**3GPP TSG-RAN WG4 Meeting # 100-e R4-2115348**

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

**Agenda item:** 9.14

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

**Title:** WF on RLM/BFD relaxation for UE Power Saving enhancements

**Document for:** Information

# Introduction

This document is to capture the all agreements in RAN4#100-e in email thread #228 on RLM/BFD relaxation for UE Power Saving enhancements.

*No CR/TPs are treated during this meeting*

*Agreements from the GTW*

# WF

## Sub-topic 1 Relaxation applicability

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

When neither serving cell quality criteria nor low mobility criteria is configured, the existing RLM/BFD requirements shall apply.

* Note: It can be revisited if
  + dedicated or broadcast signalling to indicate the UE when it is allowed to relax the RLM/BFD measurements is agreed, or
  + good serving cell criteria is agreed to be predefined.

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

* Option 1: No. It is up to network.
* Option 2: Yes.

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

* Option 1: No. It is up to network.
* Option 2: Yes.

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

If the UE applies a DRX cycle longer than 80ms, the UE is assumed not to perform relaxed RLM/BFD measurements and the existing RLM/BFD requirements would apply.

## Sub-topic 2 Low mobility criteria

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

* Agreements:
  + Low mobility criteria
    - Reuse Rel-16 low mobility criterion based on L3 RSRP measurement variation.
      * FFS the RSs for L3 RSRP measurement

## Sub-topic 3 Good serving cell quality criteria

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

* + Option 1: reuse the legacy definition of the SINR for radio link quality evaluation of RLM/BFD.
  + Option 2: L3-SINR. RSRQ and RSRP can also be used as serving cell quality metric for UE that does not support the optional L3-SINR measurement.

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

* Option 1: The thresholds are configured to the UE by the network.
* Option 2: The thresholds is predefined.
* Option 3: The offset values X to UE for deriving the threshold
  + Option 3a: The offset values are configured to the UE by the network.
  + Option 3b: The offset value(s) are predefined

Note: Values of X are discussed in issue 3-3-1/3-3-2

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

The good serving cell quality criteria for RLM is

* Option 1: radio link quality > Qout + X (dB).
  + Value of X is FFS.
    - Option a: X may depend on TSSB and TDRX
    - Option b: X may depend on scenarios, i.e., RS types (SSB/CSI-RS), frequency range
    - Other options are not precluded
* Option 2: radio link quality > Qin + X (dB).
  + Value of X is FFS.
    - Option a: X may depend on TSSB and TDRX
    - Option b: X may depend on scenarios, i.e., RS types (SSB/CSI-RS), frequency range
    - Other options are not precluded
* Other options are not precluded

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

The good serving cell quality criteria for BFD is

* Option 1: radio link quality > Qout\_LR + Y (dB).
  + Value of Y is FFS.
    - Option a: Y may depend on TSSB and TDRX
    - Option b: Y may depend on scenarios, i.e., RS types (SSB/CSI-RS), frequency range
    - Other options are not precluded
* Option 2: radio link quality > Qin\_LR + Y (dB).
  + Value of Y is FFS.
    - Option a: Y may depend on TSSB and TDRX
    - Option b: Y may depend on scenarios, i.e., RS types (SSB/CSI-RS), frequency range
    - Other options are not precluded
* Other options are not precluded

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

* Option 1: the same thresholds used for good serving cell quality and low mobility criteria are applied for both RLM relaxation and BFD relaxation
* Option 2: different threshold should be allowed.

## Sub-topic 4 Exiting Relaxation criteria

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

* Background:
* Agreement in RAN4 98-e-Bis meeting:
  + *The UE while performing relaxed RLM upon detecting certain number of out-of-sync indications or upon triggering T310 or upon observed link quality degradation or mobility state change reverts to the normal RLM operation (i.e. without relaxation).*
* Agreement in RAN4 99-e-Bis meeting:
  + *If the UE fulfills any of serving cell quality exit condition or low mobility exit condition, or DRX cycle length is NOT allowed for relaxation, UE will exit relaxation mode.*
    - *Note1: Whether the exit condition for serving cell quality is explicitly specified or not is up to issue 2-3-2.*
    - *Note2: FFS the details of the exit condition of low mobility’*

Additional criteria are discussed below.

* Option 1: Exit RLM relaxation mode when any relaxation criterion is not met, or when N310 starts to count. No additional exit criterion needs to be defined.
* Option 2: Reuse Qout as the radio link quality threshold. Exit relaxation mode when the radio link quality is worse than Qout
* Option 3: Introduce a radio link quality threshold higher than Qout. Exit relaxation mode when the radio link quality is worse than a SINR threshold (Thexit ).
  + Option 3a: Thexit = SINRenter with a hysteresis value
  + Option 3b: Thexit = SINRenter – 3dB
  + Option 3c: Thexit > Qout
  + Option 3d: Thexit = Qout+7dB or Qin
* Option 4: No additional criteria are needed, previous agreement from 98-e-bis and 99-e-bis are sufficient.

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

No additional exit criterion for low mobility, i.e. UE exit low mobility state as long as the entering condition is not met.

## Sub-topic 5 During Relaxation mode

**Issue 5-1: Whether to specify UE behavior in the relaxation mode**

* RAN4 does not specify UE RLM/BFD relaxation behaviour in the spec but to specify the evaluation period during for relaxation

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

Previous agreement:

Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on max(TDRX, TSSB) [R4-2105797].

* RAN4 specify the new evaluation period based on Max(T, Ceil([Y] x P x N) x Max(TDRX, TRLM-RS/BFD-RS))
  + where Y is K \* current Rel-15 samples, and K is the predefined relaxation factor.
  + where T is the lower bound of relaxed evaluation period. FFS whether the relaxation factor K to be applied on T.
  + Scaling factor K is defining the relaxed RLM/BFD evaluation period is defined based on max(TDRX, TSSB).
  + Note: 1.5 scaling factor is considered in current Rel-15 samples.

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

* Option 1: Yes, also lower bound of relaxed evaluation period is also relaxed.
* Option 2: No.

**Issue 5-3: relaxation factors**

Previous agreement:

Scaling factor defining the relaxed RLM/BFD evaluation period is defined based on max(TDRX, TSSB) [R4-2105797].

* + The following aspects can be considered when specify the relaxation factor:
    - different relaxation factors for FR1 and FR2
    - different relaxation factors for SSB and CSI-RS
    - FFS different relaxation factors for different SINR regions
  + FFS the exact value of relaxation factors
    - Option 1:
      * K=1 for 80 ms < TSSB ≤ 160 ms
      * K=4 for MAX(TDRX, TSSB) ≤ 80 ms
    - Option 2:
      * K=2 for MAX(TDRX, TSSB) ≤ 40 ms in FR1
      * K=1.5 for 40ms < MAX(TDRX, TSSB) ≤ 80 ms in FR1
      * FFS K for FR2.
    - Option 3:
      * K=4 for MAX(TDRX, TSSB) ≤ 80 ms in FR1
      * K=2 for MAX(TDRX, TSSB) ≤ 80 ms in FR2
    - Option 4: Relaxation factors are different for FR1 and FR2, for the different SINR regions.
    - Other options are not precluded

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

* Option 1: UE indicates OOS during relaxation mode.
* Option 2: UE is not required to send the first OOS indication to higher layers during relaxation mode.
* Option 2a: UE indicate OOS right at exiting relaxation mode
* Option 3: Left to UE implementation.
* Option 4: the UE shall continue evaluate the serving cell quality and send out-of-sync indications when the measured SINR becomes worse than Qout threshold and follow the associated procedures (including N310 counters.), i.e. same as in legacy RLM procedure

## Sub-topic 6 Other Aspects

**Issue 6-1: Specification structure**

* Option 1: Relaxed RLM/BFD requirements are introduced in new subsections within the existing RLM/BFD sections TS 38.133.
* Option 2: introduce new table for relaxation evaluation period into the current subsections.

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

* When BFD measurements are configured on SCell
  + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, the UE is allowed the operate in relaxed mode for RLM and/or BFD if UE has fulfilled the relaxation criteria for both RLM and BFD.
  + For intra-band CA with CSI-RS based RLM on SpCell and CSI-RS based BFD in SCell, if UE has failed to fulfil the relaxation criteria for any of RLM and BFD, then the UE is not allowed to operate in relaxed mode in RLM and BFD in any of the cells.
  + Note: This can be revisited upon clarification on the SCell BFD requirements in R16 eMIMO maintenance.
* When BFD measurements are configured on SpCell
  + For intra-band CA, whether to allow RLM/BFD relaxation depends upon whether both RLM and BFD measurements on SpCell fulfil the relaxation criterion.

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

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

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

FFS:

* For the case of NR-DC and inter-band CA, whether UE needs to evaluate the entering/exiting conditions for each serving cell configured for either RLM and/or BFD evaluation.
* For the case of NR-DC and inter-band CA, whether UE is allowed to relax RLM/BFD if it meets the relaxation criterion in other serving cells