**3GPP TSG-RAN2 Meeting #114-e R2-210xxxx**

**Online, May 19 – 27, 2021**

**Agenda Item: 9.1.4**

**Source: Huawei, HiSilicon**

**Title: Report of email discussion [351] NB-IoT RLF measurements (Huawei)**

**Document for: Discussion and decision**

# Introduction

This document is the report of the email discussion “[Post113bis-e][351][NBIOT/eMTC R17] NB-IoT RLF measurements (Huawei)”, as indicated below:

* [post113bis-e][351][NBIOT/eMTC R17] NB-IoT RLF measurements (Huawei)

Scope: Taking into account the reply LS from RAN4, discuss only the following 4 questions:

1. What is/are the triggering condition(s) for measurements to start (RSRP, out of sync, other)?
2. What does the network need to configure (parameters/assistance info) to the UE and how (dedicated/broadcast)?
3. What information (if any) is needed to be sent by the UE to the NW?
4. What is the trigger to perform re-establishment (legacy, early RLF, other)?

Intended outcome: Report to the next meeting

Deadline: long

# Discussion

## Triggering condition(s) for measurements to start

The following proposals for triggering measurements are made in contributions [2] - [8]:

|  |  |
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| Tdoc | Proposals |
| R2-2103014 [2] | Proposal 1: After UE has sent RAI it should not trigger neighbour cell measurements. |
| R2-2103241[4] | Proposal 2: If multiple triggers (e.g., a configured threshold of RSRP/RSRQ, T310) are applied to trigger neighbour cell measurement before RLF, the neighbour cell measurement would be triggered whichever the configured threshold of RSRP/RSRQ is met or T310 starts. |
| R2-2103320[5] | Proposal 3: The serving cell quality can be used as the triggering condition. |
| R2-2103394[6] | Proposal2: The neighbor cell measurement could be triggered based on the below two options:  • Option1, the neighbour cell measurement could be trigger when the serving cell channel quality is lower than a threshold.  • Option2, the neighbour cell measurement could be triggered after n number of consecutive "out-of-sync" indications for Pcell is detected. |
| R2-2103486[7] | Proposal 4: Consider a combination of the following criteria for starting the measurements:  • “the serving cell quality is lower than a threshold” and “the serving cell has decreased more than a threshold over a given time”  • n consecutive "out-of-sync" indications for PCell is detected  Proposal 5: Define a criteria for stopping the measurements once started. |
| R2-2103925[8] | Proposal 2 From a RAN2 perspective the UE should perform the measurement only during T310. |

In the reply LS [1], RAN4 indicated:

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| * From RAN4 point of view:   + UE starts performing the neighbour cell measurements when the serving cell quality deteriorates   + There should be mechanism to stop the neighbour cell measurement.   + It is up to RAN2 to decide the triggering condition for starting and stopping the neighbor cell measurements |

Trigger(s) to start the measurements:

The following triggers and conditions are mentioned in the above documents:

1. After UE has sent RAI it should not trigger neighbour cell measurements [2]
2. The serving cell channel quality is lower than a threshold [4], [5], [6] and [7]
3. The serving cell has decreased more than a threshold over a given time [7]
4. T310 starts [4]
5. after n number of consecutive "out-of-sync" indications for Pcell is detected [4], [6] and [7]
6. other

Q1a: Companies are requested to indicate for each option listed above, whether it should be considered or not in the triggering condition(s). Please indicate whether some options should be combined with other and any other comments as deemed necessary.

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| **Company** | **for each option a…e**  **yes/no** | **Detailed comments** |
| ZTE | b) or combination of b) and d)  Condition a) can be seen as a special process on top of b)  e) can be considered if b) have no majority support | According to RAN4 LS [1], RAN4 has agreed two kinds of time length needed for cell detection during connected mode: 1400 ms for the target cell in normal coverage and 14800 ms for the target cell in enhanced coverage. The condition b), e.g., serving cell channel quality deterioration can provide reasonable starting point of the neighbor cell measurement and make the cell detection before RLF feasible and fruitful in most cases, e.g., no matter UE in normal coverage or enhanced coverage.  Moreover, for condition b), we have the following detailed considerations:  With reference to current different thresholds for triggering intra-frequency measurements and inter-frequency measurements for UE in idle mode, e.g., *SIntraSearchP* and *SnonIntraSearchP*, we think also two different thresholds can be considered for connected mode measurements, e.g., with consideration on deployment situation, the NW can prioritize intra-frequency measurements with an “easy-to-satisfy” threshold while deprioritize inter-frequency measurements with another a bit strict threshold.  Based on our previous roughly calculation, we think the condition d) “T310 starts” may cause the trigger of measurement too late in most cases, especially for the UE in enhanced coverage. E.g., with such trigger condition, in most case, UE may not be able to have enough time to complete even one measurement before T310 expires. So we disagree with separate condition d). However, it may be possible to take condition d) as a complement to condition b), e.g., if T310 is already started and the UE still has not yet triggered connected mode measurement based on condition b), UE can directly trigger measurement along with start of T310.  The condition e) is similar to condition d) but can be earlier than d). We assume it’s a separate threshold for consecutive "out-of-sync" indications and the maximum value of this threshold would be N310. The condition e) can be seen as a condition to mainly reflect service transmission quality (a bit different from condition b) which mainly reflects radio channel quality). We are open to further discuss it.  Therefore, we prefer condition b) or can be acceptable to combination of b) and d), or open to discuss condition e).  The condition a) can be seen as a special process. If UE has not triggered measurement but sent RAI, even if the condition b) is fulfilled, the UE can choose not to start measurement as it’s highly possible that the connection would be released soon.  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  We have negative views for the following conditions:  The condition c) is a kind of condition which mainly reflects the fluctuation of the serving cell quality. As the target of the related process is to early find a suitable target cell, we don’t think fluctuation of the serving cell quality is suitable. For example, it is possible that the serving cell quality decreases a bit but the quality is still not so bad. In such case, we cannot see why the connected mode measurement needs to be triggered. Moreover, for such condition, we may need to further discuss whether and how to initialize/update RSRP reference, we see unnecessary complicity. |
| Lenovo | a) No  b) Yes  c) No  d) No  e) Yes | For a), it is possible that one shot of data could be successfully transmitted when UE is moving to neighbour cell, but it is also possible that the one shot of data could not be transmitted successfully during UE moving to another cell. So it is not an prerequisite condition to not trigger the neighbour cell measurement.  For b), yes, it is similar to the legacy rule on “s-Measure” criterion, which could be reused here.  For c), it is not clear about the given time in option.c, the option.b is also to evaluate the channel quality in a duration as the s-measure rule. In our view, option.c) has the same function as the option.b).  For d) and e), it seems that e) is more flexible, where the number of consecutive "out-of-sync" indications could be same or different from the one for T310.  Generally, we think that b) or e) could be used for neighbour cell measurement. If the network decides to make a strict trigger condition, the b) and e) could be used as a combined one. |
| Vodafone | **b** | In order to keep things simple, regular RSRP/RSRQ measuremtns will be sufficient for this purpose |
| Huawei, HiSilicon | a) no  b) yes  c) no  d) no  e) no | a) Even if the UE has sent RAI, RLF can happen and the UE is supposed to initiate RRC Connection Re-establishment so having measurements available is still helpful.  b) This is simple and we think this should be the primary criteria as this reflects the radio conditions. It also allows to perform measurement e.g. during a RACH procedure during which there is no RL monitoring.  However, it may lead to a UE using coverage enhancements to measure neighbour continuously, which should be avoided. Thus a complementary condition may be needed or left to UE implementation.  c) Not on its own as this is not as indication in itself that connection is bad. this could be a complementary conditions to b)  d) Although this is a clear indication that the connection is bad, we think it is too late for the UE to find a cell before RLF actually happens. It also does not work if the UE is performing RACH procedure.  e) Preferable to d) as it will allow to start measurements earlier but may still not be early enough. |

Trigger(s) to stop the measurements (as per RAN4 LS):

Q1b: Companies are requested to provide comments whether a trigger to stop the measurement as suggested by RAN4 should be defined or not. Please provide additional comments as necessary.

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| **Company** | **yes/no** | **Detailed comments** |
| ZTE | No | Here we understand a trigger for stopping the measurement means that, after triggering measurement and before RLF detection, the UE may temporarily stop or interrupt the measurement if the serving cell quality increases again. For such process, a threshold may be needed for determining whether the serving cell quality has become well enough. However, we don’t think such process is necessary as we think it’s more reasonable to let the UE complete the measurement as soon as the measurement is started. UE can stop the measurement after getting the results. If the measurement is stopped in halfway, it will cause the measurement previously performed in vain and cause unnecessary waste.  On the other hand, if a trigger to stop the measurement is allowed, in a case that radio quality fluctuates, it may cause frequent start and stop of measurement.  Finally, even if the UE can stop measurement in halfway, the eNB cannot resume the data scheduling that was suspended previously, unless the eNB can be explicitly informed the stop of measurement. So the benefits of such process would be very limited. |
| Lenovo | Yes | If the channel quality becomes better, or something like the “in-of-syn” is happened, the measurement could be stopped.  In our view, RAN2 could give some suggested starting/stopping conditions to RAN4, then RAN4 could evaluate it based on RAN2 input. |
| Vodafone | **Yes** | We would requirte a trigger to measure the Cell’s signal strengths when it is:   1. the signal strength is decreasing below a shreshold 2. the signal strnegth to increase above the threshold |
| Huawei, HiSilicon | yes | In the same way that the radio conditions can worsen, they can also improve so it is beneficial to have a ‘stop’ criteria. We assume that the criteria can the counterpart of the criteria for starting the measurements. |

## Network configuration

The following proposals for triggering measurements are made in contributions [3] - [8]:

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| --- | --- |
| Tdoc | Proposals |
| R2-2103191 [3] | Proposal 1: Network assistance information for connected mode measurements should be supported. FFS Parameters of network assistance.  Proposal 3: Network assistance information for early measurements should support inclusion of selected system information parameters for faster re-establishment. FFS selected subset of system information parameters. |
| R2-2103241[4] | Proposal 2: If multiple triggers (e.g., a configured threshold of RSRP/RSRQ, T310) are applied to trigger neighbour cell measurement before RLF, the neighbour cell measurement would be triggered whichever the configured threshold of RSRP/RSRQ is met or T310 starts. |
| R2-2103320[5] | Proposal 4: Network provides measurement configuration, e.g., the neighbor frequency, neighbor cells and triggering conditions via dedicated RRC signaling. |
| R2-2103394[6] | Proposal3: The neighbour cell measurement could follow the parameter such as the frequency priority information configured in SIB for cell reselection, it is UE implementation which cell is selected as the target cell. |
| R2-2103486[7] | Proposal 7: NW configures the criteria to start / stop the measurements. |

The following configuration / assistance information are mentioned in the above documents:

a) Assistance information for connected mode measurements [3], [5] and [6]

b) Selected system information parameters for faster re-establishment [3]

c) Configuration of the criteria to start the measurements [5], [6] and [7]

d) Configuration of the criteria to stop the measurements [7]

e) other

Q2: Companies are requested to indicate for each option listed above, whether it should be considered or not in the triggering condition(s). Please indicate whether the information should be provided via broadcast or dedicated signalling and any additional comments as deemed necessary.

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| **Company** | **for each option a…d**  **yes/no** | **Detailed comments** |
| ZTE | Yes for network configuration from network to UE  a) and c) can be contents of network configuration. | For a), in order to narrow down the measurement range and simplify UE’s measurement, the network can configure the dedicated neighbour frequency, and/or neighbour cells for the UE to measurement. In [3], there is another view that network may also take the time required for neighbor cell detection into consideration and may configure this value as assistance information for connected mode measurements. We cannot see the necessity and think the time required for neighbor cell detection can just follow the RAN4 requirement.  For c), via configuration of the criteria to start the measurements, the network can control the starting point of the neighbor cell measurement so that the UE can complete effective measurements as far as possible before RLF. As mentioned in Q1, such criteria can be a common threshold or several different thresholds. We assume such criteria can be provided via dedicated signalling (e.g., Msg4). If there is thinking that such information may be somewhat stable, provision via SIB may be also ok.  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  We have negative views for the following:  For b), it’s mainly used for decreasing SI acquisition time. In [3], company has mentioned that, as UE does not need all of the system information for cell selection and only a subset of system information is needed for initial access, the essential parts of target cell system information can be provided as network assistance information. However, generally, we think this cannot be discussed before we agree to further reduce SI acquisition time. Moreover, we don’t think the scheme is so feasible as the serving cell almost cannot know which cell will possibly be the target cell.  For d), as explained in Q1, we think criteria to stop the measurement is not needed. |
| Lenovo | a) Yes  b) Yes  c) Yes | Generally, all these options could be supported. For the details on the broadcast or dedicated signalling, it could be defined after we have a clear understanding to the triggering condition and the stopping condition on the measurement. |
| Vodafone | **Yes to broadcast approach** | The Broadcast approach is simple and the information can be sent in one of the SIBs |
| Huawei, HiSilicon | a) yes  b) no  c) and d) yes | We are supporting a broadcast approach as we do not see any of this being UE specific.  a) we think assistance information to limit the number of cells the UE should search could be useful, i.e. a whitelist for the serving and inter-frequency  b) this looks like assisted re-establishment. Although it could be nice, we think it is beyond the scope of the WID.  c) We think it would be beneficial to have network assistance (e.g. the NW has better understanding of the coverage of the cell).  In addition, network control may be necessary depending on the details of the solution, i.e. if UE assistance information (as discussed in 2.3) and/or ‘early RLF’ (as discussed in 2.4) are supported. |

## UE assistance information

The following proposals for UE assistance are made in contributions [3] - [8]:

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| Tdoc | Proposals |
| R2-2103191[3] | Proposal 2: Adaptation of triggering condition for connected mode measurements should be considered. |
| R2-2103320[5] | Proposal 5: Some information, such as the measured cell in idle mode, can be sent from UE to the network. |
| R2-2103394[6] | Proposal4: The assistant information including the candidate neighbour cell information could be reported to help eNB deliver the UE context to several neighbor eNB. |
| R2-2103486[7] | Proposal 6: UE informs the eNB when it starts/stops measurements requiring gaps. |

The following assistance information from the UE are mentioned in the above documents:

a) Assistance information for adaptation of triggering condition for connected mode measurements [3]

b) Measured cell(s) in idle mode [5]

c) The candidate neighbour cell [6]

d) Indication when UE starts/stops measurements requiring gaps [7]

f) other

Q3: Companies are requested to indicate for each option listed above, whether the information should be reported or not. Please provide any additional comments as deemed necessary.

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| **Company** | **for each option a…f**  **yes/no** | **Detailed comments** |
| ZTE | Yes for assistance information from UE to network  Prefer b)  Ok to discuss a) and d) (if needed) | For b), in order to facilitate eNB to provide more suitable measurement configuration, e.g., only configuration of the neighbour frequency (ies)/cell(s) just around the UE, some assistant information, e.g., the measured cell in idle mode may be helpful and can be sent from UE to eNB.  For a), it’s more like a SON function. As mentioned in [3], during RRC reestablishment procedure, UE can report some information related to effectiveness of connected mode measurement, e.g., whether the selected target cell was already known via measurements at the time of RLF. Based on such information, NW may be clearer whether the measurement configuration and/or trigger condition are suitable or not and can make use of this information to further optimize the triggering condition. We think such report from UE may be useful to NW and are open to further discuss it.  For d), it is more related to another issue, e.g., whether it’s feasible to perform connected mode measurement by using free sub-frames. If it’s infeasible to make use of free sub-frames, we think such explicit measurement start/stop indication from UE might be needed.  \*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*  We have negative views for the following:  For c), we have a doubt on the benefit of proactively providing UE context from serving cell to several candidate neighbour cells (generally serving cell only provides UE context to other cells when receiving request). And we are also not clear how the UE to report assistance information. If UE only provides one candidate neighbour cell to serving eNB, there might be risk this candidate neighbour cell is not the final target cell after RLF and then the provision of UE context to this candidate neighbour cell would be wasteful. If UE provides several candidate neighbour cells to serving eNB, the above risk can be reduced but not eliminated. Moreover, the (big) signalling overhead over S1/Ng interface might be almost unacceptable. |
| Lenovo | a) Yes  b) Yes  c) Yes  d) No | For a), b), c), UE will report the possible candidate cells to gNB, then gNB could adjust the parameters on the measurement triggering condition, or prepare the possible RRC re-establishment procedure over the Xn interface.  For d), it is doubted since it is common understanding that the gap is sufficient in NB-IOT case. |
| Vodafone | **other options** | The options shown above are not necessary nor useful |
| Huawei, HiSilicon | a) no  b) no  c) no  d) maybe | a) The proposal looks like SON. We think this is out of the scope.  b) First, we think neighbour cell information via broadcast signalling is sufficient. Then, we not sure that the reporting of neighbour cells is allowed w/o AS security and we wonder when / under which conditions this information will be reported by the UE. Finally, in the case of a long connection and a mobile UE, the information can be completely out of date.  c) The justification for the proposal is for early forwarding of the UE context to the target eNB. We think that delays on X2/Xn are negligible and do not need to be optimised.  Then similar to b) we wonder when / under which conditions this information will be reported by the UE  d) It could be useful for the eNB to know, e.g. to adapt the scheduling for the UE to be able to perform the measurements. But it will add complexity and signalling overhead and probably not worth it. |

## Trigger to perform re-establishment

The following proposals for triggering measurements are made in contributions [3] - [8]:

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| Tdoc | Proposals |
| R2-2103014[2] | Proposal 2: After UE has sent RAI it should not trigger early RLF. |
| R2-2103320[5] | Proposal 1: It’s suggested not to support earlier declaration of RLF, e.g., with introduction of T312. |
| R2-2103486[7] | Proposal 8: Agree on introducing early RLF. Details to be discussed. |
| R2-2103925[8] | Proposal 3 RAN2 to discuss the usefulness of fast RLF for NB-IOT |

The following triggers to perform RRC Connection re-establishment are mentioned in the above documents:

a) After UE has sent RAI it should not trigger early RLF [2]

b) Early RLF [7]

c) legacy RLF

d) other

Q4: Companies are requested to indicate for each option listed above, whether the trigger/condition should be supported or not. Please provide any additional comments as deemed necessary.

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| **Company** | **for each option a…d**  **yes/no** | **Detailed comments** |
| ZTE | It’s hard to say yes or no as we only consider legacy RLF trigger  c) | A short T312 would reduce the opportunity of recovery from packet loss and inevitably lead to an increase in occurrences of RLF, so the benefit of introducing T312 to NB-IoT is unconvincing. We don’t think RAN2 companies can have enough time to perform detailed evaluation for this part. Hence, it’s suggested not to support earlier declaration of RLF based on T312.  In [7], there is no detailed evaluation to show the benefit and address the disadvantage. The analysis are only based on some assumptions. We have the following considerations on those assumptions:   * Firstly, we disagree the observation that in R17 typical use case, the connection will only become worse and that RLF will happen. In hetnet, such observation may be valid as the cell coverage is small and it’s easy for UE to move out the current cell. But for NB-IoT, even mobility might be typical in R17, as the NB-IoT cell is still a large coverage cell, it’s still highly possible the UE’s radio quality fluctuates other than continuing to become worse. Then we should still try to avoid decreasing the chance of recovery. Moreover, in Q1, we already analyse it’s unnecessary to introduce a trigger about serving cell quality fluctuation. Yes, in some cases, the serving cell quality may keep getting worse, but in other cases this may be not the case. Therefore, we think only a simple absolute threshold for serving cell quality may be enough. * Secondly, even we agree more mobility cases are for UE in outdoor and with good coverage, we still disagree the restriction that the R17 re-establishment enhancements can only be applicable to UE in good coverage. The benefit of connected mode measurement for UE in enhanced coverage cannot be ignored. * Thirdly, we disagree that T310 is always set to the maximum value of 8000 ms as this highly depends on network implementation. Therefore, the maximum benefit of 8s of early RLF are not so convincing.   In a summary, without much convincing assumptions, we still have doubt on the feasibility and benefit of early RLF trigger. |
| Lenovo | a) No  b) FFS  c) Yes | For a), please see our comment to Q1a.  For b) and c), the legacy RLF such as with introduction of the T312 may be sufficient to support the UE fast moving among the cells. |
| Vodafone | **Early RLF** | A new trimer such as T310-bis with shorter period e.g. 2 seconds,  This timer, T310-bis, would kicks in once the UE has located a good neighbouring cell and tried to regitsr in it.  It is also proposed to maintain/support the legacy T310 Timer |
| Huawei, HiSilicon | **a**) yes  b) yes  c) yes | a) we agree that if no more data are expected, there is no rush to trigger RLF (no latency / bad user experience issue) and it is better to wait in the hope that the connection can be released.  b) as described in the paper, it is obvious that triggering cell selection early will be beneficial in some use cases (i.e. when the UE has more data to send and the connection is degrading). This could be e.g. a separate shorter T310 applied when UE is performing the measurements, or could be based on detection of a more suitable cell.  c) of course, the legacy triggers should still be supported. |

# Conclusion

TBD

# Reference

1. R4-2105800 Reply LS on neighbour cell measurement in NB-IoT RRC\_CONNECTED state, RAN4, April 2021

1. [R2-2103014](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103014.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103014.zip) Condition for NB-IoT connected mode neighbour cell measurement Qualcomm Incorporated

1. [R2-2103191](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103191.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103191.zip) Signalling procedure for connected mode measurements support for reestablishment time reduction Nokia

1. [R2-2103241](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103241.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103241.zip) Further discussion on the corresponding measurement before RLF Spreadtrum Communications

1. [R2-2103320](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103320.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103320.zip) RAN2 aspects of measurement in connected mode ZTE Corporation, Sanechips

1. [R2-2103394](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103394.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103394.zip) Neighbor cell measurements triggering before RLF Lenovo, Motorola Mobility

1. [R2-2103486](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103486.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103486.zip) Neighbour cell measurements in RRC\_CONNECTED Huawei, HiSilicon

1. [R2-2103925](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103925.zip" \o "https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_113bis-e/Docs/R2-2103925.zip) Discussion on Fast RLF Recovery procedures in NB-IoT Ericsson

# Participants

|  |  |  |
| --- | --- | --- |
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