3GPP TSG-RAN WG2 #123 R2-23xxxxx

Toulouse, France, August 21st – 25th 2023

Agenda Item: 7.13.1

Source: Ericsson

Title: [Post122][590][R18 SON/MDT] Open issues of SON NR-U (Ericsson)

Document for: Discussion, Decision

# Introduction

This document is to address the following email discussion:

* **[Post122][590][R18 SON/MDT] Open issues of SON NR-U (Ericsson)**

Scope: The above issues which marked as FFS.

Intended outcome: Report which is assumed to have the consensus on how to handle these issues.

Deadline: Long

Related to NR-U, the following agreements have been taken so far in RAN2:

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| **From RAN2#119-bis:**  Agreements:  1 The UE will log information of multiple RA procedures related to consistent LBT failures. FFS details.    Agreements:  1 Introduce a new raPurpose in the RA-Report to indicate that the RA was initiated following a “consistent LBT failures” in the SpCell.  2 RAN2 agree to log kind of “the number of LBT failures” in the RA report.  LBT failure is the failure to access the channel before transmission.  The definition of “the number of LBT failures” should be clarified.  FFS how to log the number of LBT failures in the RA report.  **From RAN2#121:**  Agreements:  1: Log the last successful RA procedure related information in the RA report. Only some information to be logged for multiple successive RA procedures failed due to LBT issue. FFS what information.  **From RAN2#122:**  Agreements:  1 Only the preamble transmission attempts for which LBT was successful are represented in the “per RA attempt info list” for a given beam.  2 On how to represent the preamble transmission attempts blocked by LBT,  Introduce a field (or reusing the existing field) that counts the number of preamble transmissions blocked by LBT per RA procedure, and a flag indicating transmission failures experienced right before beam switching. Details can FFS.  3 For the RA-Report, the enhancements on the handling of the “per RA attempt info list” (i.e. as per Proposal 1) apply only to the last RA procedure in the last BWP prior to the random access success.  4 For the other BWPs in which the UE experienced the consistent LBT failure, the UE logs in the RA-InformationCommon:  a. The locationAndBandwidth information of the BWP  b. The subcarrierSpacing information of the BWP  c. The absoluteFrequencyPointA information of the BWP ( How to log once for all the BWPs of the cell is FFS)  5 As baseline, RAN2 assumes the following:  a. Enhancements discussed for the RA-InformationCommon for the RA-Report are applicable also to the RLF-Report  b. The detailed “per RA attempt info” are only reported in the RLF-Report for the last RA procedure before RLF/HOF, FFS whereas limited information are reported for the other BWPs in which consistent LBT failure is detected  c. The above bullets may be revisited case by case depending on future agreements.  6 The UE logs RA-InformationCommon including LBT info in the RLF-Report, in case of HOF and when the RLF cause is randomAccessProblem or beamFailureRecoveryFailure (as in legacy).  7 The UE logs the available RSSI measurement in the RLF-Report. FFS in which case.  8 The UE should log the following RSSI values in the RLF-Report:  a. For RLF, the latest measured RSSI of the NR-U channel of the last serving cell if measRSSI-ReportConfig is configured for the corresponding frequency.  b. FFS: For HOF, the latest measured RSSI of the NR-U channel of the source cell, and the latest measured RSSI of the NR-U channel of the target cell, if measRSSI-ReportConfig is configured for the corresponding frequency. |

From the email discussion in R2-2306558 [1], the following FFS were captured in the chairman notes:

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| **FFS captures in RAN2#122 chairman notes:**  => Next meeting the discussion on NR-U will focus on the following FFS issues.  Proposal 9 FFS: The UE logs in the RLF-Report the BWP information (at least the locationAndBandwidth, and the subcarrierSpacing) of all the BWPs in which the UE detected the consistent UL LBT failures right before the RLF/HOF.  Proposal 21 FFS: Related to the target cell, the UE logs in the SHR the random access information, same as for the RA- and RLF-Report, i.e. including the number of UL LBT failures during HO (depending on the outcome of Proposal 2), and the information on the multiple BWPs (depending on the outcome of Proposal 4) in which consistent UL LBT failures was triggered. FFS on the trigger conditions to log.  Proposal 23 FFS: RAN2 to discuss what LBT information (if any) related to the source cell of the HO should be included in the SHR.  Proposal 11 FFS:Support these further options on when to log the RA-InformationCommon including LBT info in the RLF-Report:  b. When the RLF cause is lbtFailure, and the UE was performing random access in other BWPs due to triggered consistent UL LBT failures  Proposal 18 FFS: UE to log indication on whether the detected power at the moment of LBT failure was above the configured EDT threshold (maxEnergyDetectionThreshold).  Proposal 6 , 19 and 20 also FFS. |

# Discussion

## 2.1 RA-Report enhancements

### 2.1.1 Issue#1: How to represent the preamble transmission attempts blocked by LBT for the last BWP

Related to this issue, the following agreement was taken in RAN2#122 meeting:

**From RAN2#122:**

On how to represent the preamble transmission attempts blocked by LBT,

Introduce a field (or reusing the existing field) that counts the number of preamble transmissions blocked by LBT per RA procedure, and a flag indicating transmission failures experienced right before beam switching. Details can FFS.

RAN2 should then discuss the text in green in the above agreement. Namely, whether the number of preamble transmissions blocked by LBT per RA procedure are represented by a new field or by an existing field. In particular, in [R2-2304031](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304031.zip), Xiaomi proposes leveraging on the fields numberOfPreamblesSentOnSSB and numberOfPreamblesSentOnCSI-RS, such that the number of preamble transmissions blocked by LBT are represented by numberOfPreamblesSentOnSSB - the size of PerRAAttemptInfoList.  
Rapporteur notes that the legacy meaning of numberOfPreamblesSentOnSSB and numberOfPreamblesSentOnCSI-RS is the following:

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| ***numberOfPreamblesSentOnSSB***  This field is used to indicate the total number of successive RA preambles that were transmitted on the corresponding SS/PBCH block. |

Hence, this option would imply changing the legacy definition of numberOfPreamblesSentOnSSB and numberOfPreamblesSentOnCSI-RS, since currently only the RA preambles transmitted would be counted, whereas according to the proposal in [R2-2304031](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304031.zip), the RA preambles that were blocked by LBT should also be considered. Consequently, clarifications on the corresponding procedural text are needed as well. Rapporteur also notes that the maximum number of numberOfPreamblesSentOnSSB (numberOfPreamblesSentOnCSI-RS) is limited to 200, which was dimensioned considering only the RA preambles actually transmitted. If now, this field also considers the preambles blocked by LBT, the total numberOfPreamblesSentOnSSB (numberOfPreamblesSentOnCSI-RS) might exceed 200.

* **Q1: For the last BWP, how do we represent the preamble transmission attempts blocked by LBT?**
  1. **Introduce a field that counts the number of preamble transmissions blocked by LBT per RA procedure.**
  2. **Modify the field description and procedural text of the legacy fields numberOfPreamblesSentOnSSB and numberOfPreamblesSentOnCSI-RS, such that all the RA preambles, i.e. both the ones transmitted and the ones blocked by LBT, are counted**

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| Company | Preferred Option (a,b) | Comments |
| Qualcomm | B | Prefer option B. This option avoids a non-NBC change, where a beam may be selected but there may not be any preamble transmission, i.e., numberOfPreamblesSentOnSSB or numberOfPreamblesSentOnCSI-RS starting from 0. |
| Samsung | A | As described by the Rapp, the maximum number of numberOfPreamblesSentOnSSB (numberOfPreamblesSentOnCSI-RS) is limited to 200, which was dimensioned considering only the RA preambles actually transmitted. If the preamble transmissions blocked by LBT are also considered, this need to be changed and we think this change can be more complex.  Regarding the case “a beam may be selected but there may not be any preamble transmission, i.e., numberOfPreamblesSentOnSSB or numberOfPreamblesSentOnCSI-RS starting from 0”, this can be further discussed. There were already many solutions in the papers in the previous meetings, which are feasible and relatively simpler than going with option B. |
| Ericsson | A | We agree with Samsung. The approach B would imply changing the size of numberOfPreamblesSentOnSSB/ numberOfPreamblesSentOnCSI-RS which is currently limited to 200. Otherwise, an inaccurate number of LBT failures may be derived. Approach A is cleaner.  The issue highlighted by Qualcomm can be addressed separately, as proposed by Samsung. |
| CATT | A | Hope not to change the legacy description to the numberOfPreamblesSentOnSSB. This IE means the preamble transmitted without LBT failure, which has the same definition and aligned to what we have agreed to RA attempt.  For some SSB or CSI-RS on which UE tried the preamble transmission but totally failed due to LBT failure, which could be discussed further to see the necessarity and how to solve it. |
| Xiaomi | B | For the case that preamble fails on all the beams, and UE has to record at least one PerRAInfo-r16, which means at least one numberOfPreamblesSentOnSSB or numberOfPreamblesSentOnCSI-RS. As the minimum value of numberOfPreamblesSentOnSSB or numberOfPreamblesSentOnCSI-RS is one, it would require other solutions for network to understand that the reported value 1 doesn’t mean 1 successful transmission. It would complicate the specification.  Regarding the comment that the size of the number of preamble attempts would exceed 200, we don’t see this as an issue. If the total number is above 200, UE simply report 200. Reporting the number of additional LBT failures above the maximum 200 doesn’t provide any useful information for network to know. |
| Lenovo | A | Similar view as Samsung. |
| Nokia | A |  |
| Sharp | A |  |
| Huawei, HiSilicon | A | Agree with Samsung. |
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### 2.1.2 Issue#2: What to log for the other BWPs (except the last one) in which the UE experienced the consistent LBT failure

Related to what to log for the other BWPs (except the last one) in which the UE experienced the consistent LBT failure, RAN2 agreed to include the following BWP information:

**From RAN#122:**

For the other BWPs in which the UE experienced the consistent LBT failure, the UE logs in the RA-InformationCommon:

* a. The locationAndBandwidth information of the BWP
* b. The subcarrierSpacing information of the BWP
* c. The absoluteFrequencyPointA information of the BWP ( How to log once for all the BWPs of the cell is FFS)

From the reading of the above agreement, the information related to all the BWPs (including the first one) in which the UE experienced the UL consistent LBT failure prior to the successful completion of the RA should be included in the RA-Report. This view seems to be supported also by the majority of companies in the email discussion [1]. However, Rapporteur would like to confirm this:

* **Q2: Do you agree that as per the above agreement in RAN2#122, all the BWPs (including the first one) in which the UE experienced the consistent UL LBT failure, prior to the successful completion of the RA, should be included in the RA-Report?**

**If not, please explain your reason.**

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| Company | Yes/No | Comments |
| Qualcomm | Yes | UE already logs C. Therefore, no need for c for other BWP. |
| Samsung | Yes | Same view as QCT. C is already logged. |
| Ericsson | Yes |  |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| Nokia | Yes |  |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes |  |
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Besides what already agreed above, RAN2 further discussed the inclusion of the number of LBT failures experienced in the other BWPs used during the RA (except the last one for which as already agreed we will have more detailed information).

The majority of the companies (6/11) (see replies to Q4 in [1]) were in favor of it, however that was not agreed since one company argued that the number of LBT failures experienced in the other BWPs (except the last one) will always be equal to the configured *lbt-FailureInstanceMaxCount*, since the UE switches BWP when the amount of LBT failures reaches *lbt-FailureInstanceMaxCount.* However, this is not correct, since as per TS 38.321, the LBT\_COUNTER can be reset during the RA in a BWP (e.g. if the *lbt-FailureDetectionTimer* expires). This means that the overall amount of LBT failures experienced in a BWP might be higher than the configured *lbt-FailureInstanceMaxCount.*

* **Q3: Should the UE log in the RA-Report the number of LBT failures experienced in each BWP (except the last one) used during the RA?**

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| Company | Yes/No | Comments |
| Qualcomm | No | Note that UE switches the BWP only when the maximum number of configured LBT transmissions are met. The fact that UE has switched the BWP, implies that UE has reached the maximum number of LBT attempts on that BWP. Therefore, reporting the number of LBT failures is not required.  If the BWP information is included, then this implicitly implies that max number of LBT failures has been reached. No need to include the number of LBT experienced in other BWPs (apart from the last one). |
| Samsung | No | Same view as QCT. |
| Ericsson | Yes | The QC comment is not accurate from spec point of view. The overall number of failures in a BWP may be actually higher than the configured max number of LBT failures, because the counter which counts the LBT failure may be reset during the RA procedure (e.g. if the *lbt-FailureDetectionTimer* expires ). Hence this parameter can be beneficial. |
| CATT | No | Agree Ericsson’s analysis to LBT procedure, but the failed RA procedure on BWP because of the consistent LBT failure already gives the indication that this BWP is not suitable because of LBT, which has been agreed by us, the detailed information on the total number of LBT failures maybe not necessary. |
| Xiaomi | No | Not sure how network would use the number of LBT failures. |
| Lenovo | Yes | Agree with Ericsson. |
| Nokia | Yes | Provided that the rapporteur’s information is correct that the number LBT failures can deviate from “max number of LBT failures” resulting in BWP switch, it might be useful to estimate BWP quality for RA. |
| Sharp | No | Share the same view as CATT. |
| Huawei, HiSilicon | Yes | We agree with Ericsson. It has been specified that the *LBT\_COUNTER* will be set to 0 in the following case:   |  | | --- | | 1> if all triggered consistent LBT failures are cancelled in this Serving Cell; or  1> if the *lbt-FailureDetectionTimer* expires; or  1> if *lbt-FailureDetectionTimer* or *lbt-FailureInstanceMaxCount* is reconfigured by upper layers:  2> set *LBT\_COUNTER* to 0. |   Therefore, the *LBT\_COUNTER* may be reset several times before a consistent LBT failure and the appropriate method is to introduce an extra counter for the LBT failure times in other BWPs. |
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### 2.1.3 Other issues on RA-Report?

* **Q4: Is there any other issue/proposal related to the RA-Report that you would like to raise?**

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| Company | Comments |
| Qualcomm | During the meeting, Chair mentioned that no other proposals (apart from FFS) will be considered in Rel-18. |
| Samsung | As mentioned by chair, only the FFS need to be considered. |
| Ericsson | An issue from the review of the running CR on RACH is how the list of BWP information should be handled. In our view, the entries should be included in chronological order so that the NW can retrieve the order in which the RA was performed. |
| Nokia | RA is used for Initial Access (IA) and Handover (HO), i.e., it is the very first message sent to the serving cell, and a failed access results in CEF for IA and RLF/HOF for HO, respectively. RACH issues occur when LBT has been overcome. LBT just delays the RA process but does not impact the RA procedure as such. Therefore, we think that we think that the current FFS items should be reconsidered. |
| Huawei, HiSilicon | Only FFS need to be considered. |
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## 2.2 RLF-Report enhancements

### 2.2.1 Issue#3: Which BWP info to log in the RLF-Report

Related to what to log in the RA-InformationCommon within the RLF-Report, the following was agreed in RAN2#122:

As baseline, RAN2 assumes the following:

a. Enhancements discussed for the RA-InformationCommon for the RA-Report are applicable also to the RLF-Report

b. The detailed “per RA attempt info” are only reported in the RLF-Report for the last RA procedure before RLF/HOF, FFS whereas limited information are reported for the other BWPs in which consistent LBT failure is detected

c. The above bullets may be revisited case by case depending on future agreements.

Which BWP information to log in the RLF-Report was left for further discussion in RAN2#122. From the replies to Q8 in [1], it seems that majority of companies were in favor to include the BWP information of all the BWPs in which the UE detected the consistent LBT failure, right before the RLF/HOF (some of these info may be included directly in the RA-InformationCommon already included in the RLF-Report).

* **Q5: Do you agree that the UE should log in the RLF-Report, the BWP information (locationAndBandwidth, subcarrierSpacing, absoluteFrequencyPointA) of all the BWPs in which the UE detected the consistent UL LBT failure, right before the RLF/HOF?   
  If not, please provide your explanation.**

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| Company | Yes/No | Comments |
| Qualcomm | No | UE declares RLF only after consistent LBT failures on all BWPs. RLF report is generated that implies, consistent LBT failures have happened on all other BWPs. Therefore, no need to include other BWP information in the RLF report. This is implicitly known at the network. |
| Samsung | No | Agree with Qualcomm that the utility of such an enhancement is none. Additionally, Currently RA-InformationCommon has an assumption that there will be some preambles actually transmitted. Changing this can make things complex and extensibility for future releases really difficult, especially when RLF cause is lbt-failure. |
| Ericsson | Yes | It is already agreed to include in the RA-InformationCommon within the RA-Report the BWP information, since that it is beneficial to know the BWP in which consistent LBT failure occurred. The same logic can be used for the RLF-Report.  The benefit of this is quite clear. In NR-U systems, the reason for switching the BWP upon consistent LBT failure is because the UE is expected to experience different LBT performances in another BWP, i.e. LBT performed in different chunks of the NR-U band may lead to different LBT results. Hence knowing the BWPs in which consistent LBT failure occurred prior to the RLF/HOF allows the NW to identify the problematic BWPs and optimize the usage of those. For example, the network can figure out that the consistent LBT failures are persistently experienced in a certain BWP, and then optimize the configuration/allocation of this BWP in the NR-U spectrum. |
| CATT | See comments | If the other BWP information is not logged in the RLF report, how could network know the other BWP information? If this question could be solved by current procedure, we are fine not to introduce it. |
| Xiaomi | No | Agree with QC |
| Lenovo | Yes | Besides consistent LBT fails on all BWPs, there is another case that RLF report is triggered due to T304 expires but not all configured BWPs have consistent LBT failures. It is beneficial to include the BWP information (locationAndBandwidth, subcarrierSpacing, absoluteFrequencyPointA) of all the BWPs in which the UE detected consistent UL LBT failure in the RLF report. |
| Nokia | No | If the RLF is declared with cause “lbtFailure”, it is obvious that all tried BWPs failed with consistent LBT failure, and the network should know the configuration with respect to BWP information.  However, if the RLF cause is “T304 expiry” (HOF), some information about impact of LBT caused deferral or waiting would be useful, since from MRO perspective the deferral or waiting time that is used from T304 is essential |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes | Share similar views as Ericsson. |
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### 2.2.2 Issue#4: When to include the RA-InformationCommon in the RLF-Report

In RAN2#122, it was agreed to include the RA-InformationCommon in the RLF-Report as in legacy, i.e. in case of HOF and when the RLF cause is randomAccessProblem or beamFailureRecoveryFailure:

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| **From RAN2#122:**  The UE logs RA-InformationCommon including LBT info in the RLF-Report, in case of HOF and when the RLF cause is randomAccessProblem or beamFailureRecoveryFailure (as in legacy). |

Additionally, it was left as FFS whether to include the RA-InformationCommon in case the RLF-cause is *lbtFailure*.   
This proposal seems reasonable, since if the RLF cause is *lbtFailure* and the UE was performing random access right before the RLF, then it is clear that the RA was affected by LBT problems, and it is obviously beneficial to include the RA-InformationCommon in the RLF-Report (as we do whenever the RLF-Report is generated due to issue during RA, i.e. when the RLF-cause is randomAccessProblem or beamFailureRecoveryFailure, or HOF).

* **Q6: Should the UE log the RA-InformationCommon in the RLF-Report when the RLF cause is *lbtFailure* and the UE was performing random access at the moment of RLF?   
  If not, please provide your explanation.**

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| Company | Yes/No | Comments |
| Qualcomm | Yes |  |
| Samsung | Yes |  |
| Ericsson | Yes |  |
| CATT | Yes |  |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| Nokia | No | Our understanding is that there is no RA issue when this cause value is used (if there is a RA issue then other cause values are used) |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes |  |
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### 2.2.3 Issue#5: On the inclusion of the latest RSSI measurements in the RLF-Report

Related to RSSI, the following agreements were taken in RAN2#122:

**From RAN2#122:**

The UE logs the available RSSI measurement in the RLF-Report. FFS in which case.

8 The UE should log the following RSSI values in the RLF-Report:

a. For RLF, the latest measured RSSI of the NR-U channel of the last serving cell if measRSSI-ReportConfig is configured for the corresponding frequency.

b. FFS: For HOF, the latest measured RSSI of the NR-U channel of the source cell, and the latest measured RSSI of the NR-U channel of the target cell, if measRSSI-ReportConfig is configured for the corresponding frequency.

Accordingly, the following procedural text was captured in the running CR:

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| **From TS 38.331 running CR:**  The UE shall determine the content in the *VarRLF-Report* as follows:  1> clear the information included in *VarRLF-Report*, if any;  1> set the *plmn-IdentityList* to include the list of EPLMNs stored by the UE (i.e. includes the RPLMN);  1> set the *measResultLastServCell* to include the cell level RSRP, RSRQ and the available SINR, of the source PCell (in case HO failure) or PCell (in case RLF) based on the available SSB and CSI-RS measurements collected up to the moment the UE detected failure;  1> if *measRSSI-ReportConfig* is configured for the frequency of the PCell (in case of RLF), set the *measResultLastServCell-RSSI* to the linear average of the available RSSI sample value(s) provided by lower layers for the frequency of the PCell (in case of RLF) up to the moment the UE detected the failure;  Editor´s note: To discuss the case of HOF (as for the *measResultLastServCell*). |

Rapporteur notes, that in legacy (see green text above), the *measResultLastServCell* including the cell level RSRP, RSRQ and the available SINR is captured both for the case of RLF and HO failure. Hence, it seems logical that for the RSSI measurements, we align the handling of the new *measResultLastServCell-RSSI* with the handling of the legacy *measResultLastServCell,* i.e. the new *measResultLastServCell-RSSI* includes the RSSI of the source PCell (in case HO failure) or PCell (in case RLF), as long as the *measRSSI-ReportConfig* is configured for the corresponding frequency.

* **Q7: Do you agree that similar to the legacy *measResultLastServCell*, the RSSI measurement results of the frequency associated to the last serving cell are included in the RLF-Report for the source PCell (in case of HO failure) or for the PCell (in case of RLF), if the *measRSSI-ReportConfig* is configured for such frequency?  
  If not, please provide your explanation.**

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| Company | Yes/No | Comments |
| Qualcomm |  | Do not understand “what RSSI measurements of the last serving cell mean”. UE does not measure RSSI separately for source and target cell. RSSI is measured for frequency, which included from all sources. Please check RSSI definition from TS 38.215 section 5.1.21, as following 5.1.21 Received Signal Strength Indicator (RSSI)  |  |  | | --- | --- | | **Definition** | Received Signal Strength Indicator (RSSI), comprises the linear average of the total received power (in [W]) observed only per configured OFDM symbol and in the measurement bandwidth indicated by higher layers or corresponding to the channel bandwidth defined in Clause 4 of TS 37.213 [17], where the channel has the center frequency configured by *ARFCN-valueNR*, by the UE from all sources, including co-channel serving and non-serving cells, adjacent channel interference, thermal noise etc.  Higher layers configure the *ARFCN-valueNR*, the reference numerology and the measurement duration, i.e., which OFDM symbol(s) should be measured by the UE.  For frequency range 1, the reference point for the RSSI shall be the antenna connector of the UE. For frequency range 2, RSSI shall be measured for each receiver branch based on the combined signal from antenna elements corresponding to the receiver branch. For frequency range 1 and 2, if receiver diversity is in use by the UE, the reported RSSI value shall not be lower than the corresponding RSSI of any of the individual receiver branches. | | **Applicable for** | RRC\_CONNECTED intra-frequency,  RRC\_CONNECTED inter-frequency |   UE report RSSI measurements for a frequency, whose central frequency is indicated by *ARFCN-valueNR* from all sources. |
| Samsung | No for HOF, ok for RLF | While it is useful to align with the reporting of existing measurements, we also need to consider the purpose of reporting. LBT is related to the existence of other operator’s UEs transmitting in the same frequency at the same time for NR-U or other unlicensed technologies. So UE should report accordingly.  In that sense the RSSI measurement results of the frequency associated to the last serving cell could be helpful for RLF and we are ok to it.  But in case of HO failure, the RSSI measurement results of the frequency associated to the last serving cell for the source PCell are not related to the issues related to LBT in target cell and there is no need to include them. |
| Ericsson | Yes | Also for HOF, the RSSI measurements of the frequency of the source PCell is beneficial. The reason is that the NW can use the RSSI information (together with the legacy RSRP/RSRQ/SINR) to compare the quality of the frequency of the source cell with the quality of the frequency of the target cell or neighbouring cells. For example, if the RLF-Report shows very bad RSSI on the target frequency, and still acceptable RSSI on the source frequency, then the NW can conclude that this HO was executed at a bad point in time, and the UE could have been kept longer time in the source frequency. Accordingly, the NW can adjust the thresholds on HO triggering.  Please note that the UE will include these measurements only if the measRSSI-ReportConfig was configured for the concerned frequencies. So, no new measurements should be taken by the UE just for the sake of the RLF-Report. |
| CATT | Yes | Agree with Ericsson’s view. |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| Nokia | No |  |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes | We think the UE should log RSSI in the RLF report according to the failure type, i.e. both RLF and HOF should be considered. |
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Related to the RSSI measurement results of the neighbouring cells, Rapporteur highlights that the legacy RLF-Report includes in the *measResultNeighCells* all the available measurement quantities of the best measured cells, i.e. “set the *measResultListNR* in *measResultNeighCells* to include all the available measurement quantities of the best measured cells, other than the source PCell (in case HO failure) or PCell (in case RLF)….”.

Also in this case, Rapporteur wonders whether RAN2 should align with the existing procedures related to *measResultNeighCells*, i.e. the UE includes the RSSI measurements of all the neighbouring cells, if the frequency is configured with *measRSSI-ReportConfig.* This would allow the network to identify the RSSI quality of neighbouring cells and compare them with the RSSI quality of the failed cell.

* **Q8: Do you agree that similar to the legacy *measResultNeighCells*, the UE includes in the RLF-Report the available RSSI measurement results of the frequencies associated to the neighbouring cells other than the source PCell (in case of HO failure) or PCell (in case of RLF), if the *measRSSI-ReportConfig* is configured for such frequencies?  
  If not, please provide your explanation.**

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| Company | Yes/No | Comments |
| Qualcomm | No  (question is not clear) | See response in Q7. Not sure what RSSI measurement results of the neighbouring cells means. |
| Samsung | No | For the RLF,RSSI measurements in source frequency is enough and for HOF, RSSI measurements in target frequency is enough. |
| Ericsson | Yes | As per our comment in Q7, from the NW point of view, the usage of the RSSI measurements on the neighbouring frequencies is the same as for the legacy RSRP/RSRQ/SINR measurements, i.e. the NW can use the RSSI information (together with the legacy RSRP/RSRQ/SINR) to compare the quality of the frequency of the source cell with the quality of the frequency of neighbouring cells.  For example, if the RLF-Report shows very bad RSSI on the target frequency, but good RSSI on another neighbouring frequency, then the NW can conclude that this HO was executed to a wrong frequency, and hence it can adjust the thresholds on HO triggering. |
| CATT | Yes | Agree with Ericsson’s view. |
| Xiaomi | Yes |  |
| Lenovo | Yes |  |
| Nokia | No |  |
| Sharp | Yes |  |
| Huawei, HiSilicon | Yes | Agree with Ericsson. |
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Related to HOF, in RAN2#122, it was discussed whether the latest measured RSSI of the target cell should be included. Obviously, if the answer to Q6 is “Yes”, this information would not be needed, since it can be easily derived from the neighbouring cell measurement information.

* **Q9: In case of HOF, should the UE log in the RLF-Report the latest measured RSSI of the frequency associated to the target cell, if *measRSSI-ReportConfig* is configured for such frequency?**
  1. **No, if the answer to Q8 is “Yes”**
  2. **Yes**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Qualcomm | No  (Question is not clear) | Please see response to Q7. |
| Samsung | Yes |  |
| Ericsson | a)  b) if answer to Q8 is no | The RSSI of the target frequency is not needed if the neighbouring frequencies are included, since the RSSI of the target frequencies is already included in the list of the neighbouring frequencies results.  Otherwise, if the answer to Q8 is no, the RSSI measurement of the target frequency is needed. |
| CATT | a) |  |
| Xiaomi | a) |  |
| Lenovo | a) |  |
| Nokia | No | This question is unclear for us. |
| Sharp | a) |  |
| Huawei, HiSilicon | a) |  |
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### 2.2.4 Issue#6: On the inclusion of lbt-FailureRecoveryConfig in the RLF-Report

In the LS R2-2300031, RAN3 claims that NW-based solution to retrieve the lbt-FailureRecoveryConfig is possible in some cases when the UE context is still available at the network, but that is not possible always, especially when the report is fetched long time after the failure. In short, the LS points that:

* If the RLF report is fetched immediately, existing network-based mechanism can be reused.
* If the RLF is not fetched immediately, then "the likelihood that the source and the last serving node can retrieve the needed information depends on RAN implementation and is practically minimal”.

In this regard, to address the above and to reduce the overhead at the UE and the network, it was proposed in [3] to limit the logging of the lbt-FailureRecoveryConfig to the scenarios that the re-establishment procedure fails (i.e., when it is not possible for the NW to fetch the RLF report immediately).

In [2], as an alternative solution, it was proposed to introduce a new configuration index parameter to be provided by the network to the UE with the configuration. The UE stores the configuration index and provides it within the RLF reports.   
Rapporteur observes that RAN3 claims that when the UE context or the configuration is still available in the network, then “there is an existing network-based mechanism that can be reused for the NR-U case, based on the information provided from the UE (last serving PCell ID and C-RNTI), that enables the RAN to retrieve the UE context or the configuration used for the UE….”. Hence, when the UE context is still available in the network, there seems to be no problem and existing mechanisms can be reused, so the solution proposed in [2] seems to go beyond the scope of the issue highlighted in the RAN3 LS.

For example, when information are still available at the network, a NW-based solution can leverage on the existing information provided in the RLF report, such as the C-RNTI and the timeSinceFailure. In a simple scheme shown below a network node (if interested) can implement the following mechanism by mapping the C-RNTI to a specific allocated configuration in a given time period.

|  |  |  |  |
| --- | --- | --- | --- |
| **C-RNTI** | **Time period** | **NW-based configuration-Index** (if interested) | **Allocated configurations** |
| 1 | 0-100 | 1 | Mobility configuration X  RA configuration Y  LBT configuration Z |
| 2 | 0-200 | 1 (i.e., the UE with C-RNTI = 2 uses the same configuration as UE with C-RNTI =1) | Mobility configuration X  RA configuration Y  LBT configuration Z |
| 1 | 101-200 | 2 (i.e. different configuration) | Mobility configuration A  RA configuration B  LBT configuration C |

So, if the configurations are still available at the network side, the specific allocated configuration can be retrieved from the C-RNTI and the timeSinceFailure already provided by the UE in the RLF-Report. Hence, the benefit of sending the configuration index to the UE remains unclear.

Considering also the limited time left before completion of the Rel.18 WI, this latter approach seems to require more technical discussion and specification impact.

* **Q10: Do you agree that UE logs *lbt-FailureRecoveryConfig* in the RLF-Report only upon re-establishment procedure failure?** 
  1. **Yes**
  2. **No, the UE should always log the lbt-FailureRecoveryConfig in the RLF-Report**
  3. **No, other solutions should be discussed. Please describe.**

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| --- | --- | --- |
| Company | Preferred options (a,b,c) | Comments |
| Qualcomm | C | We have ongoing discussions on the configuration index. The configuration index can be used by the network for retrieving the LBT-FailureRecoveryConfig. |
| Samsung | C | Agree with Qualcomm |
| Ericsson | a) | The benefit of the “configuration index” solution is unclear. As explained above, the solution is redundant and the same result can be achieved by leveraging on the existing RLF-Report content. |
| CATT | a) | The method of “configuration index” will make network store several information which maybe not all used by SON, the UE also needs to realize the information associated to each index, which seems complex. So, we prefer a) although it seems that more signaling overhead is needed, but is more beneficial and simple if you look at the all the work, such as the stored information, needed to be done by the “configuration index” way. |
| Xiaomi | a |  |
| Lenovo | a |  |
| Nokia | c | The solution proposed in section 2.4 of R2-2305424[2] is well within the scope, because it enables detecting the LBT config, even if the RLF report is fetched from the UE after a while. It also corresponds well to the Mobility Information used on the RAN side thus helping the implementation to use the same logic in RLF handling.  In general, this LS is outdated in the context of another LS sent from RAN3 in May (in R3-233380/R2-2307030): there, the option of having some form of Mobility Information sent to the UE and then reported in case of RLF is considered. If enabled for SHR/SPR, it can also be used for retrieval of LBT config. |
| Sharp | c | Agree with Nokia. |
| Huawei, HiSilicon | a) | We think in the other use cases except for re-establishement failure, the source node shall store the lbt-FailureRecoveryConfig configuration.  For “configuration index”, we think companies are talking about the “Configuration Information” in the RAN3 LS R3-233380. Currently, the “Confiugration information” is related to SHR and SPR based on the RAN3 LS, and NR-U scenario has not been considered. So we are not sure whehther to add “Configuration information” as a candidate solution here. |
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### 2.2.5 Other issues on RLF-Report?

* **Q11: Is there any other issue/proposal related to the RLF-Report that you would like to raise?**

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| --- | --- |
| Company | Comments |
| Samsung | As mentioned by chair in last meeting, for NR-U we may focus on the listed FFS |
| Nokia | Handover failures identified and corrected by MRO are timing issues, known as “too late HO” or “too early handover”. The HO timing is triggered by radio measurement events, and MRO re-adjusts the thresholds of those events by changing the CIO.  If the timing of the HO process is spoiled by additional LBT-caused deferral or waiting, an RLF/HOF where the waiting time was rather considerable should be excluded from MRO process. Therefore, to ensure proper MRO the information about waiting/deferral time due to LBT during the HO is needed. See our discussion and proposal in section 2.3 of R2-2305424 [2]. |
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## 2.3 Issue#7: On the logging of the detected power and ED information in the RA-Information

What to log related to the detected power and energy detection (ED information has been discussed quite extensively in this release both in RAN2 and in RAN3.

Many proposals (e.g. log the average detected power during the RA, or the average applied EDT value during the RA procedure) were deemed to be too complex from the UE implementation point of view. Hence, the Proposal 18 in the RAN2 email discussion [1] was considered as a possible compromise and it was left as FFS in the chairman notes.

Rather than logging the average detected power, or the average applied EDT value during the RA procedure, it was proposed in the Proposal 18 in [1] that the UE logs in the RA-Information an indication on whether the detected power was above the configured maximum EDT threshold (e.g. at least once) during the RA procedure. This information would allow the network to adjust the value of the *maxEnergyDetectionThreshold* if the indication is often present. Otherwise, if the indication is not present it means that the LBT failures are not due to a bad NW configuration of *maxEnergyDetectionThreshold*, rather the issue might be on the EDT applied by the UE. In this latter case, there is no NW problem, and how to increase the LBT success rate can be left to the UE implementation.

* **Q12: For the sake of compromise, do you agree that the UE logs in the RA-Information an indication indicating whether, during the RA procedure, the detected power was above (at least once) the NW configured maximum EDT threshold (*maxEnergyDetectionThreshold*)?**
  1. **Yes**
  2. **No, the average detected power during the RA should be logged**
  3. **No, the average applied EDT value during the RA procedure should be logged**
  4. **No, nothing should be logged related to detected power/ED information**

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| --- | --- | --- |
| Company | Preferred option (a,b,c,d,…) | Comments |
| Qualcomm | A | As the compromise Option A is okay to us.  Options B and C are not acceptable to us. |
| Samsung | D | We think already agreed information is enough even for maximum EDT threshold. |
| Ericsson | A | Even though b) and c) may provide more exhaustive information, a) sounds as an acceptable compromise which limits the UE impact. |
| Xiaomi | D |  |
| Lenovo | D |  |
| Nokia | D | The indicator already exists with LBT failure, since LBT failure is declared if measured energy is above EDT. We see not benefit of averaging among the energy levels being measured for the set of RA attempts.  RA-Information should include only RACH related information, a blocked RACH transmission due to LBT is not really RACH related information. Measured energy levels may be used for EDT optimization, but not for RACH optimization |
| Huawei, HiSilicon | B), A) | We think a comprehensive average detected power during the channel access attempts should be logged, to help evaluate the unlicensed channels load, while A only provide limited valid information.  The compromise option a) is also acceptable to us. |
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## 2.4 SHR enhancements

### 2.4.1 Issue#8: New SHR triggering conditions

The legacy Rel.17 SHR triggering conditions are the following:

* Elapsed time of T304 exceeding configured threshold
* Elapsed time of T310 exceeding configured threshold
* Elapsed time of T312 exceeding configured threshold
* RLF in source cell during DAPS HO

In the context of NR-U the following further SHR triggering conditions were mainly discussed in [1]:

* Number of UL LBT failures experienced during HO higher than a certain threshold
* Consistent UL LBT failures triggered in at least one UL BWP on the source cell at the moment of executing the HO, or consistent UL LBT failures triggered in at least one UL BWP on the target cell during the HO
* **Q13: Which new triggering conditions should be considered for the SHR generation?**
  1. **Number of UL LBT failures experienced during HO higher than a certain threshold**
  2. **Consistent UL LBT failures triggered in at least one UL BWP on the source or target cell of the handover**
  3. **Others**

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| --- | --- | --- |
| Company | Options (a,b,c,…) | Comments |
| Qualcomm | No additional triggers are required | T304/ T312/T310 triggers are sufficient. |
| Samsung | No additional thresholds | Agree with Qualcomm. Existing thresholds are enough. |
| Ericsson | b) | It could be beneficial to generate SHR if consistent LBT failure in source/target were triggered. For example, if consistent LBT failure were triggered and not cancelled in the source cell at the moment of HO execution, that is a clear indication of “near-to-failure” event, for which the NW can possibly take necessary counteractions. None of the existing triggering conditions (T310/T304/T312) would tackle this scenario.  Option a) is probably redundant. |
| CATT | a) | Number of UL LBT failures is also a kind of information to implicitly indicate the time elapse during the HO procedure by LBT failure, while the other timers cannot be used to reflect the procedure impacted by LBT. |
| Xiaomi | No additional triggers |  |
| Lenovo | b) |  |
| Nokia | None | We see no reason for additional triggers |
| Sharp | a) |  |
| Huawei, HiSilicon | a) And b) | We think both a and b can reveal that if there is sub-success HO. We need to further note that in a, the number of UL LBT failures can reflect the NR-U load and potential consistent LBT failures in each RACH resource, which is helpful for the RACH resource allocation aiming at arrange better HO strategies. |
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### 2.4.2 Issue#9: Information to be included in the SHR

New information to be included in the SHR were discussed in [1]. Given the limited time left, Rapporteur suggests focusing on the basics information that should be included, taking into account the legacy. In legacy Rel.17 SHR, the following information are included (see section 5.7.10.6 in TS 38.331 for more details):

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| **Information included in legacy SHR:**   1. The *plmn-IdentityList* 2. The C-RNTI assigned by the target PCell of the HO 3. The source cell ID 4. The source cell measurements results (RSRP, RSRQ, SINR), and the source cell beam-level measurements 5. The target cell ID 6. The target cell measurements results (RSRP, RSRQ, SINR), and the target cell beam-level measurements 7. The neighbouring cell measurement results (RSRP, RSRQ, SINR) 8. The *ra-InformationCommon* if T304 triggering condition is fulfilled 9. A flag indicating the SHR triggering condition (i.e. *t310-cause, t304-cause, t312-cause*) 10. The *timeSinceCHO-Reconfig* for CHO*.* |

Based on the above legacy information, Rapporteur suggests discussing the following basics enhancements for the SHR in NR-U:

* The *ra-InformationCommon* including the new Rel.18 information (i.e. number of UL LBT failures during HO, info on the multiple BWPs in which consistent UL LBT failures was triggered) are included in the SHR, if T304 triggering conditions is fulfilled or if some of the new triggering conditions discussed under issue#8 are agreed.
* Including RSSI measurements related to the source/target/neighbouring cells, as enhancements of the legacy source/target/neighbouring cell measurements, if the *measRSSI-ReportConfig* is configured for those frequencies.
* **Q14: Do you agree to include the following information in the SHR?**
  1. **The *ra-InformationCommon* including the new Rel.18 information (i.e. the number of UL LBT failures during HO, the info on the multiple BWPs in which consistent UL LBT failures was triggered), if T304 triggering conditions is fulfilled.**
  2. **The RSSI measurements of the frequencies associated to the source/target/neighbouring cells (as enhancements of the legacy source/target/neighbouring cell measurements), if the *measRSSI-ReportConfig* is configured for those frequencies.**

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| --- | --- | --- |
| Company | Options (Yes, a, b) | Comments |
| Qualcomm | Okay for A  See comments for B | For A, as we are enhancing the RACH information. It should be okay  For B, see response to Q7. |
| Samsung | OK FOR A  See comments for B | For B, RSSI measurements related to source frequency, if the trigger is T310/T312. RSSI measurements related to target frequency, if the trigger is T304. |
| Ericsson | a)  b) | In legacy the RSRP/RSRQ/SINR measurements of source/target/neighbouring cells were always included (if available) irrespective of the triggering condition that generated the SHR. We prefer maintaining the same approach also in Rel.18, i.e. to log the RSSI measurements of the frequencies of source/target/neighbouring cells irrespective of the triggering conditions. Excluding certain measurements depending on the triggering condition (as proposed by Samsung) would complicate the procedural text (that can be largely reused).  Please also note that these measurements are supposed to be reported only if the measRSSI-ReportConfig is configured for those frequencies. So no new measurements should be taken by the UE for the sake of SHR. |
| CATT | 1. And b) |  |
| Xiaomi | A and b |  |
| Lenovo | a and b |  |
| Nokia | Yes to a)? No to b)? | Overall, we think that SHR for NR-U should be on hold as long as RLF is not completed for NR-U. SHR supports MRO which is based on RLF reporting, and SHR should be harmonized with RLF report and not vice versa. |
| Sharp | Yes for a and b |  |
| Huawei, HiSilicon | a) And b) |  |
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### 2.4.3 Issue#10: Other information to be included in the SHR?

In P22 and P23 in the email discussion in [1], other information were proposed, e.g:

1. Number of unavailable SMTC occasions detected during the HO
2. Time duration for UL LBT before each RACH attempt at HO
3. Time elapsed since the last HO execution until successful LBT
4. Average waiting/deferral time due to LBT during the HO
5. LBT information (e.g. number of LBT failures) related to the source cell at the moment of HO

Even though no large support was shown in the email discussion, Rapporteur would like to further ask if there is any interest for any of the above options, given that very limited online time was spent on it in RAN2#122.

* **Q15: Which of the above listed information should be included in the SHR (if any)?**

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| --- | --- | --- |
| Company | Options (a,b,c,d,e, None) | Comments |
| Qualcomm | None | They have been discussed (in the post RAN2#121bis email discussion and during the SON/MDT session) and agreed not to be included. Furthermore, in the meeting, the chair mentioned that only FFS can be discussed in future meetings. Therefore, bringing them back into the email discussion again is not required and should be avoided. |
| Samsung | E and see comments | P22 (A to D) are not part of FFS from the last meeting. We didn’t completely understand why Rapp has included them in Q15.  P23 related to E is FFS and was not discussed in detail in RAN2. We think that network needs similar information as failure report (RLF) for near failure report (SHR) also when T310/T312 conditions are satisfied. i.e. the objectives of RLF reporting and SHR are same or closely similar, only difference is one method is proactive and other is reactive. So except for the cases, where the network already has data available, the optimizations require similar information from the UE for both the cases and that is the approach followed in RAN2 in general.  Since it is already agreed that UE logs For RLF, the latest measured RSSI of the NR-U channel of the last serving cell if measRSSI-ReportConfig is configured for the corresponding frequency, the same information is needed for SHR when T310/T312 conditions are satisfied. Similarly, if RAN2 agrees to include additional information based on other questions for radio link failure, they also may be included in the SHR when T310/T312 conditions are satisfied. |
| Ericsson | E with comments | We are ok to have LBT information associated to the source cell. However, what is meant with number of LBT failures in source cell it is not clear, because it would not be clear when the UE should start count these LBT failures. It would be more sensible to us to consider including information on whether consistent LBT failure was already triggered in source cell at the moment of HO execution. |
| Xiaomi | E |  |
| Lenovo | B, C, E |  |
| Nokia | B | The *T304PercentageThresh* reflects a certain time span, and it might be very beneficial from MRO perspective to know how much of this time was spent for LBT caused waiting/deferral to see later in the root cause analysis of this SHR whether it can be used for MRO. |
| Sharp | none |  |
| Huawei, HiSilicon | B with comments | We think the average time duration for UL LBT before each RACH attempt at HO should also be included, which can reveal the potential consistent LBT failure. |
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## 2.5 Other issues on SON for NR-U

* **Q16: Is there any other general issue related to SON for NR-U that you would like to raise?**

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| Company | Comments |
| Qualcomm | In the meeting, the chair mentioned that only FFS can be discussed in future meetings. |
| Nokia | MRO has been envisaged as SON use case for NR-U as described in WID. So far MRO was only pretense for discussing LBT in context of the RA procedure. But MRO is optimizing the handover timing by creating failure cases like too late HO, etc., derived from reported RLFs. If the timing is spoiled LBT-cased waiting, RLFs need to be inspected how critical LBT impact is with respect to timing. This would be a very relevant MRO for NR-U criterion. See our discussion and proposal in section 2.3 of R2-2305424 [2]. |
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# Conclusion

TBD:

# 4. References

1. R2-2306558, Open issues and proposals on AI 7.13.5 SON for NR-U (Ericsson)

1. [R2-2305424](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_122/Docs/R2-2305424.zip), [Discussion on SON for NR-U](https://ericsson.sharepoint.com/R2-2305424.zip), Nokia, Nokia Shanghai Bell
2. [R2-2304111](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304111.zip), [Enhancements of SON reports for NR-U](https://ericsson.sharepoint.com/R2-2304111.zip), Ericsson