**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.1.2

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for RAN4#94e\_#10\_NR\_unlic\_UE\_RF

**Document for:** Information

# Introduction

This document summarizes the email discussion on topics related to NR-U UE RF requirements. The contributions presented on this topic can be divided into the following sub-topics: Tx requirements, Rx requirements, MPR, band combinations.

# Topic #1: Tx requirements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000399**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000399.zip) | Intel Corporation | Title: On NR-U ACLR requirement  Proposal 1: It is proposed to define 27 dB as NR-U ACLR for PC5. |
| [**R4-2002095**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002095.zip) | Qualcomm Incorporated | Title: NR-U general and Band n46 specific Tx requirements  Proposal 1: PC5 is 20 dBm ± 2 dB, PC3 is FFS  Proposal 2: it is proposed that ACLR is superfluous and not needed  Proposal 3: In-band emissions start with eLAA definition but further verification needed   1. The PA model, especially for PC5 at 5 to 7 GHz, is not the same as a 2 GHz LTE PA 2. The LO leakage and IQ image for NR is -28 dBc 3. Modulation should include 256QAM 4. NR-U includes both DFT-S-OFDM as well as CP-OFDM without DFT pre-coding 5. The location of RB’s for DFT-S-OFDM may be shifted relative to the center of a channel that is intended to hold 106 RB’s for 20 MHz CP-OFDM. This may have an impact on the exact RIV waveform and the expected location of image products.   Proposal 4: UL MIMO is allowed for Band n46. UL TxDiv to enable PC3 is subject to general discussion on UL TxDiv.  Proposal 5: it is proposed that the scenarios requiring A-MPR study for Band n46 are the same ones identified for eLAA in Band 46. These include NS\_28 for Europe, NS\_29 for Japan, NS\_30 for US, and NS\_31 for Korea. Companies are encouraged to check whether these regulatory requirements as adopted for eLAA are up to date so that A-MPR simulations and measurements can be conducted. |

## Open issues summary

### Power class

* Option 1: PC5 only (20 dBm ± 2 dB), PC3 is FFS
* Option 2: Both PC5 (20 dBm ± 2 dB) and PC3 (23 dBm ± 2 dB) where PC3 is allowed to be met using TxDiv between two PC5 PA’s

### ACLR

* Option 1: 27 dB
* Option 2: ACLR is not specified for NR-U

### Other Tx requirements

* See proposals 3, 4, and 5 from Qualcomm. Which ones can be agreed? If not, is there a counter-proposal?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1:  Sub topic 1-2:  ….  Others: |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Rx requirements

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2001714**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001714.zip) | Ericsson | Title: TP on Inclusion of NR-U standalone combinations in TR 38 716-01-01:  Proposal 1: Following LAA specification, REFSENS for 15kHz SCS with 20MHz CBW can be reused as -90dBm. However, the other REFENS numbers need to be investigated. |
| [**R4-2002092**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002092.zip) | Qualcomm Incorporated | Title: Band n46 reference sensitivity  Proposal 1. Reference sensitivity values according to Table 1 are agreed.  Proposal 2. Reference sensitivity and all other Rx requirements dependent on reference sensitivity for NR-U are defined with all sub-bands allocated and all downlink RB’s fully allocated.  Proposal 3. MSD requirements are to be defined for CA and EN-DC configurations as identified in Table 2. |
| [**R4-2002093**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002093.zip) | Qualcomm Incorporated | Title: NR-U receiver ACS and blocking  Proposal 1: ACS and blocking requirements apply under static/semi-static conditions of configuration and scheduling only. Interfering signals are to be specified with sub-SCS frequency offset relative to wanted signal.  Proposal 2: For 20 MHz channel bandwidth, the ACS requirements shall be 14 dB with the interferer as a 20 MHz OFDM signal.  Proposal 3: The wanted power level for ACS case 1 shall be REFSENS+14 dB. The necessity of case 2 is to be further evaluated.  Proposal 4: It is proposed that for blocking requirements, in-band blocking and out-of-band blocking, the NR requirements are leveraged for NR-U.  Proposal 5: ACS and blocker bandwidths are the same as the wideband channel bandwidth for NR-U. ACS and blocker values do not need to scale with bandwidth to account for baseband filter transition.  Proposal 6: In-channel ACS and blocking are not defined for NR-U. ACS and blocking are defined in the conventional manner to apply outside of the channel. For wideband NR-U operation, ACS and blocking requirements apply when all sub-bands are allocated in the downlink.  Proposal 7: EN-DC out-of-band blocking exception needed for IM2 products for DC\_2\_n46 and DC\_66\_n46.  Proposal 8: ACS and in-band blocking for NR-U intra-band CA according to the following table. Out-of-band blocking to reuse NR requirements. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Reference sensitivity

* Proposal: Reuse NF from LAA refsens, scale to NR-U bandwidth according to Table 1 of R4-2002092
* Reference sensitivity for wideband – with full allocation, all sub-bands allocated, or partial sub-band allocation?

### ACS and blocking

* Proposals 1 to 8 in R4-2002093. Which ones can be agreed? If not, is there a counter-proposal?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  ….  Others: |

## Summary for 1st round

### Open issues

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|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
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### CRs/TPs

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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: MPR

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000708**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000708.zip) | Skyworks Solutions Inc. | Title: [NRU] Single Carrier Back-off measurements for UE power class and MPR  Proposal 1: Proposal on spectrum mask: the 802.11ax test procedure is adopted for 3GPP measurements and should be reflected in BRAN.  Proposal 2: Proposal on QPSK PA EVM target: PA QPSK EVM budget for PC5 is 12%  Proposal 3:  Power class definition of PC5: 0 dB MPR waveform: 20 MHz 100RB0 fully allocated DFT-s-OFDM QPSK for 27 dB ACLR and NRU SEM passed. Power class tolerance: 20 dBm +2/-3 dB  Power class definition of PC3: 1 dB MPR waveform: 20 MHz 100RB0 fully allocated DFT-s-OFDM QPSK for 30 dB ACLR and NRU SEM passed. Power class tolerance: 23 dBm +2/-3 dB  Proposal 4:  MPR for PC5 QPSK:  o For all (full and interlace) DFT-s-OFDM QPSK waveforms 1 dB MPR  o For all (full and interlace) CP-OFDM QPSK waveforms 2.5 dB MPR  MPR for PC3 QPSK: one additional dB MPR is added to the PC5 case  Observations for A-MPR in section 2.6 |
| [**R4-2000709**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000709.zip) | Skyworks Solutions Inc. | Title: [NRU] Wideband Operation Back-off Measurements for UE  Proposal 1: Proposal on spectrum mask: the 802.11ax test procedure is adopted for 3GPP measurements and should be reflected in BRAN. (Same as Proposal 1 in R42000708)  Proposal 2 on image exception: exception at 28 dBr is confirmed to have acceptable impact to power capability  Proposal 3 on carrier leakage exception: with NRU mask measurement procedure proposed in [3] that uses 100 kHz resolution bandwidth, the exception bandwidth is reduced to 200 kHz  Proposal 4:  MPR definition of PC5:  o For DFT-s-OFDM QPSK waveforms 0.5 dB additional MPR compared to single carrier operation  o For CP-OFDM QPSK waveforms 1 dB additional MPR compared to single carrier operation  o TBC wideband operation with interlace waveforms (the design of these should be clarified)  MPR definition for PC3: given that PC3 has 3 dB better ACLR by default, no additional MPR is needed for the wideband operation compared to single CC case |
| [**R4-2002094**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002094.zip) | Qualcomm Incorporated | Title: NR-U MPR for PC5 single carrier  Emission requirements   * SEM in accordance with the figure in slide 3 of [2]. Measurement bandwidth in the 0 to 1 MHz transition from 0 dBr to -20 dBr was 100 kHz and compared against a requirement scaled to 100 kHz bandwidth. The mask was evaluated in (near)-continuously swept increments. * ACLR was simulated for both 26 dB and 27 dB. While there is no formal agreement on the ACLR requirement yet, the discussion seemed to gravitate to values in this range. * Spurious emissions are the same as for NR; that is, -30 dBm/MHz beyond CBW+5 MHz from the channel edge * EVM partitioned to the PA using an approach similar to [3] and [4] as follows. EVM was not indirectly estimated by time domain or frequency domain spectral analysis, but was computed directly per tone after symbol decoding in the modulation domain.  |  |  |  | | --- | --- | --- | | Modulation | Total transmitter (%) | Partitioned to PA (%) | | QPSK | 17.5 | 8 | | 16QAM | 12.5 | 7.5 | | 64QAM | 8 | 4 | | 256QAM | 3.5 | 1.5 |  * In-band emissions have not yet been discussed and are not included in these simulations.   Baseline results in Table 1  Proposal: Proposed MPR in Table 2. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Emission requirements and measurement methods

Emission requirements need to be agreed in order to properly evaluate MPR. These include power class definition, ACLR, in-band emissions, EVM and PA allocation. With the exception of allocating EVM to the PA (since that will not actually be a specified requirement, but rather an assumption for simulation), the subject of Tx requirements should be handled under “Topic #1: Tx Requirements.” The discussion in on this bullet should be on PA EVM allocation assumption, measurement bandwidth, continuous vs. stepped frequency sweep, etc.

### Baseline and alignment between different companies’ simulators and measurements

It may not be possible to align the simulation results from different simulators or measurements, but it may still be helpful to understand sources of disrepancy. And, a common understanding of waveform definition would certainly be beneficial.

### MPR results

In the moderator’s opinion, it is too premature to try to reach a conclusion on MPR yet since there are only two inputs and both of these are incomplete. Nonetheless, it may still be beneficial for other companies to ask questions, provide comment, or seek clarification for better understanding of the possible MPR as well as to help shape what simulations they may conduct for the next meeting.

### Wideband MPR

Since proposal 1 is already covered in R4-2000708, are there any comments on Proposals 2, 3, and 4 in R4-2000709 on IQ image, LO leakage exception bandwidth, and MPR. Can any of these proposals be agreed? If not, is there a counter-proposal?

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  ….  Others: |

## Summary for 1st round

### Open issues

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| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #4: Band combinations

A number of CA/DC band combination TP’s are presented in this meeting. TP’s are proposed to basket CA and DC TR’s; however, the combinations have not been included those basket work items. The approach should be that the core requirements for the feature (NR-U) along with at least one combination to complete the work item should be done under the NR-U work item. After the work item is completed, then future combinations may be added using the basket work items. Since the core NR-U work item has not been completed yet, then the band combinations should be discussed within the core work item itself rather than the basket work items. One problem is that there is no TR requested in the NR-U WID. Therefore, there is no TR to capture the band combination TP’s. Guidance from the RAN4 chairman is as follows:

Given that NR-U core part is likely to be extended to June 2020, and that the TPs are not going to take much time to agree on, we can consider the following:

1. Focus on the core requirements/baseline requirements at this e-meeting

2. Discuss the TPs and check if the technical analysis in it is complete and correct, but without any endorsement. Comments or conclusions need to be captured in moderator’s summary tdoc

3. Revise the NR-U WID to add a TR for such TPs or revise the relevant R16 basket WIs to add those band combinations in question

4. Revise and re-submit the TPs to the April meeting for approval

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2001714**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001714.zip) | Ericsson | Title: TP on Inclusion of NR-U standalone combinations in TR 38 716-01-01: NR intra band CA for xCC DL/yCC UL including contiguous and non-contiguous spectrum, (x>=y)  Intra-band combinations |
| [**R4-2000190**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000190.zip) | Charter Communications | Title: TP for DC\_n48-n46 |
| [**R4-2000191**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000191.zip) | Charter Communications | Title: TP for CA\_n48-n46 |
| [**R4-2001222**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001222.zip) | MediaTek Inc., Ericsson | Title: Harmonic MSD discussion for DC\_2\_n46, CA\_n25\_n46 |
| [**R4-2002019**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002019.zip) | Ericsson, T-Mobile US, MediaTek | Title: TP to include CA\_n25A-n46A |
| [**R4-2002020**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002020.zip) | Ericsson, T-Mobile US, MediaTek | Title: TP to include CA\_n46A-n66A |
| [**R4-2002021**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002021.zip) | Ericsson, T-Mobile US, MediaTek | Title: TP to include DC\_2A\_n46A |
| [**R4-2002022**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002022.zip) | Ericsson, T-Mobile US, MediaTek | Title: TP to include DC\_66A\_n46A |

## Open issues summary

### Harmonic and harmonic mixing MSD

Option 1: Specify MSD

Option 2: Specify exclusion region

### Other technical content within the TP’s

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 2-1:  Sub topic 2-2:  ….  Others: |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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