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

Xiamen, P.R. China, October 9th – 13th 2023

Agenda Item: 7.13.5

Source: Ericsson

Title: [Post123][558][R18 SON/MDT] SON for NR-U (Ericsson)

Document for: Discussion, Decision

# Introduction

This document is to address the following email discussion:

* **[Post123][558][R18 SON/MDT] SON for NR-U (Ericsson)**

Discussion the following FFS issues from FFS1-FFS8

Output: Report

Deadline: long

Related to NR-U, the following agreements have been taken in the last RAN2#123 meeting:

|  |
| --- |
| **From RAN2#123:**  Agreements:  1 Introduce a new field that counts the number of preamble transmissions blocked by LBT for the last BWP selected for the RA procedure. FFS how to solve the issue of no preamble transmission attempts transmitted in a selected beam due to LBT blockage.  2 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, are included in the RA-Report.  3 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.  4 The UE logs the following information in the SHR:  a. 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.  b. FFS: The RSSI measurements of the frequencies associated to the source/target/neighbouring cells, if the measRSSI-ReportConfig is configured for those frequencies.  5 BWPs information included in the RA-Report can be included, within the list of attempted BWP(s), in chronological order of BWP selection. |

From the email discussion in R2-2308899 [1], the following FFS were also captured in the chairman notes:

|  |
| --- |
| **FFS from RAN2#123:**  FFS1: BWP information should be included in the RLF-Report for all the BWPs in which the UE detected the consistent UL LBT failure, right before the RLF/HOF.  FFS2: RAN2 agrees to include the RSSI measurements of the frequency associated to the source PCell in the RLF report in case of HOF, if the measRSSI-ReportConfig is configured for such frequency.  FFS3: RAN2 agrees to include in the RLF-Report the available RSSI measurement results of the frequencies associated to the neighbouring cells, if the measRSSI-ReportConfig is configured for such frequencies.  FFS4: If Proposal 8 is not agreed, RAN2 to discuss if the UE logs in the RLF-Report the latest measured RSSI of the frequency associated to the target cell in case of HOF, if measRSSI-ReportConfig is configured for such frequency.  FFS5: UE logs lbt-FailureRecoveryConfig in the RLF-Report only upon re-establishment procedure failure.  FFS6: For the sake of progress and alignment with RAN3, RAN2 confines the discussion on the configuration index to the SHR and SPR discussion.  FFS7: Agree logging the LBT information of the source cell at the moment of performing HO. FFS the details (e.g., number of LBT failure or consistent LTB failure, etc.)  FFS8: how to solve the issue of no preamble transmission attempts transmitted in a selected beam due to LBT blockage. |

# Discussion

## 2.1 RA-Report enhancements

### 2.1.1 Issue#1: How to solve the issue of no preamble transmission attempts transmitted in a selected beam

In RAN2#123, it was agreed:

1 Introduce a new field that counts the number of preamble transmissions blocked by LBT for the last BWP selected for the RA procedure. FFS how to solve the issue of no preamble transmission attempts transmitted in a selected beam due to LBT blockage.

The FFS highlighted above is related to the scenario in which for a selected beam all the preamble transmission attempts were blocked by LBT. In current specification, the fields numberOfPreambleSentOnSSB/numberOfPreamblesSentOnCSI-RS-r16, and perRAAttemptInfoList are mandatory fields within PerRASSBInfo-r16/PerRACSI-RSInfo-r16. Hence, the UE behavior is not clear when no preamble are successfully transmitted over the air for a selected beam for RA.

Possible solutions were presented in [2], [3] and are summarized in the following:

* **Option A**: Introduce a field to indicate that all preambles transmitted in a selected beam were blocked by LBT. It is up to UE implementation how to set the numberOfPreamblesSentOnSSB-r16/numberOfPreamblesSentOnCSI-RS-r16 and the perRAAttemptInfoList.  
  Sketch of this solution is in the Annex A.
* **Option B**: The UE sets the numberOfPreamblesSentOnSSB-r16/numberOfPreamblesSentOnCSI-RS-r16 to ‘1’ and the newly introduced field lbtDetected (agreed in RAN2#122, and already captured in the running CR) is set to true. It is up to UE implementation how to set the perRAAttemptInfoList.  
  Sketch of this solution is in the Annex B.
* **Q1: In order to solve the issue of no preamble transmission attempts transmitted in a selected beam due to LBT blockage, which of the above solutions do you prefer?   
  If none of them, please describe your preferred solution.**

|  |  |  |
| --- | --- | --- |
| Company | Preferred Option (a,b) | Comments |
| Nokia | None | Leaving the other parameters for UE implementation makes unclear how the NW can interpret and use the provided information |
| CATT | Option (a) | It is simple and no complex description to indicate the case of SSB without any preamble transmission. |
| Huawei, HiSilicon | Option A | For option A, it is straightforward, but it may bring some overhead.  For option B, it is implicitly indicated and we share similar views as Nokia, i.e. how the NW can interpret and use the provided information. It may need more clarifications.  So we slightly prefer option A. |
| Ericsson | A | No strong views, however option A seems cleaner from UE implementation point of view, and spec impact. |
| ZTE | A |  |
| Sharp | A | Option A is simpler. |
| Samsung | B | Both A and B can work. We think that the specification impacts or clarity for either option are not high as shown in the annex.  But with option A, we need two fields- one which tells that there is at least one LBT failure and a new field which tells that all the transmissions have LBT failure (which also means there is at least one LBT failure). Why to transmit two information, when one information is the subset of other? |
| Lenovo | A |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.2 RLF-Report enhancements

### 2.2.1 Issue#2: BWP info in the RLF-Report

Related to the RA-Report, the following was agreed in RAN2#123:

2 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, are included in the RA-Report.

It seems natural to assume that the same principle adopted above for the RA-Report is used also for the RLF-Report.

In the last RAN2#123 meeting, some companies argued that if the RLF cause is lbtFailure, then it is obvious that the UE experienced LBT failures in the all the BWPs. However, it is noted that the RLF-Report may be generated for other reasons, or for HOFs. For example, in case of HOF (i.e. T304 expiry), if no BWP-related information are included in the RLF-Report, it will not be possible for the network to figure out that consistent LBT failures contributed to the HOF (i.e. contributed to the T304 expiry).

* **Q2: Do you agree that the information of all the BWPs (same as for the RA-Report) in which the UE experienced the consistent UL LBT failure, prior the RLF/HOF should be included in the RLF-Report?**

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

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Nokia | Yes |  |
| CATT | Yes | Agree with Rapp’s view, RLF report needs to record the failed BWP information considering the case of HOF. |
| Huawei, HiSilicon | Yes |  |
| Ericsson | Yes | We have already agreed to include all the BWP info in the RA-Report, since it is beneficial to know the BWP in which consistent LBT failure occurred. The same logic can be used for the RLF-Report. 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. |
| ZTE | Yes |  |
| Sharp | Yes |  |
| Samsung | Yes |  |
| Lenovo | Yes |  |
|  |  |  |
|  |  |  |
|  |  |  |
|  |  |  |

### 2.2.3 Issue#3: On the inclusion of the RSSI measurements in the RLF-Report

Related to RSSI, the following agreements were taken in RAN2#122 and RAN2#123:

**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.

**From RAN2#123:**

FFS2: RAN2 agrees to include the RSSI measurements of the frequency associated to the source PCell in the RLF report in case of HOF, if the measRSSI-ReportConfig is configured for such frequency

FFS3: RAN2 agrees to include in the RLF-Report the available RSSI measurement results of the frequencies associated to the neighbouring cells, if the measRSSI-ReportConfig is configured for such frequencies.

FFS3: RAN2 agrees to include in the RLF-Report the available RSSI measurement results of the frequencies associated to the neighbouring cells, if the measRSSI-ReportConfig is configured for such frequencies.

FFS4: If Proposal 8 is not agreed, RAN2 to discuss if the UE logs in the RLF-Report the latest measured RSSI of the frequency associated to the target cell in case of HOF, if measRSSI-ReportConfig is configured for such frequency.

For RLF, it was already agreed in RAN2#122 to include the RSSI measurements of the frequency of the last serving cell. RAN2 still needs to discuss the HOF case, and whether the RSSI measurements of the neighbouring frequencies should be included in the RLF-Report both for the case of RLF and HOF.

The concern raised by some companies during RAN2#123 was about whether the UE can measure the RSSI of non-serving frequencies. Rapporteur notes that according to RAN2 and RAN4 specifications (see e.g. RAN4 TS 38.133, section 9.3A.8, 9.3A.9, 10.1.34, 10.1.35), there is no restriction, i.e. “The UE physical layer shall be capable of performing the RSSI measurements, defined in TS 38.215 [4] on one or more inter-frequency carriers operating with CCA, TS 37.213 [33], if the carrier(s) are indicated by higher layers [2], and report the RSSI measurements to higher layers”. Measurement gaps can also be configured which implies that also non-serving frequencies can be configured for RSSI measurement reporting.

For the HOF, the inclusion of RSSI measurements of the frequencies associated to the source and target cell (together with the legacy RSRP/RSRQ/SINR measurements) would enable the network to compare the quality of the frequency associated to the source cell with the quality of the frequency/ies associated to the target and neighbouring cells. Obviously, if multiple cells are associated to the same frequency, only one RSSI result per frequency will be included in the RLF-Report.

* **Q3: For the HOF, do you agree that the RSSI measurement results of the serving and neighbouring frequencies should be included in the RLF-Report, if the *measRSSI-ReportConfig* is configured for those frequencies?  
  If not, please provide your explanation.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Nokia | Yes with comment | Our understanding is that this is about reporting the “configured and available” measurements results (not about “configured”).  Note that configured NR-RSSI measurements are linked to NR carrier. We assume that neighboring frequency means neighboring carrier. Inter-frequency measurements are not configured by default typically, but if they are configured and available, they can be included in the RLF report |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Ericsson | Yes | Including, the RSSI measurements of the frequency of the serving and neighbouring frequencies is beneficial to troubleshoot the HO failure. The NW can use the RSSI information (together with the legacy RSRP/RSRQ/SINR) to compare the quality of the frequency of the serving frequency with the quality of target/neighbouring frequencies. For example, if the RLF-Report shows very bad RSSI on the target frequency, and still acceptable RSSI on the serving 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 its internal thresholds on HO triggering in the unlicensed spectrum. Similarly, if the RSSI measurements in one neighbouring frequency shows good results, the NW can conclude that the HO was performed towards the wrong frequency and that high interference in the unlicensed spectrum was the reason of the HOF. |
| ZTE | Yes, and | Up to availability. And we still consider the RSSI measurement included is less useful compared to RSRP/RSRQ and SINR in terms of mobility optimization, so inclusion of the measurement shall not impact the legacy behavior of including the latest measurements on serving and neighboring cell. |
| Sharp | Yes |  |
| Samsung | See comments | Our understanding is that 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. But we can accept logging configured measurement results, if all the companies agree to it. |
| Lenovo | Yes |  |
|  |  |  |
|  |  |  |
|  |  |  |

For the RLF, it was already agreed in RAN2#122 to include the RSSI measurements of the frequency of the last serving cell. The inclusion of RSSI measurements of the neighbouring frequencies (together with the legacy RSRP/RSRQ/SINR measurements) would enable the network to compare the quality of the frequency associated to the failed cell with the quality of the frequency/ies associated to the neighbouring cells.

* **Q4: For the RLF, do you agree that the RSSI measurement results of the neighbouring frequencies should be included in the RLF-Report, if the *measRSSI-ReportConfig* is configured for those frequencies?  
  If not, please provide your explanation.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Nokia | Yes with comment | See answer of Q3 (configured and available)  For our understanding, neighboring cells means co-located cells with different NR carrier frequencies. If NR works with 100 MHz carrier, it will be hard to place a second one in unlicensed band. If we talk about BWP used by UE, it is different, there could be several ones (same like channels for Wi-Fi). Therefore, the definition of “neighboring frequency” needs to be more precise. |
| CATT | a) |  |
| Huawei, HiSilicon | Yes | We think such measurements are helpful for network decision, and the overhead should not be large. |
|  |  |  |
| Ericsson | Yes | As per our comment in Q3, 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 serving frequency, but good RSSI on another neighbouring frequency, then the NW can conclude that by performing an earlier HO to that good frequency could avoid the issue. |
| ZTE | Yes, up to availability | Please refer to comments in previous question. |
| Sharp | Yes |  |
| Samsung | See comments | Our understanding is that 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. But we can accept logging configured measurement results, if all the companies agree to it. |
| Lenovo | Yes |  |
|  |  |  |
|  |  |  |

### 2.2.4 Issue#4: 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 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).   
As an alternative solution, some companies proposed to introduce a new configuration index parameter to be provided by the network to the UE. The solution was discussed in RAN2 and an LS was sent to RAN3 in R2-2309021. This solution was however discussed in the context of SHR/SPR, whereas the inclusion of lbt-FailureRecoveryConfig is for the RLF-Report.

* **Q5: In order to address the RAN3 LS in R2-2300031, 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**

|  |  |  |
| --- | --- | --- |
| Company | Preferred options (a,b) | Comments |
| Nokia | b) | We think that the introduction of a new configuration index parameter is necessary (this is no independent from the SHR/SPR related discussion) |
| CATT | a) |  |
| Huawei, HiSilicon | a) |  |
| Ericsson | a) | b) seems an overkill from the UE implementation point of view, considering that NW solution can work when the UE successfully reestablishes after an RLF. |
| ZTE | a) | A is sufficient |
| Sharp | a) |  |
| Lenovo | a) |  |
|  |  |  |
|  |  |  |
|  |  |  |

Related to the following FFS:

|  |
| --- |
| **From RAN2#123:**  FFS6: For the sake of progress and alignment with RAN3, RAN2 confines the discussion on the configuration index to the SHR and SPR discussion. |

Rapporteur believes that this was already discussed at length in RAN2 during RAN2#123, and an LS reply was already sent to RAN3 which should now be in charge of discussing the configuration index solution. No further discussion seems to be required in RAN2.

## 2.3 SHR enhancements

### 2.3.1 Issue#5: On the inclusion of the RSSI measurements in the SHR

Related to SHR, the following was agreed in RAN2#123:

**From RAN2#123:**

4 The UE logs the following information in the SHR:

a. 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.

b. FFS: The RSSI measurements of the frequencies associated to the source/target/neighbouring cells, if the measRSSI-ReportConfig is configured for those frequencies.

As for the RLF-Report, the RSSI measurement reporting on SHR should be discussed.  
As for the RLF-Report, the use case is to enable the network to compare the quality (together with the legacy RSRP/RSRQ/SINR measurements already included in the SHR) of the frequency associated to the source cell with the quality of the frequency/ies associated to the target and neighbouring cells.

* **Q6: Do you agree to include in the SHR the RSSI measurements of the serving/neighboring frequencies, if the *measRSSI-ReportConfig* is configured for those frequencies?**

|  |  |  |
| --- | --- | --- |
| Company | Options (Yes, No) | Comments |
| Nokia | Yes with comment | See answer of Q3 (configured and available). Note that we assume that these are the measurements configured and available just before the UE performed the HO. |
| CATT | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Ericsson | Yes | 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. The same approach can be used for the RSSI, which would aid the network to analyze the root cause of the SHR generation, similar to the RLF-report case. |
| ZTE | Yes, if available |  |
| Sharp | Yes |  |
| Samsung | Yes |  |
| Lenovo | Yes |  |
|  |  |  |
|  |  |  |
|  |  |  |

### 2.3.2 Issue#6: On the inclusion of LBT information of the source cell in the SHR

The following FFS was discussed in RAN2#123:

|  |
| --- |
| **From RAN2#123:**  FFS7: Agree logging the LBT information of the source cell at the moment of performing HO. FFS the details (e.g., number of LBT failure or consistent LTB failure, etc.) |

According to Rapporteur´s recollection, the following solutions were discussed during the online discussion in RAN2#123:

* Option A: The UE logs in the SHR the last value of the LBT\_COUNTER (available at MAC layer, see TS 38.321) taken at the moment of executing the HO.
* Option B: The UE includes in the SHR an indication indicating whether consistent UL LBT failures were triggered in the source cell at the moment of executing the HO.
* **Q7: Related to the logging in the SHR of the LBT information of the source cell, which of the above options do you prefer?  
  Please describe alternative solutions, if any.**

|  |  |  |
| --- | --- | --- |
| Company | Options (a,b,etc, None) | Comments |
| Nokia | None | We do not see the benefit of logging the LBT information from the source cell when the SHR is triggered based on T304 |
| CATT | b | For option A, the *LBT\_COUNTER* will be restarted once the *lbt-FailureDetectionTimer* expires, so option A could not give the real case on NR-U cell, it just recorded the last value of LBT failed and maybe this LBT\_COUNTER is restarted several times. Option B seems reasonable as consistent UL LBT failures give an indication that the channel is busy and can’t be used. |
| Huawei, HiSilicon | FFS | As commented by some companies at RAN2#123, this information may be useful for DAPS HO. So we would like to understand more about the scenario, e.g. whether Q7 is only for DAPS HO, or Q7 is for all HO cases.  For DAPS HO, we are not sure whether NR-U is allowed to be configured on source/target cell. If no, we do not see a need for the UE to log such information in SHR. |
| Ericsson | A preferred  B acceptable | A seems to be simple from UE point of view, since the UE just has to take the current value of the LBT\_COUNTER in MAC. B also seems to be simple because, as for A, the UE has to check at MAC whether consistent LBT failure were triggered when the HO was executed. However, A is more exhaustive from the NW point of view, compared with B, because it provides the actual value of the number of failures. |
| ZTE | None | It is questionable if UE will have such information since it is not required for UE to monitor source when UE initiates HO to target, except for DAPS HO. |
| Sharp | None | Share the same view with Nokia. |
| Samsung | a) with comments | Our understanding is that SHR needs to be similar to RLF report logged for RLF in source cell and it is applicable when the threshold is T310/T312. Optimization of near failure is similar or even same as for the failure.  We can log the number of LBT failures and the RSSI information as in the RLF report. Agree that there is no need to log these information for source cell when the threshold is T304. |
| Lenovo | FFS | It is possible that due to the unlicensed spectrum of the source cell is not available enough, LBT failure or consistent LBT failure may happen in the source cell before successful handover, it is beneficial for the UE to report the number of LBT failures per BWP of the source cell in which LBT failure happens if any in the SHR.  Moreover, even though handover is successfully executed i.e. LBT in last BWP in target cell during handover execution is successful, LBT failure or consistent LBT failure in at least one UL BWP may happen in the target cell before successful handover, we think it is also beneficial for the UE to report the number of LBT failures per BWP of the target cell in which LBT failure happens during HO execution phase in the SHR. |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.4 Other stage-3 issues?

Please use this section to raise any potential stage-3 issue related to NR-U that you may have identified.

* **Q8: Is there any stage-3 issue related to SON for NR-U that you would like to raise?**

|  |  |
| --- | --- |
| Company | Comments |
| Nokia | If the RLF is due to T304, in case NR-U the LBT caused waiting time can be taken from the T304 timer and therefore the RLF report is proposed to be extended with information about this waiting/deferral time caused by LBT occurring during RA procedure as part of the mobility process. When the waiting/deferral time is significant, the RLF/HOF should be excluded from MRO process.  The same is valid for T304-triggered SHR as already agreed where also the time partition of the T304\_SHR\_percantage taken by LBT caused waiting/deferral time should be added to SHR to improve the usability of the SHR for MRO. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Conclusion

TBD

# 4. References

1. R2-2308899, [Post122][590][R18 SON/MDT] Open issues of SON NR-U (Ericsson), Ericsson discussion

1. [R2-2308473](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_123/Docs/R2-2308473.zip), [SON/MDT enhancements for NR-U](https://ericsson.sharepoint.com/R2-2308473.zip), Samsung

[R2-2308897](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_123/Docs/R2-2308897.zip), [Enhancements of SON reports for NR-U](https://ericsson.sharepoint.com/R2-2308897.zip), Ericsson

# Annex A – Option A to solve Issue#1

In the following, the latest running 38.331 CR for SON on RACH report in R2-2308502 is considered as baseline.

1> set the parameters associated to individual random-access attempt, in the chronological order of attempts in the *perRAInfoList* as follows:

2> if the random-access resource used is associated to a SS/PBCH block, set the associated random-access parameters for the successive random-access attempts associated to the same SS/PBCH block for one or more random-access attempts as follows:

3> set the *ssb-Index* to include the SS/PBCH block index associated to the used random-access resource;

3> set the *numberOfPreamblesSentOnSSB* to indicate the number of successive random-access attempts associated to the SS/PBCH block;

3> if LBT failure indication was received from lower layers for the last random-access preamble transmission attempt in the SS/PBCH block associated to the *ssb-Index*, before changing the SS/PBCH block for random access preamble transmission, set *lbtDetected* to true;

3> if LBT failure indication was received from lower layers for each of the successive random access attempts in the SS/PBCH block associated to the *ssb-Index*, set *allLBTFailures* to *true*;

NOTE 1: if LBT failure indication was received from lower layers for each of the successive random-access preamble transmission attempts in the SS/PBCH block associated to the *ssb-Index*, it is up to the UE implementation how to set the *numberOfPreamblesSentOnSSB*, and the *perRAAttemptInfoList*.

3> for each random-access attempt performed on the random-access resource, except the random-access attempts for which LBT failure indication was received from lower layers, include the following parameters in the chronological order of the random-access attempt:

4> if the random-access attempt is performed on the contention based random-access resource and if *raPurpose* is not equal to '*requestForOtherSI*', include *contentionDetected* as follows:

5> if contention resolution was not successful as specified in TS 38.321 [6] for the transmitted preamble:

6> set the *contentionDetected* to *true*;

5> else:

6> set the *contentionDetected* to *false*;

4> if the random access attempt is a 2-step random access attempt:

5> if fallback from 2-step random access to 4-step random access occurred during the random access attempt:

6> set *fallbackToFourStepRA* to *true*;

4> if the random-access attempt is performed on the contention based random-access resource; or

4> if the random-access attempt is performed on the contention free random-access resource and if the random-access procedure was initiated due to the PDCCH ordering:

5> if the random access attempt is a 4-step random access attempt and the SS/PBCH block RSRP of the SS/PBCH block corresponding to the random-access resource used in the random-access attempt is above *rsrp-ThresholdSSB*; or

5> if the random access attempt is a 2-step random access attempt and the SS/PBCH block RSRP of the SS/PBCH block corresponding to the random-access resource used in the random-access attempt is above *msgA-RSRP-ThresholdSSB*:

6> set the *dlRSRPAboveThreshold* to *true*;

5> else:

6> set the *dlRSRPAboveThreshold* to *false*;

2> else if the random-access resource used is associated to a CSI-RS, set the associated random-access parameters for the successive random-access attempts associated to the same CSI-RS for one or more random-access attempts as follows:

3> set the *csi-RS-Index* to include the CSI-RS index associated to the used random-access resource;

3> set the *numberOfPreamblesSentOnCSI-RS* to indicate the number of successive random-access attempts associated to the CSI-RS;

3> if LBT failure indication was received from lower layers for the last random-access preamble transmission attempt in the CSI-RS associated to the *csi-RS-Index*, before changing the CSI-RS for random access preamble transmission, set *lbtDetected* to true;

3> if LBT failure indication was received from lower layers for each of the successive random-access preamble transmission attempts in the CSI-RS associated to the *csi-RS-Index*, set *allLBTFailures* to *true*;

NOTE 1: if LBT failure indication was received from lower layers for each of the successive random-access preamble transmission attempts in the CSI-RS associated to the *csi-RS-Index*, it is up to the UE implementation how to set the *numberOfPreamblesSentOnCSI-RS*.

RA-InformationCommon-r16 ::= SEQUENCE {

<Text Omitted>

PerRAInfoList-r16 ::= SEQUENCE (SIZE (1..200)) OF PerRAInfo-r16

PerRAInfoList-v1660 ::= SEQUENCE (SIZE (1..200)) OF PerRACSI-RSInfo-v1660

PerRAInfoList-v18xx ::= SEQUENCE (SIZE (1..200)) OF PerRAInfo-v18xx

PerRAInfo-r16 ::= CHOICE {

perRASSBInfoList-r16 PerRASSBInfo-r16,

perRACSI-RSInfoList-r16 PerRACSI-RSInfo-r16

}

PerRAInfo-v18xx ::= CHOICE {

perRASSBInfoList-v18xx PerRASSBInfo-v18xx,

perRACSI-RSInfoList-v18xx PerRACSI-RSInfo-v18xx

}

PerRASSBInfo-r16 ::= SEQUENCE {

ssb-Index-r16 SSB-Index,

numberOfPreamblesSentOnSSB-r16 INTEGER (1..200),

perRAAttemptInfoList-r16 PerRAAttemptInfoList-r16

}

PerRASSBInfo-v18xx ::= SEQUENCE {

lbtDetected-r18 ENUMERATED {true} OPTIONAL,

allLBTFailures-r18 ENUMERATED {true} OPTIONAL,

...

}

PerRACSI-RSInfo-r16 ::= SEQUENCE {

csi-RS-Index-r16 CSI-RS-Index,

numberOfPreamblesSentOnCSI-RS-r16 INTEGER (1..200)

}

PerRACSI-RSInfo-v18xx ::= SEQUENCE {

lbtDetected-r18 ENUMERATED {true} OPTIONAL,

allLBTFailures-r18 ENUMERATED {true} OPTIONAL,

...

}

<Text Omitted>

# Annex B – Option B to solve Issue#1

1> set the parameters associated to individual random-access attempt, in the chronological order of attempts in the *perRAInfoList* as follows:

2> if the random-access resource used is associated to a SS/PBCH block, set the associated random-access parameters for the successive random-access attempts associated to the same SS/PBCH block for one or more random-access attempts as follows:

3> set the *ssb-Index* to include the SS/PBCH block index associated to the used random-access resource;

3> if LBT failure indication was received from lower layers for each of the successive random access attempts in the SS/PBCH block associated to the *ssb-Index*:

4> set the *numberOfPreamblesSentOnSSB* to 1;

3> else:

4> set the *numberOfPreamblesSentOnSSB* to indicate the number of successive random-access attempts associated to the SS/PBCH block;

3> if LBT failure indication was received from lower layers for the last random-access preamble transmission attempt in the SS/PBCH block associated to the *ssb-Index*, before changing the SS/PBCH block for random access preamble transmission; or

3> if LBT failure indication was received from lower layers for each of the successive random access attempts in the SS/PBCH block associated to the *ssb-Index*:

4> set *lbtDetected* to true;

NOTE 1: if LBT failure indication was received from lower layers for each of the successive random-access preamble transmission attempts in the SS/PBCH block associated to the *ssb-Index*, it is up to the UE implementation how to set the *perRAAttemptInfoList*.

3> for each random-access attempt performed on the random-access resource, except the random-access attempts for which LBT failure indication was received from lower layers, include the following parameters in the chronological order of the random-access attempt:

4> if the random-access attempt is performed on the contention based random-access resource and if *raPurpose* is not equal to '*requestForOtherSI*', include *contentionDetected* as follows:

5> if contention resolution was not successful as specified in TS 38.321 [6] for the transmitted preamble:

6> set the *contentionDetected* to *true*;

5> else:

6> set the *contentionDetected* to *false*;

4> if the random access attempt is a 2-step random access attempt:

5> if fallback from 2-step random access to 4-step random access occurred during the random access attempt:

6> set *fallbackToFourStepRA* to *true*;

4> if the random-access attempt is performed on the contention based random-access resource; or

4> if the random-access attempt is performed on the contention free random-access resource and if the random-access procedure was initiated due to the PDCCH ordering:

5> if the random access attempt is a 4-step random access attempt and the SS/PBCH block RSRP of the SS/PBCH block corresponding to the random-access resource used in the random-access attempt is above *rsrp-ThresholdSSB*; or

5> if the random access attempt is a 2-step random access attempt and the SS/PBCH block RSRP of the SS/PBCH block corresponding to the random-access resource used in the random-access attempt is above *msgA-RSRP-ThresholdSSB*:

6> set the *dlRSRPAboveThreshold* to *true*;

5> else:

6> set the *dlRSRPAboveThreshold* to *false*;

2> else if the random-access resource used is associated to a CSI-RS, set the associated random-access parameters for the successive random-access attempts associated to the same CSI-RS for one or more random-access attempts as follows:

3> set the *csi-RS-Index* to include the CSI-RS index associated to the used random-access resource;

3> if LBT failure indication was received from lower layers for each of the successive random access attempts in the CSI-RS associated to the *csi-RS-Index*:

4> set the *numberOfPreamblesSentOnCSI-RS* to 1;

3> else:

4> set the *numberOfPreamblesSentOnCSI-RS* to indicate the number of successive random-access attempts associated to the CSI-RS;

3> if LBT failure indication was received from lower layers for the last random-access preamble transmission attempt in the CSI-RS associated to the *csi-RS-Index*, before changing the CSI-RS for random access preamble transmission; or

3> if LBT failure indication was received from lower layers for each of the successive random access attempts in the CSI-RS associated to the *csi-RS-Index*:

4> set *lbtDetected* to true;