**3GPP TSG-RAN WG4 Meeting # 98-e R4-2103307**

**Electronic Meeting, 25 Jan. – 05 Feb., 2021**

**Agenda item:** 9.20

**Source:** Moderator (China Unicom)

**Title:** Email discussion summary for [98e] [ENDC\_UE\_PC2\_R17\_NR\_TDD]

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

# Topic #1: PC2 for EN-DC

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2100266 | Verizon | TP for TR 37.826 for DC\_2\_n77 |
| R4-2100268 | Verizon | TP for TR 37.826 for DC\_5\_n77 |
| R4-2100269 | Verizon | TP for TR 37.826 for DC\_13\_n77 |
| R4-2100271 | Verizon | TP for TR 37.826 for DC\_66\_n77 |
| R4-2100286 | LGE | **Proposal 1**: For cross-band isolation issue of PC2 DC UE, the proposed MSD values in Table 3 shall be considered in TS38.101-3.**Proposal 2**: For IMD problem by dual uplink transmission, the proposed MSD values in Table 7 shall be considered in TS38.101-3. |

## 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: TP for TR 37.826

* Recommended WF
	+ Consider the proposed values in Table-7 of R4-2100286, it is recommended to approve the PC2 combinations captured in TP R4-2100266, R4-2100268, R4-2100269 and R4-2100271 with agreeable MSD values.

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Sub topic 1-1: We think the MSD should be discussed for case a(23+23) and case b(23+26) for PC2 FDD-TDD ENDC combination separately. A question for clarification, the cross band isolation MSD for 2+n41, 66+n41 and 7+n78 are only applied for case b(23+26) power configuration? And also for IMD MSD, is it only applied to case b(23+26) power configuration?For the TPs, it seems all of the TPs are not use the TR template, i.e. not split the subclause for case a(23+23) and case b(23+26) . Also we think it is no need to include OOB exception blocking requirements since it have already included for PC3 combination.Others: |
| Huawei | Sub topic 1-1:Our MSD estimation for the EN-DC combos are listed below.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Combo** | **IMD Order** | **IMD** | **LGE (R4-2100286)** | **Verizon, Ericsson** | **Huawei** |
| DC\_2A\_n77A | IMD2 | B2-n77 | 32.6 | 32 | 31.7 |
|   | IMD4 | 3\*B2-n77 | 17.5 | 20 | 19.8 |
| DC\_5A\_n77A | IMD4 | 3\*B5-n77 | 17.7 | 20.3 | 17.8 |
|   | IMD5 | 4\*B5-n77 | N/A | 20.5 | [16.4] |
| DC\_13A\_n77A | IMD5 | 4\*B13-n77 | 11.3 | 20.5 | 14.3 |
| DC\_66A\_n77A | IMD2 | B66-n77 | 34.6 | 37 | 31.4 |
|   | IMD5 | 3\*B66-2\*n77 | 10.8 | 20 | <3 |

There’re significant variations on the MSD for IMD5 of DC\_66A\_n77A. On the other hand, our estimation is close to LGE’s for DC\_13A\_n77A. The cause of MSD is IMD5 in both cases, but the orders of the frequency components are different. Moreover, for DC\_13A\_n77A, the main source of IMD5 is PA forward mixing, however, this is no longer the case for DC\_66A\_n77A. We encourage companies to double check IMD5 for DC\_66A\_n77A. |
| Qualcomm | According to the table summary from Huawei, the MSD values are extremely large. Except for the IMD5 of 66\_n77, the MSD values range from 11.3 dB to 34.6 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 DC 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 shared same comments as Qualcomm above and support the MSD improvement. We also realize the proposals are still under discussion. And, our proposals to this meeting 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.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, then we further made average of individual values with LGE based on the current approach. In addition, we have counted the PA in 3dBm increase from PC3 to PC2 in FDD UL carrier with the RF architecture.For ZTE comment about the TR template, we referred the [R4-2014649.zip](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014649.zip) with the same format as Rapporteur suggested.  |
| LGE | We can make same comment as in [118] e-mail thread. 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. |
| **MediaTek** | Same comment was made in thread [118]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 |
| **Huawei** | Copy our comments from [118]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. 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 66+n77. |

### 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

*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:* MSD values in the TPs need to be revised.*Candidate options:**Recommendations for 2nd round:* Continue discussion and to agree on TPs for the proposed PC2 combos. |

*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*

|  |  |
| --- | --- |
| **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”* |
| R4-2100266 | *To be revised* |
| R4-2100268 | *To be revised* |
| R4-2100269 | *To be revised* |
| R4-2100271 | *To be revised* |

## Discussion on 2nd round (if applicable)

Comments are collected based on draft revision2 of TP R4-2100266/ R4-2100268/ R4-2100269/ R4-2100271 uploaded to the draft folder [98e][119] ENDC\_UE\_PC2\_R17\_NR\_TDD.

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| revision2 of R4-2100266 | LGE :support TP |
| Company B |
|  |
| revision2 of R4-2100268 | LGE :support TP |
| Company B |
|  |
| revision2 of R4-2100269 | LGE :support TP |
| Company B |
|  |
| revision2 of R4-2100271 | LGE :support TP |
| Company B |
|  |

## 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”* |
| R4-2103175 | *TP is” to be approved”.* |
| R4-2103176 | *TP is” to be approved”.* |
| R4-2103177 | *TP is” to be approved”.* |
| R4-2103178 | *TP is” to be approved”.* |

# Topic #2: MSD for PC2 combinations

*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** |
| R4-2101184 | CHTTL | **Proposal 1**: RAN4 should continue discussing the possibility of improving MSD requirements. The starting point can be from the existing PC2 combinations in the specifications.**Proposal 2**: Agree on the new capability for the improved MSD. If the UE support this capability for specific inter-band EN-DC combinations with IM2/IM3 self-desense issue, the rule for single UL allowance is not applicable and dual uplink shall be mandatorily supported. |
| R4-2102415 | Qualcomm | **Proposal 1**: Two options have been presented in this paper. Our preference is Option 1.***Option 1***: Define two sets of MSD values – one according to more aggressive assumptions and the other using conventional assumptions. Companies are free to use aggressive assumptions according to their own technical judgment and experience. There is no need to agree to the assumptions themselves, but only to the final MSD value.***Option 2***: For MSD values > 10 dB, do not list any specific value in 3GPP (just specify as >10 dB). The actual value could then possibly come as an operator requirement outside of 3GPP. |

## 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

*Sub-topic description:*

*Open issues and candidate options before e-meeting:*

**Issue 2-1: MSD for PC2 combinations**

* Proposals:
	+ Option 1: MSD requirements are calculated based on existing assumptions.
	+ Option 2: RAN4 study the possibility of improving MSD requirements based on options listed in R4-2101184 and R4-2102415.
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Sub topic 2-1: We support Option 2. For R4-2101184, we agree with the proposal 1. For proposal 2, we would not need “the rule for single UL allowance is not applicable and”.For R4-2102415, we support Option 1 in principle, but we also need to think about if we specify aggressive MSD and non-aggressive MSD only for PC2 and/or those for PC3. Others: |
| ZTE | Currently, we support option 1. But in principle we also agree with the possibility for the MSD improvements. So if the aggressive parameters are approved for MSD improving, we can also accept option 2. In addition, 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.Moreover, it seems it would be no need to introduce capability for MSD, MSD value is the RF requirement to illustrate the self-interference and are calculated by different parameters assumption. |
| Huawei | Sub topic 2-1:We support option 1. The 3GPP convention is to define the minimum requirements. For the same UE power class, there should be only one set of requirements. Some implementations may perform better under the same channel conditions, which can be seen by the network from CQI report or ACK/NACK feedback. This is business as usual. There’s no need to define new capability for this. Moreover, the scheduling of dual UL is under the control of the base station. The benefit of defining two sets of MSD values is dubious. |
| Qualcomm | We support option 2. We don’t see the value to specify a minimum requirement that is 30 dB of degradation. No network will operate in that condition, so we don’t see it as a minimum requirement because it does not work. We also do not believe that CQI and ACK/NAK counting will be accurate and reliable. Instead, they will not detect the problem, they will be very slow, and they will consume a lot of network resources in the meantime. The only real 3GPP-based option we see is to improve the MSD. |
| Verizon | Verizon supports Option 2.  |
| LGE | **Issue 2-1: MSD for PC2 combinations**Prefer option1. We are similar view with ZTE, HW. 3GPP RAN4 make min. RF requirements for communication device. So the UE type is different, then we can consider different min. requirements.But this is for smartphone type UE. So only need one set of RF requirements. |
| MediaTek | **Issue 2-1:****Option 1 shall be baseline for RAN4 spec. But we do not against option 2. We can still study improving UE performance. There’s no conflict between the two options. Aggressive MSD values shall be discussed and agreed case by case for every combinations that basket WI approach is not proper for the discussion. New capability signalling also need to be considered.** |
| DISH | **Issue 2-1: We support option 2. In addition, we think it’s appropriate to address large MSD’s for PC3 as well in a holistic manner.** |
| OPPO | **Option 1** MSD requirements are calculated based on existing assumptions. |
| CHTTL | We also support option 2. And within the option 2, we think the possibility to improve is to have a new capability and another additional set of requirements , since it is not possible to revisit the defined MSD in the current spec, also the progress of new proposed or on-going PC2 combos will not be delayed due to the MSD improvement discussion.  |
| Vivo | MSD is the minimum requirement, it doesn’t exclude better implement. And network deployment can consider another typical MSD.In fact, MSD improvement may be totally unnecessary. Actually, UE supporting ENDC, 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 ENDC combination.  |
| Huawei | Copy our comments from [118]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 all 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 yet.Secondly, the impact of large MSD may have been somewhat 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. UE at the cell edge. In this case, it’s debatable whether UE should use dual TX at all or only Tx at the low frequency band. When the UE moves closer to the base station or the channel condition improves, the UE Tx power could be reduced and the IMD level would decrease 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 EN-DC combo is not usable at all simply because of large MSD defined in the spec. Meanwhile, the feasibility of MSD improvement (such as reducing IMD2) is not clear. Therefore it’s premature to conclude whether we should have new UE capability or two sets of requirements. |
| Apple | We support Option 1 as MSD requirements should be calculated on existing assumptions. As stated during discussing of last meeting we do not see the benefit in improving MSD via optional capability signaling and prefer to have only one set of requirements. |

### 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

*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.*

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:* *Candidate options:**Recommendations for 2nd round:* Companies can further discuss whether new MSD with more aggressive assumptions are needed for PC2 combinations. |

*Suggestion on WF/LS assignment*

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

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

Companies can further discuss whether new MSD with more aggressive assumptions are needed for PC2 combinations.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Nokia | We believe that additional MSD requirements together with a capability are quite useuful. 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, the network may not configure both UEs to EN-DC because the values in the 3GPP specification are quite pessimistic. This current situation is lose-lose situation.  |
| LGE | Same as 1st round. As UE vendor perspective it is already considered to derive MSD with enhanced RF component performance. So not necessary to define additional capability. |
| DISH | We are supporting the idea to look at large MSD values, and what could be done to mitigate those. At the end it is no-ones (operator, UE vendor, chipset vendor, RF FE vendor) benefit if specification allows e.g 30dB MSD. The thing is that there is no operator who would deploy band combination with that assumption. Instead, they go to vendors and require better performance. Then at the end of the day vendors have multiple beyond 3GPP defined performance requirements from operators for a given band combination which they have to somehow manage, which is time/resource consuming. We understand the background and rationales why/how 3GPP has chosen certain assumptions for MSD calculations starting from the “legendary” CA\_4A-17A for LTE H3 almost 10 years ago. In general, that system has worked well in the sense that it has been possible to define requirements of some kind for virtually any kind of band combination. We also understand that as long as RAN4 continues using the approach of conservative assumptions guaranteeing ample design margin for e.g PCB isolation and PA linearity, the MSD numbers especially for IMD2 look nasty. Large MSD’s (IMD2) have become more of an issue because of EN-DC (2UL) and the fact that many LTE mid-bands and combined with NR high bands, and then later replaced by similar NR combination. Vendors need some design margins to operate efficiently, there is no question about that. However, we truly believe that now RAN4 has a chance to improve the specifications for said large MSD’s. It has been interesting to note that actually no vendor has said that it is impossible from technical perspective to do that. |
| Huawei | As expressed before, we believe the existing specs can already accommodate diverse UE implementations with different MSD performances and the network can schedule the UEs accordingly based on UE feedback. We don’t see the benefit of defining additional requirements/capabilities. Moreover, if companies wish to continue, it’s better for the discussions to take place at a more suitable place so that we don’t have to repeat the same arguments in both 118 and 119. |
| Qualcomm | We agree with the comments from Nokia and Dish. We do not believe there is any value to defining requirements that are not usable and it is our observation (also expressed by Dish) that operators will simply circumvent 3GPP to define proprietary requirements that meet their needs and that UE vendors are able to deliver. Perhaps to move forward and to motivate reluctant UE vendors, we should take a poll among operators on whether there is interest to improve MSD values in 3GPP or whether the current methodology is acceptable. |
| T-Mobile USA | We support improved MSD. We agree with the comments from Nokia, DISH and Qualcomm.  |
| CHTTL | We also share the same view as Nokia and Dish. The cell edge performance is also very important from our perspective, also here the target MSD improvement includes the harmonic and the IMD, even only Tx at the low frequency band is used, the MSD for second harmonic is still very large. |
| Verizon | We agree with the comments from Nokia, Dish, Qualcomm, T-Mobile and CHTTL. As mentioned in [118] thread, the related enhancements are truly needed for the UEs to deal with the noise impact on its DL due to IMD/Harmonics because of MSD level is getting worse and worse from PC3, PC2 and PC1.5.In practical, the option 1 is a good solution, which allows additional set of requirements with the enhancement comparing to existing/minimum requirements. Meanwhile, the existing approach will be kept too. We truly believe RAN4 has a chance now to improve the related requirements in 3GPP specifications. |
| **Vivo** | Prefer option 1. It’s too aggressive to start improving MSD from PC2 UE. UE capability for inter-band CA combination is already specified, the minimum requirement of MSD can be updated if necessary, additional optional requirement is not needed. |
| ZTE | Similarly as 1st round, currently we support option 1, but in principle we also agree with the possibility for the MSD improvements if the full picture such as benefit, capability, aggressive parameters, and how it will impact the future work for PC2/PC3 combinations etc... are clear. Seems more discussions are needed. |
| Apple | As commented in the first round and last meeting we don’t prefer to have an optional capability and agree with Huawei that more aggressive MSD is not required as the network could use UE feedback. |

## 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”* |