**3GPP TSG-RAN WG4 Meeting #97-e R4-201xxxx**

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

**Agenda item:** 7.1.2

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for RAN4#97e\_#107\_NR\_unlic\_UE\_RF

**Document for:** Information

# Introduction

This document summarizes the email discussion on topics related to NR-U UE RF requirements in Agenda 7.1.2, 7.1.2.1, and 7.1.2.2.

# Topic #1: Tx requirements

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2014903**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014903.zip) | Apple Inc. | PC5 NR-U MPR for NS\_53 and NS\_54  Proposal: Remove brackets for all A-MPR found in NS\_53 and NS\_54 |
| [**R4-2015697**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015697.zip) | Huawei, HiSilicon | A-MPR evaluation for NR-U  Proposal 1: A-MPR for NS\_54 is defined in Table 2-2. |

## Open issues summary

### A-MPR for NS\_53 and NS\_54

Simulation results from R4-2014903 have confirmed A-MPR for NS\_53. Moderator recommends that square brackets can be removed from A-MPR table for NS\_53.

For NS\_54 A-MPR, there is a proposal in R4-2015697 to reduce a few values by 0.5 dB due to the increased guard band.

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Agree to remove square brackets for NS\_53. For the proposal on NS\_54, we are still evaluating. |
| Charter Communications Inc | Agree to remove square brackets for NS\_53 and NS\_54 |
| Skyworks | Sub topic 1.1: agree to remove brackets, for improved values we have a question for clarification: are the wideband operation cases considered in this proposal. We found that these have a slightly worse behavior in some partial sub-band cases where the image is symmetrized in the OOB domain. |
| Huawei | To Skyworks: we evaluated two cases: full allocation case and interlace case |

### 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.*

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| **CR/TP number** | **Comments collection** |
| [**R4-2016436**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016436.zip) | Qualcomm: Will need to revise and merge based on outcome of this meeting. |
| Charter Communications, Inc.: We support the removal of the square brackets for 38.101-1 NR-U |
| Skyworks: we will check later based on the outcome of round 1 |
| [**R4-2014916**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014916.zip) | Qualcomm: Will need to revise and merge based on outcome of this meeting. |
| Charter Communications, Inc.: We support the removal of the square brackets for 38.101-1 NR-U |
| Skyworks: we will check later based on the outcome of round 1 |
| Nokia: We can not agree to the introduction of reference to capabilities in section 4.3 and 5.3.3. Other corrections can when agreed be merged with R4-2016436. |

## 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** |
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### 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”* |
| [**R4-2016436**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016436.zip) | Removal of square brackets for 38.101-1 NR-U (Qualcomm Incorporated) |
| [**R4-2014916**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014916.zip) | CR for TS 38.101-1: NR-U UE RF open requirements (Apple Inc.) |

## 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*

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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 #2: Rx requirements

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

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2014185**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014185.zip) | MediaTek Inc. | Discussion and TP for NR-U UE ACS  Proposal 1: ACS for NR-U UE is 25dB for 20MHz channel bandwidth  Moderator’s comment: There is no TP in this document. |
| [**R4-2015018**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015018.zip) | MediaTek Inc. | Architecture and REFSENS discussion for NR-U 6GHz  Proposal 1: RAN4 shall agree on FE architecture and total loss for n96 REFSENS evaluation assumption first  Proposal 2: We propose n96 REFSENS as below table   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | Operating band / SCS / Channel bandwidth | | | | | | | Operating Band | SCS kHz | 20 MHz (dBm) | 40 MHz (dBm) | 60 MHz (dBm) | 80 MHz (dBm) | | n96 | 15 | -88 | -84.9 |  |  | | 30 | -88.2 | -85 | -83.1 | -81.9 | | 60 | -88.4 | -85 | -83.3 | -81.9 |   Proposal 3: 6GHz front-end loss assumption shall be at least 6dB  Proposal 4: We propose n79 REFSENS as below table (1.6dB relaxation than current values) according to FE architecture change |
| [**R4-2014497**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014497.zip) | Skyworks Solutions Inc. | [NRU] UE REFSENS for NRU Band n96  Proposal:  • Band n96 REFSENS is specified as the same than n46  • The only aspect that is different from n46 is a 20% frequency increase and a 4% increase in fractional bandwidth. Only a 0.5dB relaxation could be acceptable to account for this. |
| [**R4-2015799**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015799.zip) | Charter Communications, Inc, Qorvo, Inc. | UE Reference Sensitivity considerations for band n96  Proposal: The reference sensitivity for n96 should be derived by the standalone case. For more complex architectures were multiple bands are integrated with n96, analysis should dictate what the ΔRIB,c. values shall be for such aggregation. The reference sensitivity values for n96 should be the same as n46, worse-case scenario 0.3 dB higher. |
| [**R4-2016294**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016294.zip) | Apple Inc. | REFSENS for n96  Proposal 1: For band n96 a margin of 0.5 dB should be considered compared to band n46 for the REFSENS requirement, as shown in Table 1. |
| [**R4-2016437**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016437.zip) | Qualcomm Incorporated | Reference sensitivity for NR-U band n96  It is proposed to adopt the same value as already agreed for Band n46, which is already significantly relaxed compared to other 3GPP bands and compared to studies conducted by RAN4 in the context of IMT parameters in the same frequency range. |

## Open issues summary

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

### ACS value

The compromise value is [24] dB. Proposal in R4-2014185 is 24.5 dB which is then rounded to 25 dB. Since the previous compromise value was already 24 dB and the calculated value in R4-2014185 is 24.5 dB, the calculated value is no closer to proposal of 25 dB than it is to compromise from many companies of 24 dB. Moderator suggests to accept the 24 dB ACS value and remove the square brackets in the specification. Can companies agree?

### Refsens

It is proposed in R4-2015018 to first agree on a reference architecture and FE loss for Band n96 (at least 6 dB) before deciding reference sensitivity. Do companies feel it is mandatory for RAN4 to agree on a reference architecture and FE loss for band n96 before RAN4 can agree to a reference sensitivity value? The view of the moderator is that reference architecture and FE loss are not requirements that will be specified in 38.101-1, so while it may be helpful it is not absolutely required to agree upon them. It is only required to agree on the reference sensitivity value itself. Do companies have the same or different view?

Reference sensitivity value: Contributions mentioned refsens values 0 dB, 0.3 dB, 0.5 dB, 1.7 dB degraded compared to Band n46. All contributions on this topic included technical justification for their proposals. Reasons cited include increased FE loss due to sharing with other bands, increased LNA noise figure due to wider bandwidth and higher frequency. Moderator requests companies to share views on what value to agree upon for refsens.

It is proposed in R4-2015018 to revisit reference sensitivity for Band n79 due to expected common RF FE with 5 and 6 GHz bands. Proposal to relax Band n79 reference sensitivity by 1.6 dB. The view of the moderator is that the reference sensitivity for Band n79 has already been defined some time ago and network operators may have already planned deployment with this understanding. It seems unfair and inappropriate to degrade the reference sensitivity on an existing band because a new band in a nearby frequency range has been defined. If this were to become a norm, new bands would never be allowed since they might negatively impact another operator’s existing band. At the minimum, before degrading Band n79 reference sensitivity, the opinion of the impacted operators should be sought.

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Sub topic 2.2.1 ACS: Agree to remove square bracket around 24 dB value.  Sub topic 2.2.2 Refsens: We don’t think that formal agreement on reference architecture and parameters such as FE loss are required since it is only the final refsens value that will be specified and different companies may have different architectures or loss budgets for their evaluation. For the reference sensitivity value, we support the same as Band n46. We do not support revisiting the reference sensitivity for n79 due to the introduction of n46 and n96. |
| Charter Communications Inc | Sub-topic 2.2.1 ACS: We are in agreement of removing the square bracket around 24 dB.  Sub-topic 2.2.2 Ref Sens: Several companies have made proposals with values ranging from 0 dB, 0.3 dB, 0.5 dB (2 companies) and one company at 1.7 dB. The average is 0.6dB.  Our proposal is reference sensitivity the same as n46, worse case 0.3dB. For purposes of converging to a value quickly, we are open to the average value. |
| Skyworks | Sub-topic 2.2.1: 24dB ACS is the consensus  Sub-topic 2.2.2: we believe that most of the architecture and additional component aspects that are presented as a delta value to n46 is actually already embedded in the large margin agreed for LAA thus the difference if any is small and can be absorbed in the margin but as discussed in our paper, for the sake of compromise we are OK with an additional 0.5dB. For that same reason n46 cannot be taken as the baseline for n79 numbers and n79 already account for RF front end aspects together with n77: n79 REFSENS should not be re-discussed |
| Huawei | ACS value: as discussed in previous meeting, the relaxed ACS compared to WIFI is not desired. We agree MTK proposal.  Reference sensitivity value: we think extra LNA is a normal impletation which can be considered. Hence lower reference sensitivity can be achieved. We support 0 dB or even lower. |
| MediaTek | Sub-topic 2.2.2: To Skyworks, if I read TR 38.814, it is difficult to tell that band n79 already account for RF front end together with n77 since n79 filter insertion loss is as high to 2.5dB that FE loss may be near 4dB with T/R switch, if adding band switch it will definitely over 4dB FE loss which the number was RAN4 common understanding. Further, it did not consider implementation loss such PCB trace loss, matching components loss as well as connector loss and other components loss such as diplexer/triplexer. And there was only band n79 around the 5GHz range without considering FE configuration with existing LAA.  Regarding R4-2014497, it seems WiFi REFESNS is -82dBm, this number is much worse than any proposal of n46/n96, is there misunderstanding?  We think RAN4 need to consider that from implementation aspect, 5GHz range FE architecture would be different when new NR-U bands are introduced. And RAN4 shall agree on reasonable FE architecture/loss assumption and their impact to REFSENS as well as PA target output power design criteria.  Regarding re-visit n79 REFSENS, if REFSENS of n46 is agreed as is which is 3dB relax than n77 that gives us a hint that n79 REFSENS is too stringent after introducing new NR-U bands. If the n79 REFSENS is not changed, and FE loss were still within 4dB for n79 as well as new NR-U bands, to us it looks like RAN4 would force n46/n79/n96 to using individual antenna for every bands for implementation. Then how man antennas do we need if considering a world phone?  With above clarifications, we think our proposals are reasonable. |
| Qorvo | Sub-topic 2.2.2  We agree with the moderator’s proposal that only the final REFSENS value needs to be agreed and that reference architecture agreement is not essential to achieve this  We support a REFSENS value the same as n46  In terms of n79, we should not degrade the agreed n79 value of REFSENS but instead consider whether the combination of n79 and n46/n96 requires some other more combination specific provision such as delta Rib |
| Ericsson | Sub-topic 2.2.1: 24 dB for the 20 MHz channel bandwidth.  Sub-topic 2.2.2: the same requirement as n46. The NF for 5 GHz already contains margins that should be able to absorb the claimed 1.6 dB difference for the RFFE architecture discussed in R4-2015018. Any impairment of n79 performance can be handled with a specific relaxation for UEs also supporting n46/n96. |
| LG Electronics | We are OK with 24dB ACS.  We do not see need for agreeing nor capturing the reference architecture at this point. We support adopting same REFSENS value for n96 as for n46.  We should not change earlier agreed requirement like n79 REFSENS, but OK to discuss relaxations to certain combinations via using already agreed mechanisms like delta Rib. |

### 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.*

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| **CR/TP number** | **Comments collection** |
| [**R4-2015974**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015974.zip) | Skwyworks: we will review by end of round1 |
| Company B |
|  |
|  | Company A |
| Company B |
|  |

## 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:* |

*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

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

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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”* |
| [**R4-2015974**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015974.zip) | Correction to receiver requirements for shared spectrum channel access (Ericsson) |

## 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 #3: Dual connectivity requirements

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2015927**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015927.zip) | Ericsson, Charter Communications, T-Mobile US | Rel-16 CR 38.101-3 NR-U EN-DC band combinations |
| [**R4-2015803**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015803.zip) | Charter Communications, Inc. | Draft CR to add NR-DC\_n48-n46 combinations |

## Open issues summary

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

Technical requirements for EN-DC combinations with NR-U Band n46 are provided in R4-2015927 as a CR to 38.101-3. However, the general requirements for EN-DC with NR-U (suffix F) are not available. Will there be a “big CR” made available for 38.101-3 or is R4-2015927 intended for that purpose? Are suffix F general requirements needed?

NR-DC combinations are introduced in R4-2015803 to 38.101-1 in a draft CR. However, general requirements for NR-DC with NR-U are not yet available. For example, ACS is defined for NR-U in clause 7.5F of 38.101-1, with NR-U CA in sub-clause 7.5F.2. DC with NR-U could possibly be added as sub-clause 7.5F.3 but a discussion is welcomed. Furthermore, while NR-DC is included in the NR-U WID [RP-192926] as scenario E, it is included in the Objective section of the WID that scenario E “will be treated with lower priority in the context of this WI.” There are no band combinations listed for Scenario E in Annex A of the WID so the band combinations in R4-2015803 are without support in the WID and there is no mention of NR-DC in the work item exception sheet [RP-202099]. The moderator recommends to have brief discussion and collect comments on R4-2015803, but that this topic should be treated with lower priority since the focus of this meeting should be to complete those items listed in the WID and in the exception sheet.

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| Qualcomm | EN-DC combinations, we think that suffix F general requirements are still needed. If it is agreed there is no additional requirement requirement, then it would be better to indicate that in Suffix F.  NR-DC combination needs general requirements also. |
| Charter Communications Inc. | We are open to further discussions regarding whether suffix F needs further general requirements. We will like companies to discuss if this is the case during round 1. If no additional general comments are needed then we can indicate this in suffix F. A draft revision can be made with the appropriate changes and further discussed in round 2. Once agreement is reached in round 2, a revision of the original CR can be requested to get it finalized and approved.  For the NR-DC combinations, the goal of this draft CR is to have companies made comments regarding the technical content. Once these comments are available, a revision can be made (round 2) to incorporate the changes and get the revised draft CR technically endorsed. We considered the discussion of this draft CR fairly straight forward and it should not take too much time from the other items of higher priority like the items in the exception sheet |
| Skyworks | R4-2015927:Table 7.3B.2.3.4-2 has wrong UL config for LTE band 48  R4-2015803:  Table 5.5B.1-1: n48 configuration n48D/E are not feasible and not specified  Table 6.2B.1.3-1: which NRDC power class for PC3 NR and PC5 NRU: I believe PC3 should apply: same for ENDC.  Some table format issues and void reused |
| Charter Communications , Inc | Thanks Skyworks for the feedback. I will make the changes suggested and request for a revision of the draft. Perhaps offline I can get further feedback on “Some table format issues and void re-used”. It will be greatly appreciated to avoid multiple revisions. |

## 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:* |

*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

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

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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”* |