**3GPP TSG-RAN WG4 Meeting #97-e *R4-2017086***

**Electronic Meeting, 2nd – 13 November, 2020**

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| *CR-Form-v12.1* |
| **CHANGE REQUEST** |
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|  | **38.133** | **CR** | **1386** | **rev** | **1** | **Current version:** | **16.5.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network |  | Core Network |  |

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| ***Title:***  | Updates in RLM requirements for NR-U |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | R4 |
|  |  |
| ***Work item code:*** | NR\_unlic-Core |  | ***Date:*** | 2020-10-23 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-16 |
|  | *Use one of the following categories:****F*** *(correction)****A*** *(mirror corresponding to a change in an earlier release)****B*** *(addition of feature),* ***C*** *(functional modification of feature)****D*** *(editorial modification)*Detailed explanations of the above categories canbe found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | *Use one of the following releases:Rel-8 (Release 8)Rel-9 (Release 9)Rel-10 (Release 10)Rel-11 (Release 11)…Rel-15 (Release 15)Rel-16 (Release 16)Rel-17 (Release 17)Rel-18 (Release 18)* |
|  |  |
| ***Reason for change:*** | Misaligned notation.The agreement “For both LBE and FBE, RLM requirements shall not rely on COT” (WF in R4-2005367) is not captured in RLM requirements for NR-U in 38.133.The agreement “UE behaviour when Lin,max is exceeded: For this evaluation period, UE layer 1 shall not send any in-sync indication to higher layers.” (WF in R4-1912851) is not captured. |
|  |  |
| ***Summary of change:*** | The agreements from R4-2005367 and R4-1912851 are captured.Notation corrected. |
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| ***Consequences if not approved:*** | Incomplete and inconsistent specification. |
|  |  |
| ***Clauses affected:*** | 8.1A.1, 8.1A.2.2, 8.1A.5 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS/TR ... CR ...  |
| ***affected:*** | **X** |  |  Test specifications | TS 38.533 |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

## 8.1A Radio Link Monitoring with CCA on Target Frequency

8.1A.1 Introduction

The requirements in clause 8.1A apply for radio link monitoring on a carrier frequency with CCA for cells:

- PCell in SA NR operation mode,

- PSCell in EN-DC operation mode.

The UE shall monitor the downlink radio link quality based on the reference signal configured as RLM-RS resource(s) in order to detect the downlink radio link quality of the PCell and PSCell as specified in TS 38.213 [3]. The configured RLM-RS resources can be all SSBs, or all CSI-RSs, or a mix of SSBs and CSI-RSs. UE is not required to perform RLM outside the active DL BWP.

On each RLM-RS resource, the UE shall estimate the downlink radio link quality and compare it to the thresholds Qout,CCA and Qin,CCA for the purpose of monitoring downlink radio link quality of the cell.

The threshold Qout,CCA is defined as the level at which the downlink radio link cannot be reliably received and shall correspond to the out-of-sync block error rate (BLERout,CCA) as defined in Table 8.1A.1-1. For SSB based radio link monitoring, Qout\_SSB,CCA is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1A.2.1-1.

The threshold Qin,CCA is defined as the level at which the downlink radio link quality can be received with significantly higher reliability than at Qout,CCA and shall correspond to the in-sync block error rate (BLERin) as defined in Table 8.1A.1-1. For SSB based radio link monitoring, Qin\_SSB,CCA is derived based on the hypothetical PDCCH transmission parameters listed in Table 8.1A.2.1-2.

The out-of-sync block error rate (BLERout,CCA) and in-sync block error rate (BLERin,CCA) are determined from the network configuration via parameter *rlmInSyncOutOfSyncThreshold* signalled by higher layers. When UE is not configured with *rlmInSyncOutOfSyncThreshold* from the network, UE determines out-of-sync and in-sync block error rates from Configuration #0 in Table 8.1A.1-1 as default. All requirements in clause 8.1A are applicable for BLER Configuration #0 in Table 8.1A.1-1.

**Table 8.1A.1-1: Out-of-sync and in-sync block error rates**

|  |  |  |
| --- | --- | --- |
| **Configuration** | **BLERout,CCA** | **BLERin,CCA** |
| 0 | 10% | 2% |

UE shall be able to monitor up to NRLM RLM-RS resources of the same or different types in each corresponding carrier frequency range, depending on a maximum number Lmax of SSBs per half frame according to TS 38.213 [3], where NRLM is specified in Table 8.1A.1-2, and meet the requirements as specified in clause 8.1A. UE is not required to meet the requirements in clause 8.1A if RLM-RS is not configured and no TCI state for PDCCH is activated.

**Table 8.1A.1-2: Maximum number of RLM-RS resources NRLM**

|  |  |
| --- | --- |
| **Lmax** | **Maximum number of RLM-RS resources, NRLM**  |
| 8 | 4 |

The requirements in clause 8.1A apply regardless of whether *CO-DurationPerCell* is configured or not [TS 38.213, 3]. The requirements in clause 8.1A apply for any *channelAccessMode* configuration and regardless of whether it is configured or not [TS 38.331, 2].

8.1A.2 Requirements for SSB Based Radio Link Monitoring

8.1A.2.1 Introduction

The requirements in this section apply for each SSB based RLM-RS resource configured for PCell or PSCell, provided that the SSB configured for RLM are actually configured to be transmitted within UE active DL BWP during the entire evaluation period specified in clause 8.1A.2.2 but occasionally may not be transmitted due to CCA operation.

**Table 8.1A.2.1-1: PDCCH transmission parameters for out-of-sync evaluation**

|  |  |
| --- | --- |
| **Attribute** | **Value for BLER Configuration #0** |
| DCI format | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 8 |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 4 dB |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 4 dB |
| Bandwidth (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

**Table 8.1A.2.1-2: PDCCH transmission parameters for in-sync evaluation**

|  |  |
| --- | --- |
| **Attribute** | **Value for BLER Configuration #0** |
| DCI payload size | 1-0 |
| Number of control OFDM symbols | 2 |
| Aggregation level (CCE) | 4 |
| Ratio of hypothetical PDCCH RE energy to average SSS RE energy | 0dB |
| Ratio of hypothetical PDCCH DMRS energy to average SSS RE energy | 0dB |
| Bandwidth (PRBs) | 24 |
| Sub-carrier spacing (kHz) | SCS of the active DL BWP |
| DMRS precoder granularity | REG bundle size |
| REG bundle size | 6 |
| CP length | Normal |
| Mapping from REG to CCE | Distributed |

8.1A.2.2 Minimum Requirement

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_out\_SSB,CCA [ms] period becomes worse than the threshold Qout\_SSB,CCA within TEvaluate\_out\_SSB,CCA [ms] evaluation period.

UE shall be able to evaluate whether the downlink radio link quality on the configured RLM-RS resource estimated over the last TEvaluate\_in\_SSB,CCA [ms] period becomes better than the threshold Qin\_SSB,CCA within TEvaluate\_in\_SSB,CCA [ms] evaluation period. During the in-sync evaluation procedure, layer 1 of the UE shall not send any in-sync indication for the cell to the higher layers when Lin exceeds Lin,max, where Lin and Lin,max are defined in Table 8.1A.2.2-1.

TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA are defined in Table 8.1A.2.2-1, where

- $P=\frac{1}{1-\frac{T\_{SSB}}{MRGP}}$, when in the monitored cell there are measurement gaps configured for intra-frequency, inter-frequency or inter-RAT measurements, and these measurement gaps are overlapping with some but not all occasions of the SSB RLM-RS resources; and

- P=1 when in the monitored cell there are no measurement gaps overlapping with any occasion of the SSB RLM-RS resources.

If the high layer in TS 38.331 [2] signaling of *smtc2*is present, TSMTCperiod follows *smtc2*; Otherwise TSMTCperiod follows *smtc1.*

Longer evaluation period would be expected if the combination of RLM-RS, SMTC occasion, and measurement gap configurations does not meet previous conditions.

**Table 8.1A.2.2-1: Evaluation period TEvaluate\_out\_SSB,CCA and TEvaluate\_in\_SSB,CCA**

|  |  |  |
| --- | --- | --- |
| **Configuration** | **TEvaluate\_out\_SSB,CCA (ms)**  | **TEvaluate\_in\_SSB,CCA (ms)**  |
| **RLM-RS SSB Es/IotNote4 ≥-7 dB** | **RLM-RS SSB Es/Iot Note4 <-7 dB** |
| no DRX | Max(200, Ceil(17\*P)\*TSSB) | Max(200, Ceil(24\*P)\*TSSB) | Max(100, Ceil((5+Lin)\*P)\*TSSB) |
| DRX cycle≤320 | Max(200, Ceil(1.5\*15\*P)\*Max(TDRX,TSSB)) | Max(200, Ceil(1.5\*20\*P)\*Max(TDRX,TSSB)) | Max(100, Ceil(1.5\*(5+Lin)\*P)\*Max(TDRX,TSSB)) |
| DRX cycle>320 | Ceil(13\*P)\*TDRX | Ceil(16\*P)\*TDRX | Ceil((5+Lin)\*P)\*TDRX |
| NOTE 1: TSSB is the periodicity of the SSB configured for RLM. TDRX is the DRX cycle length.NOTE 2: Lin is the number of RLM-RS SSBs which are not available at the UE during TEvaluate\_in\_SSB,CCA, where Lin ≤ Lin,max.NOTE 3: Lin,max=7 for Max(TDRX,TSSB) ≤ 40 assuming TDRX=0 for non-DRX case,  Lin,max=5 for 40<Max(TDRX,TSSB)≤320,  Lin,max=3 for TDRX>320.NOTE 4: RLM-RS SSB Es/Iot is the averaged Es/Iot over the most recent previous out-of-sync evaluation period. |

8.1A.2.3 Measurement Restrictions for SSB based RLM

The UE is required to be capable of measuring SSB for RLM without measurement gaps. The UE is required to perform the SSB measurements with measurement restrictions as described in the following clauses.

When the SSB for RLM is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement,

- If SSB and CSI-RS have same SCS, UE shall be able to measure the SSB for RLM without any restriction;

- If SSB and CSI-RS have different SCS,

- If UE supports *simultaneousRxDataSSB-DiffNumerology*, UE shall be able to measure the SSB for RLM without any restriction;

- If UE does not support *simultaneousRxDataSSB-DiffNumerology*, UE is required to measure SSB for RLM.

### 8.1A.3 Minimum requirement at transitions

When the UE transitions between DRX and no DRX or when DRX cycle periodicity changes, for each RLM-RS resource, for a duration of time equal to the evaluation period corresponding to the second mode after the transition occurs, the UE shall use an evaluation period that is no less than the minimum of evaluation period corresponding to the first mode and the second mode. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second mode for each RLM-RS resource. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

When the UE transitions from a first configuration of RLM resources to a second configuration of RLM resources that is different from the first configuration, for each RLM resource present in the second configuration, for a duration of time equal to the evaluation period corresponding to the second configuration after the transition occurs, the UE shall use an evaluation period that is no less than the minimum of evaluation periods corresponding to the first configuration and the second configuration. Subsequent to this duration, the UE shall use an evaluation period corresponding to the second configuration for each RLM resource present in the second configuration. This requirement shall be applied to both out-of-sync evaluation and in-sync evaluation of the monitored cell.

### 8.1A.4 Minimum requirement for UE turning off the transmitter

The transmitter power of the UE in the monitored cell shall be turned off within 40ms after expiry of T310 timer as specified in TS 38.331 [2]. The UE shall not perform CCA procedure on any of the serving carrier frequencies with CCA after the expiry of T310, except when the UE is performing RRC re-establishment on the PCC with CCA.

### 8.1A.5 Minimum requirement for L1 indication

When the downlink radio link quality on all the configured RLM-RS resources is worse than Qout,CCA, layer 1 of the UE shall send an out-of-sync indication for the cell to the higher layers. A layer 3 filter shall be applied to the out-of-sync indications as specified in TS 38.331 [2].

When the downlink radio link quality on at least one of the configured RLM-RS resources is better than Qin,CCA, layer 1 of the UE shall send an in-sync indication for the cell to the higher layers. A layer 3 filter shall be applied to the in-sync indications as specified in TS 38.331 [2].

The out-of-sync and in-sync evaluations for the configured RLM-RS resources shall be performed as specified in clause 5 in TS 38.213 [3]. Two successive indications from layer 1 shall be separated by at least TIndication\_interval,CCA.

When DRX is not used TIndication\_interval,CCA is max(10ms, TRLM-RS,M), where TRLM,M is the shortest periodicity of all configured RLM-RS resources for the monitored cell, which corresponds to TSSB specified in clause 8.1A.2 if the RLM-RS resource is SSB.

In case DRX is used, TIndication\_interval,CCA is Max(10ms, 1.5 × DRX\_cycle\_length, 1.5 × TRLM-RS,M)) if DRX cycle\_length is less than or equal to 320ms, and TIndication\_interval,CCA is DRX\_cycle\_length if DRX cycle\_length is greater than 320ms. Upon start of T310 timer as specified in TS 38.331 [2], the UE shall monitor the configured RLM-RS resources for recovery using the evaluation period and layer 1 indication interval corresponding to the no DRX mode until the expiry or stop of T310 timer.

### 8.1A.6 Scheduling availability of UE during radio link monitoring

When the reference signal to be measured for RLM on a carrier frequency with CCA has different subcarrier spacing than PDSCH/PDCCH, there are restrictions on the scheduling availability as described in the following clauses.

#### 8.1A.6.1 Scheduling availability of UE performing radio link monitoring with the same subcarrier spacing as PDSCH/PDCCH

There are no scheduling restrictions due to radio link monitoring performed with a same subcarrier spacing as PDSCH/PDCCH.

#### 8.1A.6.2 Scheduling availability of UE performing radio link monitoring with a different subcarrier spacing than PDSCH/PDCCH

For UEs which support *simultaneousRxDataSSB-DiffNumerology* [14] there are no restrictions on scheduling availability due to radio link monitoring based on SSB as RLM-RS. For UEs which do not support *simultaneousRxDataSSB-DiffNumerology* [14] the following restrictions apply due to radio link monitoring based on SSB as RLM -RS.

- The UE is not expected to transmit PUCCH, PUSCH or SRS or receive PDCCH, PDSCH or CSI-RS for tracking or CSI-RS for CQI on SSB symbols to be measured for radio link monitoring.

When intra-band carrier aggregation is performed, the scheduling restrictions on PCell or PSCell applies to all serving cells in the same band on the symbols that fully or partially overlap with the restricted symbols.