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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### 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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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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### 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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## 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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### 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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### 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 as for the legacy *measResultLastServCell*, the RSSI measurement results of 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 that frequency?  
  If not, please provide your explanation.**

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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 as for the legacy *measResultNeighCells*, the UE includes in the RLF-Report the available RSSI measurement results of 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 those frequencies?  
  If not, please provide your explanation.**

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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 target cell, if *measRSSI-ReportConfig* is configured for that frequency?**
  1. **No, if the answer to Q6 is “Yes”**
  2. **Yes**

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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.

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| **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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### 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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## 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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## 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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### 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 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.**

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| Company | Options (Yes, a, b) | Comments |
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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 |
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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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# 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