**3GPP TSG-RAN WG2 Meeting #116-e R2-210xxxx**

**Online, November 1 – 12, 2021**

**Source: Xiaomi**

**Title: Summary of [AT116-e][036][ePowSav] RLM/BFD relaxation (Xiaomi)**

**Agenda Item: 8.9.3**

**Document for: Discussion and Decision**

# Introduction

This contribution provides a summary of the following email discussion:

**RLM BFD relaxation**

* [AT116-e][036][ePowSav] RLM/BFD relaxation (XIaomi)

Scope: Progress the topics of RLM/BFD relaxation based on contributions to this meeting. Identify agreements, and potential discussion points. Converge as much as possible offline. Cb Online if needed.

Intended outcome: Report with Agreements

Deadline: Wednesday W2 (Online CB if needed)

There could be online CB on Wednesday W2 if needed, therefore the deadline is: Monday W2 Nov 8 10:00 UTC

# Contact information

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| --- | --- | --- |
| Company | Name | Email address |
| Xiaomi | Rao Shi | shirao@xiaomi.com |
| Samsung | Anil Agiwal | anilag@samsung.com |
| MediaTek | Li-Chuan TSENG | li-chuan.tseng@mediatek.com |
| OPPO | Haitao Li | lihaitao@oppo.com |
| Interdigital | Brian Martin | [Brian.martin@interdigital.com](mailto:Brian.martin@interdigital.com) |
| Huawei, HiSilicon | Jagdeep Singh | jagdeep.singh6@huawei.com |
| LGE | SangWon Kim | sangwon7.kim@lge.com |
| Vivo | Chenli | Chenli5g@vivo.com |
| CATT | Pierre Bertrand | pierrebertrand@catt.cn |
| Intel | Seau Sian im | seau.s.lim@intel.com |
| Qualcomm | Linhai He | linhaihe@qti.qualcomm.com |
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# Discussion

In RAN4#100 meeting, an LS[1] on criteria for RLM/BFD relaxation has been sent to RAN2. And RAN4 respectfully ask RAN2 to take the conclusions made by RAN4 into considerations and start work in RAN2. RAN2 may work on at least following aspects:

- Specify corresponding signaling for the relaxation criteria defined by RAN4.

Therefore, RAN2 should be responsible for starting to research RLM/BFD relaxation from RAN2 perspective.

## Signaling related for RLM/BFD relaxation criteria

### Provision for parameters of criteria

For the low mobility criteria, RAN4 have achieved agreements so far as follows:

* *Low mobility criterion (in RAN4#100e)*
  + *Reuse Rel-16 low mobility criterion based on L3 RSRP measurement variation.*
    - *FFS the RSs for L3 RSRP measurement*

For the cell quality criterion, RAN4 have achieved agreements so far as follows:

* *Good serving cell quality criteria of RLM/BFD relaxation is defined as the radio link quality is better than a threshold. The radio link quality in good serving cell quality criteria for R17 RLM/BFD relaxation is based on SINR. (in RAN4 #98e-bis)*
* *UE reuse the SINR for RLM/BFD evaluation when determine whether the serving cell quality criteria is fulfilled or not (in RAN4 #99e)*
* *FFS: (in RAN4#100e)*
  + *SINR definition for good serving cell quality criterion*
  + *Predefined or configured threshold*

As we can see from RAN4 agreements, the low mobility criterion for RLM/BFD relaxation is reused based on Rel-16 RRM relaxation, which means there would be two parameters (i.e. SSearchDeltaP and TSearchDeltaP) configured by network. And for the cell quality criterion, some parameters may also require network configuration (e.g. threshold and offset). Therefore RAN2 should be responsible for providing parameters of criterion to UE if RAN4 decides to provide parameters instead of predefined or by implementation.

Some companies [3][4][5] mentioned that using dedicated RRC signalling to provide the RLM/NFD configuration is more reasonable. Here rapporteur think there could be two options (note that the pre-condition is that RAN4 decides to provide parameters instead of predefined or by implementation):

**Option 1:** Dedicated signalling (e.g. *RadioLinkMonitoringConfig*), which is applicable for the corresponding UE

**Option 2:** Broadcast signalling, which is applicable for all UEs in this cell

**Q1: Which option above do companies support if RAN4 decides to provide parameters instead of predefined or by implementation?**

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| --- | --- | --- |
| **Company** | **Option 1/2** | **Comments** |
| Samsung | Option 1 | As the UE is in connected state, dedicated signaling can be used for the configuration. |
| MediaTek | Option 1 |  |
| OPPO | Option 1 |  |
| Interdigital | Option 1 |  |
| Huawei, HiSilicon | Option 1 | Dedicated signaling is more suitable for RRC\_connected state. |
| LGE | Option 1 |  |
| Vivo | Option 1 | Considering the RLM/BFD configuration in RadioLinkMonitoringConfig is dedicated signaling in BWP-DownlinkDedicated, it is more reasonable to also configure the RLM/BFD relaxation in dedicated signaling. Besides, different UEs may have different requirements on traffics or service levels. UE specific configuration in dedicated signaling could provide more flexibility. |
| CATT | Option 1 |  |
| Intel | Option 1 | Since the feature is just for connected mode |
| Qualcomm | Option 1 |  |

### Network enable and disable

In RAN4#98bis meeting, it was agreed that *network to enable and disable this feature*, which means the RLM/BFD relaxation should be configured and controlled by network. Some companies [4][5][6][7] mentioned this and considered that the network can enable/disable relaxed RLM/BFD via explicit or implicit way.

For this part, as RAN4 has not yet decided the final criteria, RAN2 is not sure whether there is configuration for corresponding criteria. For example, if the threshold of cell quality criterion is predefined or low mobility is evaluated by implementation, there would not be configuration for criteria. Therefore explicit indication (e.g. 1bit) should be introduced to enable/disable the RLM/BFD relaxation. On the contrary, if the parameters of criteria are configurable, then it is better to implicitly indicate to UE.

It is also noted that RAN4 has concluded that *whether relaxed RLM/BFD requirements can be applied depends on both the serving cell quality and UE mobility state*, it seems only both criteria are fulfilled that UE can perform RLM/BFD relaxation. Therefore, if one criterion is configurable and another is predefined or implementation, network still can implicitly indicate to UE based on that one configurable criterion.

Therefore, rapporteur suggests that:

**Proposal: The enable and disable for RLM/BFD relaxation should be controlled by network as follow:**

* **If the relaxation criteria is configurable, network implicitly indicates enable/disable by the presence/absent of configuration for RLM/BFD relaxation in signalling.**
* **If no any configuration is needed for RLM/BFD relaxation (e.g. based on predefined or implementation), explicit indication is introduced to enable/disable the RLM/BFD relaxation.**

**Q2: Do companies agree with the above proposal and if not, please provide your suggested change?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Interdigital | Yes |  |
| Huawei, HiSilicon | Yes |  |
| LGE | Yes |  |
| vivo | Yes | Some comments on the wording:  **If the relaxation criteria is configurable, network implicitly indicates enable/disable by the presence/absent of configuration for RLM/BFD relaxation criteria in signalling.** |
| CATT | Yes |  |
| Intel | Yes | But we can wait for further RAN4 progress whether the criteria is predefined or configured. |
| Qualcomm | Yes | We also agree with the wording suggested by vivo |

### UE capability

In last section, we talked about the network capability to enable/disable RLM/BFD relaxation. Here, rapporteur thinks from RAN2 perspective, we also need to consider the UE capability for RLM/BFD relaxation as this is an optional feature.

Referring to Rel-16 RRM relaxation, the UE capability of supporting RRM relaxation is optional features without UE radio access capability parameters. However, since UE performs RLM and BFD in RRC\_CONNECTED, it is straightforward to use AS capability procedure (i.e. *UECapabilityInformation*) to report UE capability. Therefore there could be some options to design UE capability:

**Option 1:** Using AS capability procedure to report UE capability

**Option 2:** Reusing Rel-16 RRM relaxation mechanism (i.e. optional features without UE radio access capability parameters)

**Option 3:** Other

**Q3: Which option above do companies support to design UE capability of supporting RLM/BFD relaxation?**

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| --- | --- | --- |
| **Company** | **Option 1/2/3** | **Comments** |
| Samsung | Option 1 | *UECapabilityInformation*  can be used as UE is in connected state. |
| MediaTek | Option 1 |  |
| OPPO | Option 1 |  |
| Interdigital | Option 1 |  |
| Huawei, HiSilicon | Option 1 | RLM/BFD relaxation is a mechanism used in RRC\_connected state, thus an AS capability is needed. On the other hand Rel-16 RRM relaxation mechanism (i.e. optional features without UE radio access capability parameters signalling) is for RRC\_idle/inactive state and hence reusing this mechanism is not suitable for RLM/BFD relaxation. |
| LGE | Option 1 |  |
| vivo | Option 1 |  |
| CATT | Option 1 | The network can decide if RLM/BFD relaxation is enabled via dedicated signaling based on the UE capability. |
| Intel | Option 1 | UE capability signalling is definitely needed for this in order for the network to configure RLM/BFD relaxation |
| Qualcomm | Option 1 |  |

### The independence of RLM and BFD relaxation

Actually, RLM and BFD are two different mechanisms that RLM is monitored by UE for RLF in RRC layer and BFD is monitored by UE for BFR in MAC layer. Some companies [3][5][7] mentioned that whether RLM and BFD can be enabled/disabled separately can be further studied. For example, the network may consider RLM (applying on SpCell) is important and can not be relaxed while BFD can be relaxed with certain conditions (e.g. if only applied to SCells).

(BTW, Rapporteur reminds that DCCA scenario will be discussed in next question)

**Q4: Do companies agree that the network can enable/disable RLM and BFD relaxation separately (e.g. UE is configured relaxation for BFD but not for RLM)?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | No | In our understanding, according to RAN4 LS criterion to perform RLM and BFD relaxation are same i.e. same thresholds etc. are applied. So it is not clear why RLM relaxation can be applied while the BFD relaxation is not applied or vice versa. |
| MediaTek | No |  |
| OPPO | See comments | Not sure about the intention of the question. BFD is applied for each serving cell, but RLM is only performed on SpCell. It depends on the granularity by which NW enable/disable RLM and BFD relaxation, e.g. per serving cell, or per cell group, or per UE? We think this issue should be first resolved.  Rapporteur:  Thanks for comments~ but please note that this question is to discuss whether RLM and BFD relaxation are bind or not. For example, network only configures BFD relaxation (no matter per-CC or per-UE), but not to configure RLM relaxation. |
| Interdigital | No | Unless use-case identified. |
| Huawei, HiSilicon | Yes | We think enabling/disabling RLM and BFD relaxation separately gives flexibility for NW implementation and is better for system performance. Besides, we understand the same criterion can be applied to RLM/BFD but the threshold for RLM/BFD can be different. |
| LGE | Maybe yes, | If explicit indication is introduced to enable/disable the RLM/BFD relaxation, the separate indication can be considered. |
| vivo | No? or Depends | It depends on the scenarios:  In SA scenario, we donot see the motivation to enable/disable RLM and BFR relaxation separately. Unless any use case is identified.  In DC/CA scenario, only BFD could be performed on Scell. In this case, whether BFD relaxation could be enabled/disabled separately depends on the control granularity from network side. |
| CATT | Yes | According to RAN4 LS, it is unclear if RLM and BFD relaxation can be enabled/disabled separately. And we need to support the flexibility. |
| Intel | Yes | It can be left to network to decide whether to enable both or just one of them on the SpCell. Anyway, we can first discuss the BFD and RLM criteria/measurement granularity |
| Qualcomm | Yes | RLM is performed on SpCell only, whereas BFD can be performed on either SpCell or SCell. And in case of inter-band or mixed-FR CA, SpCell and SCell can be located in different bands/FRs. So network should have the flexibility in configuring and controlling RLM and BFD relaxation independently. |

### RLM/BFD relaxation in DCCA scenario

RAN4 has confirmed that *Relaxed BFD/RLM requirements shall be supported for all deployment scenarios supported by current specification which includes: NR SA, EN-DC, NE-DC, NR intra-band CA, NR inter-band CA and NR-DC.* And some companies[2][3][4][7] mentioned that for RLM procedure, it is performed by UE in SpCell and BFD can be performed in PCell/PSCell/SCell. For example, considering DC may be deployed cross FR, MN is deployed on FR1 while SN is deployed on FR2. There would be different FR1 and FR2 requirements for RLM/BFD. Also different serving cell can have different requirement for BFD monitoring. Thus whether the configuration of RLM/BFD relaxation in different cell should be separate or not can be considered.

Therefore there are some considerations from RAN2 perspective for RLM/BFD relaxation in DCCA scenario:

**Q5.1: Do companies agree that RLM relaxation can be configured separately between MCG and SCG in DC case?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| MediaTek | Yes |  |
| OPPO | See comments | This depends on the detailed relaxation criteria. If we reuse legacy low mobility and not-cell-edge criteria, then we don’t see the need for separate configuration between MCG and SCG. However, if we introduce beam-specific relaxation criteria, then I guess the configuration for MCG and SCG can be different. |
| Interdigital | Yes |  |
| Huawei, HiSilicon | Yes |  |
| LGE | Yes |  |
| vivo | Yes | For RLM procedure, the corresponding timers and counters to determine RLF is configured separately between MCG and SCG. Considering DC may be deployed cross FR, e.g. MN is deployed on FR1, while SN is deployed on FR2. There would be different requirements FR1 and FR2 for RLM/BFD. Thus, the configuration (e.g. threshold) should be separate between MCG and SCG.  For BFD, it could be performed separately on Pcell/Pscell and Scell, there will be higher power consumption and more flexibility if Pcell/PScell and Scell could be performed relaxation separately. |
| CATT | Yes |  |
| Intel | Yes |  |
| Qualcomm | Yes |  |

**Q5.2: Do companies agree that BFD relaxation can be configured separately between PCell/PSCell and SCell?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes |  |
| MediaTek | Yes |  |
| OPPO |  | See comments for Q5.1. |
| Interdigital | Yes |  |
| Huawei, HiSilicon | Yes |  |
| LGE | Yes |  |
| vivo | Depends | If BFD relaxation could be configured per-CC, it may not consistent with RLM relaxation. It could be further discussed based on the detailed design for BFD relaxation methods and corresponding criteria, which is still being discussed in RAN4. |
| CATT | Yes |  |
| Intel | Maybe | Needs to wait for further progress from RAN4. |
| Qualcomm | Yes | See our comment to Q4 |

### UE report of fulfilling and leaving criteria

Two companies[5][6] mentioned this, as UE shall monitor RLM/BFD in RRC\_CONNECTED which is important for the continuity of service. Any relaxation in RRC\_CONNECTED should be careful. Referring to Rel-17 RRM relaxation for redcap in RRC\_CONNECTED, when UE fulfills the criteria, the UE needs to inform network that the criterion is fulfilled, and the network indicate whether the UE can perform RRM measurement relaxation or not. Similarly, for RLM/BFD relaxation, such a mechanism could also be considered.

**Q6: Do companies agree that there should be a UE report mechanism when RLM/BFD relaxation is fulfilled and/or exit (but details can be further studied)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | Yes | Similar approach as redcap can be considered |
| MediaTek | Yes |  |
| OPPO | Yes |  |
| Interdigital | Yes |  |
| Huawei, HiSilicon | Yes | Similar approach as redcap can be considered as both are related to RRC\_connected state. |
| LGE | Yes |  |
| vivo | Partial Yes | We could agree in principle that UE should report to network when RLM/BFD relaxation is fulfilled/exit. But when need the UE to report, and which information needs to be reported, and how does the network/UE to perform relaxation needs further discussed based on RAN4 progress. |
| CATT |  | We need check further with RAN4. And if it is agreed, we need to further clarify network enable and disable (i.e. Q2) only means whether RLM/BFD relaxation criteria is fulfilled and/or exit. |
| Intel | No for now | It is unclear how such report can be used by the network to decide whether UE can perform or exit RLM/BFD relaxation. Maybe more details are needed before we can agree to such proposals which seem more as a potential enhancement.  This is also linked to where the criteria are specified as in Q8 as the enabling of the relaxation can be handled as part of the RRM framework where the criteria can be viewed as just RRM events. It also depends on how RAN4 relax the measurement and the performance, which may not justify the need of such reporting. |
| Qualcomm | No | Presence of relaxation criteria and parameter(s) for relaxation methods (e.g. scaling factor for measurement periodicity) indicates network enables relaxation.  When UE has met the configured relaxation criteria, UE applies relaxation.  When UE no long meets the relaxation criteria, UE stops applying relaxation methods and fallback to its default measurement configuration.  As we may see from the above, entry and exit for relaxation can be performed by UE itself. Having UE report to network that it has met or no long meets relaxation criteria and network then signals UE to apply or stop relaxation is an unnecessary overhead for both UE and network. |

## Issues related to RAN4

### The definition of low mobility criterion for BFD relaxation

RAN4 has concluded that *Reuse Rel-16 low mobility criterion based on L3 RSRP measurement variation*. According to companies contributions[2][4], some think Rel-16 low mobility criterion is designed to evaluate UE “L3 mobility” which is unaware of beam change. For example, UE circling around the cell is still considered as a low mobility UE, but BFR will happen therefore it is not suitable for BFD relaxation.

For this part, rapporteur think as least for this moment, RAN4 is still discussing what RS will be used for L3 RSRP in low mobility criterion. But anyway we can provide some information to RAN4 from RAN2 perspective since the corresponding criteria will be captured in RAN2 specification.

Therefore there are some suggestions for low mobility criteria for BFD relaxation:

**Option 1:** Using beam-level measurement

**Option 2:** Introducing beam-change related criterion

**Option 3:** Using the difference in SINR between the weakest BFD-RS and the strongest candidate beam which is not QCL with the weakest BFD RS is larger than a configured threshold.

**Option 4:** Waiting for RAN4 (maybe inform RAN4 of the concern about low mobility criterion for BFD from RAN2 perspective)

**Q7: Which option above do companies support to consider low mobility criterion for BFD relaxation?**

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| --- | --- | --- |
| **Company** | **Option 1/2/3/4** | **Comments** |
| Samsung | See comments | Since the criterion is defined by RAN4, we can wait for RAN4 decision. |
| MediaTek | Option 4 | According to the WID, the criteria should be discussed in RAN4. We should avoid parallel discussions in two WGs. |
| OPPO | Option 4 | Agree with Samsung and MediaTek. |
| Interdigital | Option 4 |  |
| Huawei, HiSilicon | Option 4 |  |
| LGE | Option 4 |  |
| vivo | Option 1, 2, 3, 4 | Based on our information from RAN4, there is some relevant discussion in RAN4 about this issue. Thus, we could just wait for RAN4 progress. |
| CATT | Option 4 |  |
| Intel | Option 4 | Just wait for RAN4 since our understanding is that this is currently being discussed in RAN4 whether additional criterion is needed. |
| Qualcomm | Option 1, 2, 3, 4 |  |

### Responsibility between RAN2 and RAN4 for specification

Referring to Rel-16 RRM relaxation, there are some misunderstanding between RAN2 and RAN4 as some criteria and relaxed methods are put into both RAN2 and RAN4 specification. Therefore rapporteur thinks we can make the responsibility more clearly. Three companies[4][5][8] mentioned this part. With this relaxation procedure, one way is that RAN4 specification should capture the relaxed methods as well as the corresponding requirements for RLM/BFD relaxation, while RAN2 specification should capture the relaxation criteria as well as the RRC configurations. Rapporteur also wants to remind that RLM is handled by RRC layer while BFD is handle by MAC layer. So furthermore RAN2 can capture RLM relaxation criteria in RRC aspect (i.e. TS 38.331) and BFD relaxation criteria in MAC aspect (i.e. TS 38.321). However there is still argument[8] that the relaxed RLM/BFD criterion are discussed in RAN4 and captured in 38.133. Anyway rapporteur think we can proposal a suggestion as way forward.

**Proposal: The relaxation methods as well as the corresponding requirements for RLM/BFD relaxation should be captured in RAN4 specification, while the criteria as well as the configurations should be captured in RAN2 specification(e.g. RLM captured in TS 38.331 and BFD captured in TS 38.321).**

**Q8: Do companies agree with the above proposal and if not, please provide your suggested change?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | No | Configuration aspects are captured in RRC. Detailed criterion is specified in 38.133 |
| MediaTek | No | The criteria are defined by RAN4, and should also be captured in RAN4 specifications (38.133) |
| OPPO | No | Same view as Samsung. |
| Interdigital | No | We assume only the configuration needs to be specified in RAN2 specs unless RAN4 request something specific. |
| Huawei, HiSilicon | - | Generally agree that RAN4 specification captures the relaxation methods as well as the corresponding requirements for RLM/BFD relaxation, while RAN2 specification captures the relaxation criteria as well as the RRC configurations. The details can be discussed further. |
| LGE | No | Same view as Samsung |
| vivo | Yes | Similar as Rel-16, for the relaxation procedure, RAN4 specification should capture the relaxed approaches as well as the corresponding requirements for relaxed RLM/BFD measurement, while RAN2 specification should capture the relaxation criteria as well as the RRC configurations. |
| CATT |  | Share the same view with Huawei. |
| Intel | Wait for RAN4 | Our understanding is that this will be discussed in RAN4 and we can wait for RAN4 to decide whether the criteria are to be included in RAN4 specs or RAN2 specs. From the LS, RAN4 asked RAN2 to discuss:  Specify corresponding signalling for the relaxation criteria defined by RAN4  RAN4 is also discussing this. |
| Qualcomm | No | Not sure why we need to discuss this in an email discussion.  In any case, configuration aspects should be captured in 38.331. Relaxation criteria should be captured in 38.133. Procedural aspects should be captured in 38.213. No impact on 38.321 is expected. |

## LS information to RAN4

Once RAN2 has reached some agreements, rapporteur wonders whether to provide our suggestions to RAN4 as a reference for future work.

**Q9: Do companies agree to send an LS about our RAN2 suggestions to RAN4 as a reference for future work?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comments** |
| Samsung | No strong view | We can follow majority view. |
| MediaTek | No | According to the WID, RAN2 should do RLM/BFD works based on RAN4 results. We can simply wait for RAN4. |
| OPPO | No | Agree with MediaTek. |
| Interdigital | No strong view | It doesn’t hurt to update RAN4 with our progress, but on the other hand there doesn’t seem to be any critical aspect discussed, most of the questions above have obvious answers. |
| Huawei, HiSilicon | No strong view | We can follow majority view. |
| Vivo | No | Agree with MediaTek. As RAN4 has ongoing discussion, we could just wait for their inputs. |
| CATT | No strong view | We can decide it if there is any issue that needs to be clarified further in RAN4 with latest agreements. |
| Intel |  | We can check what agreements we have made before making this decision. |
| Qualcomm | - | We can decide after we make some agreements. No need to discuss this now. |
|  |  |  |

## Other issues

If companies raise some issues which are not mentioned in this contribution, please provide your opinions here.

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| **Company** | **Comments** |
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3. Conclusion

4. Reference

1. R2-2109362\_R4-2115349 LS on criteria for RLM/BFD relaxation
2. R2-2109454 Criteria and configuration for BFD relaxations Qualcomm Incorporated
3. R2-2109879 Signalling aspect on criteria of RLM/BFD relaxation Intel Corporation
4. R2-2109739 RAN2 impact on RLM/BFD relaxation for power saving vivo
5. R2-2110194 Discussion on RLM\_BFD measurement relaxation Xiaomi Communications
6. R2-2110541 Discussion on criteria for the RLM/BFD relaxation Huawei, HiSilicon
7. R2-2110404 Configurations for RLM/BFD Relaxation CATT
8. R2-2110414 Other aspects on UE power saving Ericsson