**3GPP TSG-RAN WG4 Meeting # 98-e R4-210xxxx**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

**Agenda item:** 9.19.1

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [98e][118] NR\_PC2\_CA\_R17\_2BDL\_2BUL

**Document for:** Information

# Introduction

This email discussion thread is related to NR PC2 CA basket WI, and will focus on the topic of following aspects:

* Topic #1: draft TR and revised WID
* Topic#2: UE RF requirements
  + Issue 2-1-1: MSD analysis
  + Issue 2-1-2: TPs for approval

Note that the tables for collecting comments for sub-topic issues are arranged just below each issue.... and the tables for collecting comments for CR/TP are still kept at the original position.

# Topic #1: draft TR and revised WID

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2101125 | China Telecom | **Abstract**:This draft TR provides the draft TR v0.2.0, which was reserved for email approval and aims to reflect the TP approved in this meeting. |
| R4-2101126 | China Telecom | **Abstract**:revised WI to update the WI code according to MCC suggestion and the target completion time. |

## Open issues summary

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

### Sub-topic 1-1: draft TR and revised WID

This sub-topic will discuss rapporteur input for draft TR and revised WID.

**Issue 1-1-1: draft TR**

* Recommended WF
  + It is recommended for email approval for the draft TR of R4-2101125

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| **Company** | **Comments on Issue 1-1-1: draft TR** |
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**Issue 1-1-2: Revised WID**

* Summarization for the WID revision
  + Update the WI code according to MCC suggestion and the target completion time.
* Recommended WF
  + It is recommended to approve the revised WID of R4-2101126

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| **Company** | **Comments on Issue 1-1-2: Revised WID** |
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## 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:* No comments on the issue 1-1-2, the revised WID is recommended as endorsed.  *Candidate options:*  *Recommendations for 2nd round:*  No need discuss on 2nd round. Topic #1 is closed |

*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** |
| R4-2101125 | For email approval |
| R4-2101126 | Endorsed |
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## Discussion on 2nd round (if applicable)

Topic #1 is closed

# Topic #2: UE RF requirements

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2100273 | Verizon Denmark | TP for TR38.xxx for PC2 CA\_n2A-n77A |
| R4-2100274 | Verizon Denmark | TP for TR38.xxx for PC2 CA\_n5A-n77A |
| R4-2100276 | Verizon Denmark | TP for TR38.xxx for PC2 CA\_n66A-n77A |
| R4-2100285 | LG Electronics France | Proposal 1: For cross-band isolation issue of PC2 NR inter band CA UE, the proposed MSD values in Table 5 shall be considered in TS38.101-1.  Proposal 2: For IMD problem by dual uplink transmission of PC2 NR inter band CA UE, the proposed MSD values in Table 9 shall be considered in TS38.101-1. |
| R4-2102220 | ZTE Corporation, CMCC | TP for TR38.xxx\_Clarification on PC2 CA\_n28A-n41A, CA\_n28-n79A and CA\_n40A-41A |
| R4-2102221 | ZTE Corporation, CMCC, Xiaomi | TP for TR38.xxx\_ PC2 CA\_n41A-n79A |
| R4-2102713 | vivo | Observation 1: As PC2 UE has higher maximum output power and larger dynamic power range, the linearity requirements of RF components is more stringent to meet the similar MSD requirement of PC3 UE.  Observation 2: To support multi-RAN, multi-bands, wide bandwidth, maintaining isolation in the limit area is a challenge.  Observation 3: CQI can already implicitly signal the quality of UE receiver sensitivity. Network would not have to rely on new capability to differentiate UE.  Proposal 1: MSD improvement analysis per band combination for PC3 UE is proposed.  Proposal 2: The MSD improvement is proposed to base the minimum requirement, new UE capability for MSD is not needed. |

## Open issues summary

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

### Sub-topic 2-1: UE RF requirements

This sub-topic will discuss UE RF requirements for proposed combinations.

**Issue 2-1-1: MSD analysis for PC2 NR inter-band CA**

* Proposals (R4-2100285)
  + Proposal 1: For cross-band isolation issue of PC2 NR inter band CA UE, the proposed MSD values in Table 5 shall be considered in TS38.101-1.

**Table 5 MSD due to cross band isolation for PC2 for CA band combinations**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NR Band / Channel bandwidth of the affected DL band / MSD | | | | | | | | | | | | | |
| UL band | DL band | 5 MHz  (dB) | 10 MHz  (dB) | 15 MHz  (dB) | 20 MHz  (dB) | 25 MHz  (dB) | 30 MHz  (dB) | 40 MHz  (dB) | 50 MHz  (dB) | 60 MHz  (dB) | 70 MHz  (dB) | 80 MHz  (dB) | 90 MHz  (dB) | 100 MHz  (dB) |
| n41 | n25 | **2.3** | **2.3** | **2.3** | **2.3** |  |  |  |  |  |  |  |  |  |
| n41 | n66 | **5.3** | **5.3** | **5.3** | **5.3** |  |  |  |  |  |  |  |  |  |
| n78 | n40 | **6.5** | **6.5** | **6.5** | **6.5** |  |  |  |  |  |  |  |  |  |
| n77 | n41 | **6.5** | **6.5** | **6.5** | **6.5** |  |  |  |  |  |  |  |  |  |
| n41 | n77 |  | **10.5** | **10.5** | **10.5** | **9.5** | **8.6** | **8.3** | **7.2** | **6.3** | **6.0** | **5.7** | **5.6** | **[5.6]** |

* + Proposal 2: For IMD problem by dual uplink transmission of PC2 NR inter band CA UE, the proposed MSD values in Table 9 shall be considered in TS38.101-1.
* **Table 9: Proposed MSD test configuration and results by IMD problems for PC2 NR inter-band CA UE**

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| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CA bands | UL band | IMD | UL Fc  (MHz) | UL BW (MHz) | UL  RB # | DL Fc  (MHz) | DL BW (MHz) | MSD  (dB) |
| CA\_n41A-n71A | n41 | IMD4  |3\*fn71 -fn41| | 2614 | 5 | 25 | 2614 | 5 | **18.2** |
| n71 |  | 665 | 5 | 25 | 619 | 5 | N/A |
| CA\_n2A-n77A | n2 | IMD2  |fn2 -fn77| | 1855 | 5 | 25 | 1935 | 5 | **32.6** |
| n77 | 3790 | 10 | 50 | 3790 | 10 | N/A |
| n2 | IMD4  |3\*fn2 -fn77| | 1885 | 5 | 25 | 1965 | 5 | **17.5** |
| n77 | 3690 | 10 | 50 | 3690 | 10 | N/A |
| CA\_n5A-n77A | n5 | IMD4  |3\*fn5 -fn77| | 844 | 5 | 25 | 889 | 5 | **17.7** |
| n77 | 3421 | 10 | 50 | 3421 | 10 | N/A |
| CA\_n66A-n77A | n66 | IMD2  |fn66 -fn77| | 1730 | 5 | 25 | 2130 | 5 | **34.6** |
| n77 | 3860 | 10 | 50 | 3860 | 10 | N/A |
| n66 | IMD5  |3\*fn66 -2\*fn77| | 1730 | 5 | 25 | 2130 | 5 | **10.8** |
| n77 | 3660 | 10 | 50 | 3660 | 10 | N/A |
| CA\_n71A-n77A | n71 | IMD5  |4\*fn71 -fn77| | 681.5 | 5 | 25 | 635.5 | 5 | **12.2** |
| n77 | 3361.5 | 10 | 50 | 3582.5 | 10 | N/A |

* Recommended WF
  + Collect views on these two proposals

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| **Company** | **Comments on Issue 2-1-1: MSD analysis for PC2 NR inter-band CA** |
| **ZTE** | Generally, the MSD should be discussed per case per band combination. For FDD-TDD NR CA combination, case a(23+23) and case b(23+26) are applied, and for TDD-TDD NR CA combination, case a(23+23), case b(23+26), case c(26+23) and case d(26+26) are applied. We think the MSD should be defined for each power configuration.  For example: CA\_n41A-n71A, we think MSD should be defined for case b/c/d for IMD MSD. But from the table, it seems no different cases are distinguished. |
| Huawei | Our MSD estimation for the ULCA combo are listed below.   |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | | **Combo** | **IMD Order** | **IMD** | **LGE (R4-2100285)** | **Verizon, Ericsson** | **Huawei** | | CA\_n2A\_n77A | IMD2 | n2-n77 | 32.6 | 32 | 31.7 | |  | IMD4 | 3\*n2-n77 | 17.5 | 20 | 19.8 | | CA\_n5A\_n77A | IMD4 | 3\*n5-n77 | 17.7 | 20.3 | 17.8 | |  | IMD5 | 4\*n5-n77 | n/a | 20.5 | [16.4] | | CA\_n41A\_n71A | IMD4 | 3\*n71-n41 | 18.2 | n/a | 17.9 | | CA\_n66A\_n77A | IMD2 | n66-n77 | 34.6 | 37 | 31.4 | |  | IMD5 | 3\*n66-2\*n77 | 10.8 | 20 | <3 | | CA\_n71A-n77A | IMD5 | 4\*n71-n77 | 12.2 | n/a | 14.4 |   Similar to our comments in the EN-DC PC2 thread, the MSD for IMD5 of CA\_n66A\_n77A should be double checked due to large variations among proposals. |
| Qualcomm | According to the table summary from Huawei, the MSD values are extremely large. Except for the IMD5 of n66\_n77, the MSD values range from 12.2 dB to 32.6 dB. Can anyone (operator, infra-vendor, UE vendor) tell me how MSD values like this can be used in a real network deployment? Does your company think that these values are useful (other than as an indication that CA should not be deployed where such MSD’s exist)? My understanding is that a network cannot be deployed with these MSD’s. If that is the case, is there any need to specify them at all? |
| Verizon | We continually support the MSD improvement, also realize the proposals are still under discussion. Our proposals are for urgent deployment and follow the existing approach for the MSD values. We want to use our current proposals and let RAN4 approve our proposals in this meeting before an agreement reached for the MSD improvement.  Two more clarifications, first, we are in confident for the derived the MSD values. This is because we used the same formula as Mediatek commented, and then we further made an average of individual value with LGE results based on current existing MSD approach.  In addition, we have considered the PA in 3dBm increase from PC3 to PC2 in FDD UL following the RF architectures for both option a) and b).  We do not understand how Huawei MSD estimates their results (suggest them to exchange all of the assumptions with others). Also, we do not quick get the ZTE question about the difference of power allocation for both case a) and case b) from realistic RF architecture. But, RAN4 should discuss this further as part of MSD improvement. |
| LGE | We are fine the final VzW TPs will propose the MSD values for these CA band combinations. The MSD will be derived as average manner as same LTE CA and NR DC.  For the MSD for IMD2, LGE, HW and MTK results quite aligned within 31.4~34dB for case A.  Also the difference level is 1~3 dB for IMD3 and IMD4. So RAN4 can make decision for MSD levels for PC2 for Case A. For the case B, we can need more inputs from interested companies. |
| China Telecom | We tend to define the MSD values based on the power class cases at least for the TR now, in case MSD is specified by cases in the spec. Maybe just only the worst case is specified in order to make the spec simplifier or by following method from EN-DC case, that could be decided in next meeting. |
| **MediaTek** | There are proposals in R4-2100273, R4-2100274, R4-2100276. From PC3 to PC2, MSD would be raised based on 3 \* (order of aggressor UL) dB. MSD due to harmonic mixing shall be added ~ 3dB for all cases since it is proportional to 1st order of UL power. Since there are different MSD values proposed, it is suggested to take average values between the companies’ proposals. For case b, those MSD values could be even higher (at least 3dB higher) due to 3dB higher output power in band n77 |
| Vivo | MSD is the minimum requirement, it doesn’t exclude better implement. And network deployment can consider another typical MSD. |
| Huawei | Regarding the question on how our MSD values are derived, allow me to clarify as follows. We’ve contributed many MSD analysis to 3GPP and the assumptions on isolation, IP2/3/4/5 etc were published in early papers. Actually they’re similar to the ones used in LGE’s paper. For PC2, the main change is the output power is increased from 20 to 23 dBm on each band. We believe equal power allocation is the worst case for IMD. Due to the constraint of CA power class, if n77 is transmitting at 26 dBm, the other band cannot transmit simultaneously. The extra TX power may increase the MSD caused by cross band isolation, but wouldn’t affect IMD.  Moreover, it can be seen that our MSD values are close to those proposed by LGE except n66+n77, while the proposals from Verizon seem to be the outliers. This cast doubt on their estimations. Actually we’re not so confident as Verizon in their results.  We agree in principle that the final MSD values take the average of proposals. However, we strongly encourage companies to double check the case of n66+n77. |

**Issue 2-1-2: TPs for approval**

* Proposed TPs
  + R4-2100273, R4-2100274, R4-2100276, R4-2102220, R4-2102221
* Recommended WF
  + Collect the comments for proposed TPs in the section 2.3.1. If no comments for certain of TP’s, the TP’s will be recommended as approved.

### Sub-topic 2-2: MSD improvement

**Issue 2-2-1: MSD improvement**

* Proposals (R4-2102713)
  + Proposal 1: MSD improvement analysis per band combination for PC3 UE is proposed.
  + Proposal 2: The MSD improvement is proposed to base the minimum requirement, new UE capability for MSD is not needed.
* Recommended WF
  + Collect views on these two proposals

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| **Company** | **Comments on Issue 2-2-1: MSD improvement** |
| **Nokia** | We don’t think that the Observation 3 justifies denying necessity of new UE capability. The point is that by seeing huge MSD, network even may not try to configure CA. Even if we assume dual UL becomes active, then, suddenly DL quality degrades and network would de-configure the CA. This may be repeated. And this is an unnecessary overhead.  For proposal 1, we need to study if there is meaningful information by having two types requirements for both PC3 and PC2 UL before we agree with this proposal.  For proposal 2, as commented to the Observation 3, we need a new UE capability to make network aware which UEs can deal with the noise impact on its DL due to IMD/Harmonics. |
| ZTE | **Issue 2-1-2:** |
|  | For these three TPs: R4-2100273, R4-2100274, R4-2100276, it seems the MSD for case a and case b are the same. But we think they are not the same, especially for IMD MSD, since the power allocation for case a and case b are different.  **Issue 2-2-1:**  In principle we also agree with the possibility for the MSD improvements. The question is how to improve the MSD if there are no agreements on the aggressive parameters?  Also we have a question for clarification. if define two sets of MSD value, does it mean that the completed combination with high MSD needs to be re-defined? Even for PC3.  We agree with Proposal 2. |
| Huawei | This is a PC2 WI. Proposal 1 is about PC3 hence should not be discussed here. For the various reasons as described in Vivo’s paper, MSD improvement is very challenging. The evidence in the paper to support Proposal 2 is lacking. Moreover, as we commented in the EN-DC PC2 thread, the MSD values defined in the spec do not preclude certain UE implementations to have smaller degradations. And this potential advantage could be seen by the network from CQI report, ACK/NACK feedback, etc. Hence we do not see the need for two sets of requirements or new UE capability. |
| Qualcomm | On proposal 1, we are ok to also evaluate PC3, but we started with PC2 because the MSD will be even larger for PC2. On proposal 2, we still see the value in signaling. It is more direct and much more accurate and reliable than detection based on CQI reporting. In fact, I find it doubtful that CQI reporting or ACK/NAK counting will even detect this sort of interference in a reliable manner and would be very slow consuming a lot of overhead. |
| Verizon | First, the discussed MSD improvement here should not delay the exiting proposals from this meeting, because the related discussions are still in high-level above the grand.  Also, Verizon support the MSD improvement and shared the comments from Qualcomm and others above for both PC3 and PC2. RAN4 should have a detail approach from companies. |
| LGE | **Issue 2-1-2: TPs for approval**  These TPs will be updated by VzW based on the consensus in e-mail discussion  **Issue 2-2-1: MSD improvements**  Prefer proposal 2 as The MSD improvement is proposed to base the minimum requirement, new UE capability for MSD is not needed. |
| OPPO | **Issue 2-2-1:** We also don’t see how this can be called an improvement. The minimum requirements are defined based on the assumption of UE implementation ability in PCB design, and of course UE might be able to do better than the minimum requirement but this is always the case. If we define a requirement that is not realistic for most of the UE then it is no longer minimum requirements and people can always come to RAN4 ask defining “improved” requirements with capability. The magic door is open. Thus we do not think this is the correct way to “improve” requirements. |
| CHTTL | Issue 2-2-1: MSD improvements  We share the same view as Nokia and Qualcomm to have the new capability. In addition to the benefits mentioned above, it is not possible to revisit the defined MSD in the current spec, so we think additional set of requirement and a capability to inform the network is necessary. |
| Vivo | MSD improvement starting from PC2 may be challenging, if improvement is needed, it’s better to start from PC3.  In fact, MSD improvement may be totally unnecessary. If only UE with better MSD can be configured with CA, UE capability for inter-band CA seems useless. Actually, UE supporting inter-band CA, but with too large degradation, seem no reason to exist in the real network. More reasonable solution may be is to declare not supporting this inter-band CA combination. |
| Xiaomi | **Issue 2-2-1: MSD improvements**  The MSD value in current spec is just the minimum requirements, which doesn’t preclude any UEs with better MSD in reality. From our view, the better MSD can be implicitly reflected by the reporting channel quality for BS scheduling. So we don’t see the benefit of introducing this improved requirements. In addition, we think current MSD requirements which are derived with case by case manner are reasonable from implementation point of view. |
| Huawei | 2-2-1:  UE vendors have been polishing their product design all the time, including MSD improvement. However, whether the bar in 3GPP requirements should be raised is a different issue.  Firstly as seen from numerous papers, lower order IMD products such as IMD2 tend to cause excessive MSD (e.g. > 30 dB). However, no concrete solutions have been proposed to reduce IMD2. The parameters used in the analysis are based on surveys of state-of-the-art components from various vendors. Unless there’s breakthrough in transceiver design or component performances, we don’t see a clear path on reducing IMD2.  Secondly, the impact of large MSD may have been exaggerated. It depends on the combination of carrier frequencies. By carefully planning the carrier frequencies of the two bands, the IMD product may not fall inside the DL carrier. Furthermore, the MSD analysis corresponds to an extreme case, i.e., the UL is transmitting at max power and DL is receiving at REFSENS level, e.g. at the cell edge. In this case, it’s debatable whether UE should use ULCA at all or only Tx at the low frequency band. When the UE moves closer to the base station or the channel fading improves, the UE Tx power could be reduced and the IMD level would be decreased even faster, proportionate to the IMD order. In other words, the IMD interference may no longer be the limiting factor.  Based on the above analysis, it’s not true that certain UL CA combo is not usable simply because of large MSD defined in the spec. Meanwhile, the feasibility of MSD improvement (such as reducing IMD2) is not clear. It’s premature to conclude whether we should have new UE capability or two sets of requirements. |
| Apple | We share similar view to Huawei and OPPO. We prefer to have only one set of minimum requirements which allows enough room for implementation variations and increasing PCB density. |

## Companies views’ collection for 1st round

### CRs/TPs comments collection

The following table aims to collect the comments for proposed TPs. If no comments for certain of TP, the TP will be recommended as approved in the summary for 1st round.

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2100273 | company A: |
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| R4-2100274 |  |
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| R4-2100276 |  |
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| R4-2102220 |  |
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| R4-2102221 |  |
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## 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#2-1** | *Tentative agreements:*  No comments on the TP R4-2102220, TP R4-2102220 is recommended as approved.  The TP R4-2102221 is based on proposal in topic 1 of thread 117, it is recommended to check with Apple and Huawei who have comments on this. TP R4-2102220 is recommended as return to.  Continue discuss on the revisions of the TP’s from Verizon. The TP R4-2100273, R4-2100274 and R4-2100276 are recommended as revised to  *Candidate options:*  *Recommendations for 2nd round:* Continue discussion on the revised or return to TP’s on 2nd round |
| **Sub-topic#2-2** | *Candidate options for information:*  Options on Reference sensitivity exception sets:  Option1: Specify additional set of requirements which are improved comparing to existing/minimum requirements   * Whether need a capability to inform the network is FFS   Option2: Keep only one set of minimum requirements, no need to improve  Option3: Keep only one set of minimum requirements, update if necessary/request to improve  Option4: Other options are not precluded.  *Recommendations for 2nd round:* Continue discuss on 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** |
| R4-2100273 | revised to R4-2103169 |
| R4-2100274 | revised to R4-2103170 |
| R4-2100276 | revised to R4-2103171 |
| R4-2102220 | approved |
| R4-2102221 | return to |

## Discussion on 2nd round (if applicable)

**Issue 2-1-2(continual): TPs for approval**

Continue discussion on the revised or return to TP’s

The following table aims to collect the comments for revised or return to TPs. If no comments for certain of TP, the TP will be recommended as approved.

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2100273 -> R4-2103169 | company A: |
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| R4-2100274 -> R4-2103170 |  |
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| R4-2100276 -> R4-2103171 |  |
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| R4-2102221 | Huawei: As we commented in the 117 thread, we believe n79 could suffer from harmonic interference from n41 in case of large CBWs, even for PC3 (see R4-2016483). Since the MSD numbers are not agreed yet, we suggest to use FFS for harmonic MSD in this TP. Alternatively, we could come back to the TP in the next meeting. |
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**Issue 2-2-1 (continual): MSD improvement**

Continue discussion based on the following candidate options

*Candidate options for information:*

Options on Reference sensitivity exception sets:

Option1: Specify additional set of requirements which are improved comparing to existing/minimum requirements

* Whether need a capability to inform the network is FFS

Option2: Keep only one set of minimum requirements, no need to improve

Option3: Keep only one set of minimum requirements, update if necessary/request to improve

Option4: Other options are not precluded.

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| **Company** | **Comments on Issue 2-2-1 (continual): MSD improvement** |
| **Nokia** | Option 1. Just for clarification, we do not propose to make the improved MSD values mandatory for all the new UEs. The requirements themselves are optional. If what Qualcomm mentioned in their paper in the last meeting is true, in some cases, UE vendors’ whole effort has been in vain in the real field because network cannot distinguish UEs with better performance and the others. In the end, network may not configure both UEs to UL CA because the values in the 3GPP specification are quite pessimistic. This current situation is lose-lose situation. |
| **Huawei** | As discussed before, we don’t see the need to change the way how MSD is defined in the current specs. Hence our preferred option is Option 2. If other companies wish to continue, a better place should be found so that we don’t have to repeat the same discussions in both 118 and 119. |
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