mobility status accurately and timely. Therefore, RSRP with less filtering is preferred.For option 3, we consider mobility condition as necessary, since it has been there for eMTC/NB-IOT and R16 idle mode relaxation. We don’t see significant difference in mobility condition between idle and connected mode.For option 4 and 5, since the threshold is configured by gNB, gNB can take whatever the condition it would like to consider to determine the threshold. Therefore, we believe option 4 and 5 can be combined with option 1.**Issue 2-3-6: Exiting criteria of RLM relaxation**For option 1, we believe that when low mobility condition is added to option 4, option 1 is included in option 4. We agree that low mobility condition should be added to option 4.For option 2, the problem is that a fixed threshold is given to UE. How to define this threshold becomes an issue, we prefer to have a more flexible approach as option 4.For option 3, the increase in additional delay on RLF declaration becomes a function of relaxation factor K. Option 3a has an additional delay of (K-1)\* Tevaluation. Option 3b,c,d has an additional delay of a\*(K-1)\*Tevaluation, where a is the number of OOS indicators sent under power saving mode.Option 4 is better from both UE implementation and system performance guarantee perspective:From UE implementation perspective, UE can determine the exit threshold and relaxation factor based on its measurement accuracy and different conditions, e.g., SINR, mobility etc. In fact, for an optimized system design, relaxation factor and measurement accuracy are the function of SINR. However, it is too complicated for RAN4 to specify different relaxation factors/exit threshold for different SINR conditions, leaving this to UE implementation can lead to best power saving for all Ues. The only concern is how can we guarantee system performance when we leave this to UE implementation.Option 4 addressed this concern for system performance by directly specifying the additional delay in the RAN4 spec as Tevaluation. While option 2 and 3 provide no guarantee or longer additional delay, option 4 guarantee the additional delay within Tevaluation, which better protect system performance.To Vivo: option 4 doesn’t specify the SINR threshold. If option 2 can leave SINR threshold and relaxation factor up to UE implementation, we can support option 2 and propose option 4 under option 2.**Issue 2-3-8: Alternative N310/N311 values in relaxation mode** If option 4 in issue 2-3-6 is agreed, UE is guaranteed to be in normal mode once UE starts to count N310/N311**Issue 2-3-9: Re-entry to the RLM relaxation mode**We are open to discuss adding a timer for blocking power saving mode after OOS is indicated. But for the proposed scheme, we have the following concern: (1) In practice, gNB has no idea whether UE revert to normal or is always in normal mode. Therefore, if we want to add a timer to block power saving mode, it should apply to all circumstances after OOS indication, regardless of UE is in power saving mode or not before OOS indication. (2) We don’t understand why the condition is specified as counting in-sync indication instead of timer. A timer makes more sense. |
| Apple  | Issue 2-3-1: Option 1 is preferred. Both serving cell quality and UE mobility criterion is needed. Issue 2-3-2: OK with option 1. Issue 2-3-3: Option is OK.Issue 2-3-4: Do not see the need to define different threshold for SSB versus CSI-RS based RLM/BFD Issue 2-3-5: Option 1, option 4 and option 5 are preferred. Issue 2-3-6: Option 1 and option 3 are preferred. Do not see the need to specify another set of thresholds. Issue 2-3-7: Both option 1 and option 3 are OK. Similar to 2-3-6, we do not see the need to define another set of thresholds. Issue 2-3-8: This depends on existing criterion discussed in 2-3-6. Issue 2-3-9: Re-entry and entry RLM relaxation mode can be the same.  |
| ZTE | **Issue 2-3-1: Criteria of RLM/BFD relaxation – General**Support option 1**Issue 2-3-6: Exiting criteria of RLM relaxation**Prefer Option 1. Having separated threshold seems not necessary and moreover, if there is a threshold for the UE to exit relaxation mode and the threshold is a different criterion other than the ones used for the UE to enter relaxation mode, ping-pong effect may arise. Option 1 is enough and quite clear.2-3-7: Option 3. |
| Xiaomi | Issue 2-3-1: Prefer Option 1.Issue 2-3-2: Option 1 is fine to us.Issue 2-3-3: Prefer Option 2. From the point of ensuring consistent behavior between different UEs, we think it is more appropriate to use BLER of hypothetical PDCCH as metric for the serving cell quality criteria.For Option 1, as the mapping between the SINR and BLER is determined by what receiver the UE implemented, if we use the SINR to evaluate, the SINR threshold value would have to be designed considering different UE implementation. We can further discuss.For Option 3, in our understanding, the BFD and CBD are separate procedure and there may be no strong connection between them.Issue 2-3-4: Prefer to come back to this issue after we have conclusion on issue 2-3-3.Issue 2-3-5: Prefer Option 1, Option 4 and Option 5.Issue 2-3-6: Prefer Option 2 and Option 3.Issue 2-3-7: Prefer Option 6, Option 2 is also fine to us.Issue 2-3-8: Wait for the conclusion from issue 2-3-6Issue 2-3-9: We don’t see the necessity to set re-entry condition. |
| Intel | **Issue 2-3-1:** Support Option 1. **Issue 2-3-2:** Generally fine with option 1 to choose a threshold. However, how to design the threshold, it’s FFS. For example, it can also be based on Qin+Margin or some other value. **Issue 2-3-3:** Support option 1 and option 3.For option 3, To vivo, it’s not linked to CBD. It only use the CBD condition to make sure that current beam is in good state to relax the BFD. CBD can be assumed as the In-sync condition of beam management. From our understanding, both RLM and BFD should be relaxed at least better than In-Sync condition. In-sync condition is different from RLM and BFD. For RLM, In-Sync means that SINR is higher than Qin threshold. Different from RLM, the criteria for good beam condition in BM satisfied that the measured L1-RSRP is equal to or better than the threshold Qin\_LR, which is indicated by higher layer parameter rsrp-ThresholdSSB.**Issue 2-3-5:** Support option 2.**Issue 2-3-6:** Support option 2a. Different radio link quality threshold for entering and exiting the relaxation is needed. Otherwise, UE will frequently enter and exit the relaxation. A margin between the thresholds can avoid ping-pong issue.**Issue 2-3-7:** Support option 2a. |
| CMCC | Issue 2-3-1: Criteria of RLM/BFD relaxation – GeneralWe support Option1. In RRC-CONNECTED relaxation (RLF/BFD), the SINR should be the major factor into the criteria. We should both consider the SINR value and SINR variation.Issue 2-3-2: Good serving cell quality criteria of RLM/BFD relaxationBasically, we support Option1 that radio link quality is better than a threshold. The threshold can be configured by network, if there is no configuration, then use a default value. Whether the threshold is same or different for RLM and BFD should be further studied.Issue 2-3-3: what is the radio link quality in Issue 2-3-2We support Option1 since SINR is the main factor in RLM/BFD. We also support Option 1a that the SINR variation during a time window should be considered. we capture this into low-mobility rule in our contribution, we are also OK to consider it in the radio link quality rule.Issue 2-3-5: Low mobility criteria of RLM/BFD relaxationWe support Option2 and Option2a. As the comments for Issue 2-3-3, we think the SINR variation during a time window should be considered, and we are both OK to capture this in low-mobility rule or capture this in serving cell’s quality rule.Issue 2-3-6: Exiting criteria of RLM/BFD relaxationWe support Option 3d and Option 3b.* In Option 3d, the number of consecutive out-of-sync indications should be configured by network, we propose to configure a new counter to UE
* The Option3b should combine with the precondition that new N310 value or new counter is configured to UE.

For Option1, if UE exit relaxation mode when any relaxation criterion is not met, then severe Ping-Pong affection will be caused since the channel quality degradation is common in real network.For Option2a, we think it can be used together with Option3d and/or Option3b. Option2a is suitable for the case that SINR drops slowly, Option3d and/or Option3b is suitable for the case that SINR drops quickly.For Option2b, the logic is similar to Option2a+ Option3d and/or Option3b. However, we concern about the accuracy of one-shot SNIR result.For Option 4, the RLF triggering latency can be guaranteed in an evaluation period. However, proper test case should be designed carefully, because the exiting threshold and the number of samples in the first evaluation period are all up to UE implementation.Issue 2-3-7: Exiting criteria of BFD relaxationFirst, we want to clarify that Option 5 is not our proposal, it is a typo in our contribution, sorry for the misleading. To avoid the confusion, we are OK to remove Option5.We support Option 4; UE should revert to normal BFD measurement after several BFI. We propose that network configure the number of “several BFI” by a new parameter or a new counter.Issue 2-3-8: Alternative N310/N311 values in relaxation modeWe support Option1 if Option3b in issue 2-3-6 is agreed.Issue 2-3-9: Re-entry to the RLM relaxation modeWe propose Option1 in our contribution, and we give more clarification here.We think after UE triggering the reverting, there should be a period of punish time to prevent UE to perform relaxation again. As we known, the relaxation should be performed under strict entering criteria, if reverting happens in this condition, it means channel quality is unstable which corresponds to two case. The first case is the channel quality is low and the variation is slow, in this case, the channel quality will not raise to entering threshold suddenly, the punish period can prevent extra relaxation evaluation. The second case is channel variation is fast, in this case, the punish period can avoid frequent “go into relaxation” and “fall back”.Issue 2-3-10: Re-entry to the BFD relaxation modeWe propose Option1 in our discussion paper, and the reason of Option1 is same with the comments in Issue 2-3-9. |

**Sub-topic 2-4 Relaxation scheme**

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| **Company** | **Comments** |
| XXX | Issue 2-4-1: **Relaxed evaluation period of RLM/BFD**We do not think it is necessary to scale the out-of-sync evaluation period K times, while K = 2,3,…, if limited system level impact needs to be considered.The extended evaluation period agreed in last meeting, in our understanding, is the interval between measurement samples for UE deriving RLM/BFD measurement results.Therefore, we further propose another option:Option 1c (or Option 2): If power saving conditions are satisfied, allow TEvaluate\_ps\_out\_SSB for the first OOS indication and the original TEvaluate\_out\_SSB doesn’t apply.

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| Configuration | TEvaluate\_ps\_out\_SSB (ms)  |
| no DRX | Max(200, Ceil(10 × P) × TSSB) |
| DRX cycle≤80ms | Max(200, Ceil(15 × P) × Max(TDRX,TSSB) + (K-1) × Max(TDRX,TSSB)) |
| 80ms<DRX cycle≤320ms | Max(200, Ceil(15 × 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, K is the relaxation factor. |

Issue 2-4-2: **Are the parameters of relaxation criteria predefined or configurable**We support option 2, 3a, and 3b.Option 4 is also acceptable, but we slightly not prefer it because scaling evaluation period 2 times is considered. In this case the impact to system is slightly higher. But we are open to further discussion.Issue 2-4-3: **network or UE to determine the relaxation criteria is fulfilled or not**We support option 1. Regarding option 1a, test cases are necessary.Issue 2-4-4a: **Different Relaxation factors between FR1 and FR2**Suggest to focus on 2-4-1 first. FFS.Issue 2-4-4b: **Different Relaxation factors for different SINR range**Suggest to focus on 2-4-1 first. FFS.Issue 2-4-4c: **Different Relaxation factors for different UE speed**Suggest to focus on 2-4-1 first. FFS.Issue 2-4-4e: **Different Relaxation factors for SSB and CSI-RS**Suggest to focus on 2-4-1 first. FFS.Issue 2-4-4f: **Different Relaxation factors for different DRX cycle**FFSIssue 2-4-5:For RRM, it is already agreed in RAN plenary and last RAN4.For RLM and BFD, we don’t think measurement accuracy requirements needs to be impacted. Such accuracy requirement is to ensure the UE performance at cell-edge condition, which is important to UE experience and network performance. However, how UE relax RLM and BFD in higher SINR should not have any impact to such requirements. |
| QC | **Issue 2-4-1: Relaxed evaluation period of RLM/BFD**We support option 1b. As we explained in issue 2-3-6, specifying the allowed additional delay in first OOS indication is beneficial to UE and system performance.Vivo’s proposal option 1c/2 is fine for us if DRx 80~320ms is updated to satisfy the DRx cycle monotonicity w.r.t. evaluation time. We think RAN4 spec can directly use K = 2, but we are open to discuss K>2. Note that even with K = 2, UE can implement relaxation of taking one observation per x DRx cycles, x is up to 10, but need to adjust its implementation of exit condition accordingly to satisfy the requirement.**Issue 2-4-2: Are the parameters of relaxation criteria predefined or configurable**For low mobility condition, we can agree with option 2. For the good cell/link quality condition to enter power saving mode, we also can agree with option 2. But for exiting condition, we support option 4.**Issue 2-4-3: network or UE to determine the relaxation criteria is fulfilled or not**Support option 1**Issue 2-4-4a: Different Relaxation factors between FR1 and FR2****Issue 2-4-4b: Different Relaxation factors for different SINR range****Issue 2-4-4c: Different Relaxation factors for different UE speed****Issue 2-4-4d: Different Relaxation factors for SSB and CSI-RS****Issue 2-4-4e: Different Relaxation factors for different DRX cycle**Support the option of “Relaxation factor and exit SINR threshold (for good cell quality condition) is up to UE implementation, but the “additional delay for first OOS indication” requirement has to be satisfied” for the above 5 issues**Issue 2-4-5: Measurement accuracy**Under our proposal, no measurement accuracy should be defined |
| Apple  | Issue 2-4-1: Option 1 is agreeble. Issue 2-4-2: Option 2. Network configure the criterion. Issue 2-4-3: Option 1. Issue 2-4-4a: Option 1. Different factors for FR1 and FR2 Issue 2-4-4b: Agree with WF. Issue 2-4-4c: FFS after mobility criterion is defined. Issue 2-4-4d: Agree with WFIssue 2-4-4e: Agree with WF.  |
| ZTE | 2-4-2:We actually want to suggest a new Option with a slightly different wording than Option 2. The original wording in our paper is “The relaxation criteria shall be configured by the network to the UE. If the threshold (criteria) is not configured, it means the UE cannot go into relaxation mode.”This means that there is no pre-defined threshold. The threshold must be configured by the network. If no threshold is configured, the UE cannot enter relaxation mode. Issue 2-4-3: **network or UE to determine the relaxation criteria is fulfilled or not**We support option 1a. The threshold must be configured by the network. |
| Xiaomi | Issue 2-4-1: Support Option 1.Issue 2-4-2: Option 2 is fine to us. Also agree with ZTE’s view.Issue 2-4-3: Support Option 1.Issue 2-4-4a: Support Option 1.Issue 2-4-4b: Wait the conclusion from other open issuesIssue 2-4-4c: Wait the conclusion from other open issuesIssue 2-4-4d: Support Option 1.Issue 2-4-4e: Support Option 1.Issue 2-4-4f: Wait the conclusion from other open issues |
| Intel | **Issue 2-4-2:** Option 2. Network configure the criterion. **Issue 2-4-3:** Option 1. |
| CMCC | Issue 2-4-1: Relaxed evaluation period of RLM/BFDWe think the definition of scaling factor should consider two factors below: RLM/BFD performance after relaxation The evaluation period after relaxation, which should be smaller or equal to a thresholdIssue 2-4-2: Are the parameters of relaxation criteria predefined or configurableWe support Option2.Issue 2-4-3: network or UE to determine the relaxation criteria is fulfilled or notSupport the Option1.Issue 2-4-4a: Different Relaxation factors between FR1 and FR2Basically, we think relaxation factors can be configured by network according to some rules that: RLM/BFD performance after relaxation The evaluation period after relaxation, which should be smaller or equal to a thresholdSo different relaxation factors can be applied.Issue 2-4-4b:Same views with the comments in Issue 2-4-4aIssue 2-4-4c:Same views with the comments in Issue 2-4-4aIssue 2-4-4e:Same views with the comments in Issue 2-4-4aIssue 2-4-4f: Other consideration on Relaxation factorsWe support Option3 here. Option3 is a rule for relaxation factor configuration, relaxation factor can configure to any value as long as the rule is fulfilled. |

**Sub-topic 2-5 Others**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Issue 2-5-1: **Entering relaxation mode in intra-band CA/DC**We support option 2 because UE measures only one CC as agreed in R16. This can be FFS.Issue 2-5-2: **Exiting relaxation mode in intra-band CA/DC**FFS.Issue 2-5-3: **Relaxation criteria in intra-band CA/DC**We support option 1 and 1a because UE measures only one CC as agreed in R16. FFSIssue 2-5-4: **Applicability for BFD relaxation requirement**Option 1 is fine. |
| Apple | Issue 2-5-1: Option 2. Relax for all other serving cells for UE power benefit. Issue 2-5-2: Agree with WF Issue 2-5-3: Option 1. Issue 2-5-4: Agree with option 1   |
| ZTE | **Issue 2-5-1:** Support Option 1. |
| Xiaomi | Issue 2-5-1: Support Option 2.Issue 2-5-2: Support Option 1.Issue 2-5-3: Support Option 1.Issue 2-5-4: Support Option 1. |
| Intel | **Issue 2-5-3:** Support Option 1. |
| CMCC | Issue 2-5-1: Entering relaxation mode in intra-band CA/DCFor this issue, we support Option1. The UE behavior under Option1 is same with the UE behavior under Option2 in most cases, since the measurement results for intra-band cells is same based on our common understanding. However, when the conner case happens that the measurement results for intra-band cells have large gap, or when the relaxation criteria for sPCell and Scell is different, Option1 can guarantee the network performance.Issue 2-5-2: Exiting relaxation mode in intra-band CA/DCFor this issue, we want to add a new proposal:For intra-band CA/DC, if UE meets the conditions of reverting to the normal RLM/BFD in the serving cell(s), it is expected the reversion operations are applied to the serving cell(s).We are Ok with Option1.Issue 2-5-3: Relaxation criteria in intra-band CA/DCWe support Option2 that if relaxation criteria can be configured by network, theoretically, SpCells and SCells can be configured with different RLM/BFD measurement relaxation criteria. Issue 2-5-4: Applicability for BFD relaxation requirementIn our view, the BFD relaxation requirement is applicable for the serving cells which perform measurement relaxation. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

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

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

Notes:

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

## 2nd round

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

Notes:

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