**3GPP TSG-RAN WG4 Meeting #94-e R4-2002700**

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

**Agenda item:** 9.14

**Source:** Moderator (Sprint)

**Title:** Email discussion summary for RAN4#94e\_#27\_LTE\_NR\_B41\_Bn41\_PC29dBm

**Document for:** Information

# Introduction

This e-mail discussion will cover contributions for the LTE\_NR\_B41\_Bn41\_PC29dBm Work Item, submitted under Agenda Item 9.14.

To submit comments delegates are asked to enter comments in the appropriate tables below in this word doc, rename the file by adding your company name at the end (before .docx). To limit the number of e-mail attachments, delegates are requested to upload the file to the draft inbox in this e-mail discussion input for 29 dBm HPUE:

<ftp://ftp.3gpp.org/tsg_ran/WG4_Radio/TSGR4_94_e/Inbox/Drafts/%2327_LTE_NR_B41_Bn41_PC29dBm/e-mail_discussion_input/>

or

<https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_94_e/Inbox/Drafts/%2327_LTE_NR_B41_Bn41_PC29dBm/e-mail_discussion_input>

Note: To upload files you must use your 3GPP userid and password to login. If you are not able to login, then you can send the file to the reflector with the proper subject for this discussion: RAN4#94e\_#27\_LTE\_NR\_B41\_Bn41\_PC29dBm

Also, if you are able to upload your comment file, in order to let everyone know that there are new comments please send an e-mail to the reflector with the subject RAN4#94e\_#27\_LTE\_NR\_B41\_Bn41\_PC29dBm to announce that your file has been uploaded.

The documents in agenda item 9.14 contain the following four main topics and sub-topics:

* Topic #1: B41/n41 Intra-band EN-DC A-MPR / MPR Improvements
  + Issue 1-1: Can PC2 A-MPR be re-used for PC 1.5?
  + Issue 1-2: A-MPR improvements
  + Issue 1-3: Basic scenario/condition for gNB measurement accuracy requirements
* Topic #2 Issues specific to 29 dBm HPUE
  + Issue 2-1: PC 1.5 behavior when P-Max is not present
  + Issue 2-2: Transmit diversity
  + Issue 2-3: 29 dBm HPUE Power Class Logic
  + Issue 2-4: EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability
  + Issue 2-4: Draft CRs

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

* 1st round: Deadline Wednesday 5pm UTC Feb. 26
* 2nd round: Deadline Thursday 5pm UTC Mar.5

# Topic #1: B41/n41 Intra-band EN-DC A-MPR / MPR Improvements

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000007**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000007.zip) | Apple | **A-MPR Proposal for B41/n41 EN-DC**  Proposal 1: Proposal:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **-13dBm/MHz** | | | | | | **MA =** | **11 :** | **0** | **< B <** | **0.54** | |  | **10 :** | **0.54** | **< B <** | **1.08** | |  | **8 :** | **1.08** | **< B <** | **2.16** | |  | **6 :** | **2.16** | **< B <** | **11.88** | |  | **6 :** | **11.88** | **< B <** | **25.2** | |  | **6 :** | **25.2** | **< B <** | **-** |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **-25dBm/MHz** | | | | | | **MA =** | **15 :** | **0** | **< B <** | **1.08** | |  | **14 :** | **1.08** | **< B <** | **2.16** | |  | **12 :** | **2.16** | **< B <** | **11.88** | |  | **10 :** | **11.88** | **< B <** | **25.2** | |  | **6 :** | **25.2** | **< B <** | **-** |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **-30dBm/MHz** | | | | | | **MA =** | **18 :** | **0** | **< B <** | **1.08** | |  | **17 :** | **1.08** | **< B <** | **2.16** | |  | **14 :** | **2.16** | **< B <** | **11.88** | |  | **12.5 :** | **11.88** | **< B <** | **25.2** | |  | **6 :** | **25.2** | **< B <** | **-** | |
| [**R4-2001239**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001239.zip) | LGE | **New A-MPR curves for 29dBm HPUE B41/n41 EN-DC**  **Observation 1:** The current Rel-15 A-MPR curves of -13 dBm/MHz SEM and -25 dBm/MHz SE cannot satisfy the requirements when NS\_04 signaling is indicated for 29 dBm HPUE B41/n41 EN-DC in Rel-16.  **Proposal 1:** It is proposed to take below figure 4, figure 5, and figure 6 as new A-MPR curves for 29 dBm HPUE EN-DC in Rel-16.  **Figure 4. New A-MPR for NS\_04 additional SEM to meet -13 dBm/MHz**  A-MPRIM3 for NS\_04 additional SEM to meet -13 dBm/MHz = MA where MA is defined as follows:  MA =  12 dB; 0≤B<0.54  10 dB; 0.54≤B<1.08  8 dB; 1.08≤B<5.4  6 dB; 5.4≤B<8.1  5 dB; 8.1≤B<13.5  4 dB; 13.5≤B  **Figure 5. A-MPR for NS\_04 SE to meet -25 dBm/MHz for 29 dBm HPUE**  A-MPRIM3 for NS\_04 SE to meet -25 dBm/MHz for 29 dBm HPUE = MA where MA is defined as follows:  MA =  15 dB; 0≤B<1.08  14 dB; 1.08≤B<5.4  13 dB; 5.4≤B<8.1  12 dB; 8.1≤B<10.8  11 dB; 10.8≤B<13.5  10 dB; 13.5≤B<21.6  9 dB; 21.6≤B  **Figure 6. A-MPR for general SE to meet -30 dBm/MHz for 29 dBm HPUE**  A-MPRIM3 for general SE to meet -30 dBm/MHz for 29dBm HPUE = MA where MA is defined as follows:  MA =  18 dB; 0≤B<1.08  17 dB; 1.08≤B<2.16  16 dB; 2.16≤B<2.7  15 dB; 2.7≤B<5.4  14 dB; 5.4≤B<10.8  13 dB; 10.8≤B  **Proposal 2:** any new defined A-MPR curves in this Work item should be only applied to 29 dBm HPUE that supports dual PAs and it shouldn’t be applied to general cases. |
| [**R4-2000423**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000423.zip) | Sprint | **CR for 38.101-3: Allocation aware MPR for intra-band EN-DC**  **CR to make intra-band EN-DC MPR allocation aware, as was done already for A-MPR.** |
| R4-2000425 | Sprint | **Applying the PC2 A-MPR requirements to PC1.5**  Tdoc is late. Pre-meeting e-mail discussions made it apparent that this issue needs to be addressed. A draft will be provided in the folder for this e-mail discussion: <ftp://ftp.3gpp.org/tsg_ran/WG4_Radio/TSGR4_94_e/Inbox/Drafts/%2327_LTE_NR_B41_Bn41_PC29dBm/>  <https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Inbox/Drafts/%2327_LTE_NR_B41_Bn41_PC29dBm> |

## Open issues summary

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

Intra-band EN-DC A-MPR improvements are in the scope of the WI, but so far agreement cannot be reached on acceptable A-MPR improvements. Also, there is an issue if PC2 EN-DC A-MPR can be re-used for PC1.5 EN-DC.

Allocation aware MPR was proposed at RAN#93 in but there were comments that the power classes should be removed from the section headings.

### Sub-topic 1-1 Can PC2 A-MPR be re-used for PC 1.5?

This sub-topic is for discussion of whether PC1.5 EN-DC can use the same A-MPR as PC2 EN-DC, or if different A-MPR needs to be defined for PC 1.5 EN-DC.

Under the guidance of the RAN4 UE RF chairman the 29 dBm HPUE Work Item has been focused on improving A-MPR for B41/n41 intra-band EN-DC. Some delegates believed the same A-MPR would apply both the PC2 EN-DC UEs as well as 29 dBm 1.5 UEs, while others apparently think the A-MPR needs to be different. This has not been formally agreed at this point but needs to be discussed and agreed before the requirements for 29 dBm HPUE can be finalized.

**Issue 1-1: Is Can PC2 A-MPR be re-used for PC 1.5?**

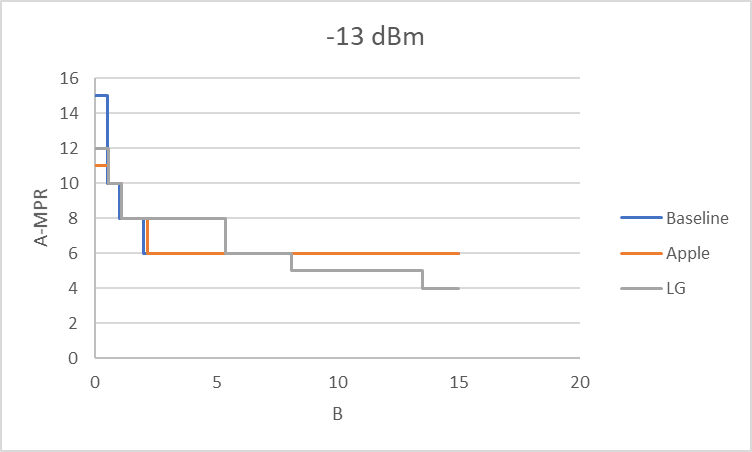
* Proposals
  + Option 1: Agree that PC2 EN-DC A-MPR also applies to PC 1.5 EN-DC
  + Option 2: Agree that separate A-MPR is needed for PC 1.5 EN-DC
  + Option 3: Approve a Way Forward
* Recommended WF
  + Agree that PC2 EN-DC A-MPR can be reused for PC 1.5 EN-DC

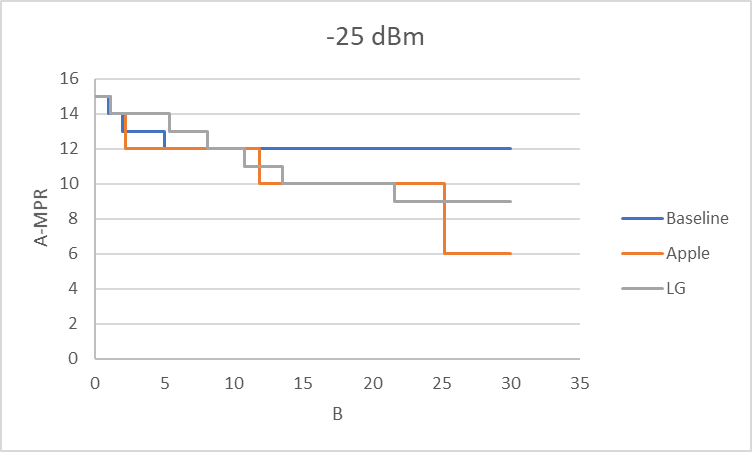
### 1-2: A-MPR improvements

A-MPR improvements have been discussed for several meetings, and there are two proposals at this meeting related to B41/n41 intra-band EN-DC.

**Issue 1-2: A-MPR improvements**

* Proposals





* + Option 1: Apple: A-MPR Proposal for B41/n41 EN-DC
  + Option 2: LGE: New A-MPR curves for 29dBm HPUE B41/n41 EN-DC
  + Option 3: Keep the A-MPR curves as they are.
  + Option 4: Merge proposals. Previous proposals from Skyworks, Intel and Sprint can be considered.
* Recommended WF
  + Attempt to agree on a proposal or merge proposals

### Sub-topic 1-3: Allocation aware MPR

Sprint has proposed allocation Aware A-MPR in [**R4-2000423**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000423.zip)**.** This would bring MPR in line with the allocation-aware A-MPR improvement that has already been incorporated in 38.101-3.

A Draft CR was presented in Reno for allocation Aware A-MPR [R4-1915418](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_93/Docs/R4-1915418.zip). The only feedback was a question about why 26 dBm was in the section title. This has been corrected. This CR is in scope of the WI but otherwise independent of the 29 dBm HPUE work, so the CR could be agreed independent of the rest of the CRs for the WI, just as the CR for allocation aware A-MPR was already approved.

**Issue 1-3: Allocation aware MPR CR**

* Proposals
  + Option 1: Agree the CR in [**R4-2000423**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000423.zip)
  + Option 2: Note the CR.
* Recommended WF
  + Agree the CR in [**R4-2000423**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000423.zip)

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Skyworks | Sub topic 1-1:  Since AMPR for PC2 is based on two 26dBm PAs same AMPR back-off can be used for PC1.5 but restricted for NS04. The only difference is that in the PC2 case power will be capped by power class (ie both PAs cannot be simultaneously at 26dBm). Some text addition in the section may be beneficial for people understanding). similarly the AMPR cannot be used as is for PC2 with 2 PC3 PAs.Sub topic 1-2:  Input on MPR and AMPR from Intel and Skyworks in previous meetings should be considered in the discussion  [**R4-2000007**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000007.zip) **and** [**R4-2001239**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001239.zip)  **: question for clarification: are the -13/-25/-30dBm/MHz proposed back-off related to H3?**  **If so should it be understood as?**   * **DC\_(n)41 and DC\_41\_n41 NS04 should apply -13 and -25 dBm/MHz depending on IM3 position as A-MPR** * **DC\_(n)41 NS01 should apply -13 dBm/MHz only as MPR** * **DC\_41\_n41 NS01 should apply -13 or -30dBm/MHz depending on IM3 position as MPR**   Sub topic 1-3:  ….see CR comment  Others: |
| Qualcomm | Withdraw the comment |
| Huawei | Sub topic 1-2:  For A-MPR, prefer option 2: Agree that separate A-MPR is needed for PC 1.5 EN-DC. |
| LG Electronics | Sub topic 1-1:   * Proposal   + Option 2: Agree that separate A-MPR is needed for PC 1.5 EN-DC   Currently, there is at least one company believes that both 26dBm PAs can possibly transmit simultaneously at 26dBm with 3dB A-MPR on each RAT to define A-MPR for PC2 EN-DC. As we all know, LTE is always the first priority in EN-DC mode and NR will be dropped if LTE reaches its maximum power level which is 26dBm for PC2 EN-DC. For dynamic power sharing, the maximum power on each RAT (even for 26dBm + 26dBm PC2 EN-DC architecture) should be limited to 23 dBm. For PC1.5, I have no doubt that each RAT can be set to 26dBm equally. Based on our understanding above, it is clear that A-MPR for PC2 EN-DC can’t be reused for PC1.5 EN-DC and the current Rel-15 A-MPR can be modified (some ranges can be relaxed and improved like R4-2001239) so that the modified A-MPR can cover both PC2 and PC1.5.  At the beginning when RAN4 started to discuss about improved A-MPR for PC1.5, one company suggests the improved A-MPR for PC1.5 as an optional feature. Since then, we’ve been proposing new A-MPR that can satisfy the emission requirement for PC1.5. In RAN4 #94-e, the company proposed to reuse PC2 A-MPR for PC1.5 and this was even late submission. And then, the company is asking why LGE compare A-MPR for PC1.5 to the current Rel-15 A-MPR for PC2. Then, why reuse the current Rel-15 A-MPR for PC2 for PC1.5 all of sudden?  It is clear that maximum output power can’t be transmitted on each RAT as 26dBm even if its PC2 EN-DC architecture is 26dBm + 26dBm. The maximum output power should be set to 23dBm on each RAT when measuring your A-MPR. However, sprint has been defining A-MPR for PC2 EN-DC based on the assumption that each RAT transmit 26dBm equally. This assumption is not valid when considering dynamic power sharing in Rel-16.  Sub topic 1-2: answers to Skyworks   * Proposal   Option 2: LGE: New A-MPR curves for 29dBm HPUE B41/n41 EN-DCA. LGE: Our proposals are related to IM3.  • DC\_(n)41 and DC\_41\_n41 NS04 should apply -13 and -25 dBm/MHz depending on IM3 position as A-MPR  • DC\_(n)41 NS01 should apply -13 dBm/MHz only as MPR  • DC\_41\_n41 NS01 should apply -13,-25, and -30dBm/MHz depending on IM3 position as MPR  Q. Shouldn’t we discuss the equal power back off based on the agreed WF (R4-1910306)? We can discuss A-MPR including unequal power back off in the future.  The current Rel-15 A-MPR for PC2 can’t satisfy the emission requirements based on our measurement and we keep telling that some specific range needs to be relaxed in order to meet the requirements. Since there is a relaxation in the middle range in our new A-MPR, we can cover both PC2 and PC1.5. However, we can’t reuse the current Rel-15 A-MPR for PC2 to PC1.5 if there is no relaxation and the same A-MPR for PC2 apply to the middle range.  Sub topic 1-3:   * Proposal   + Option 2: Note the CR.   This MPR improvement is based on a dual PAs architecture and should a single PA architecture be baseline for general intra-band (non-contiguous/contiguous) EN-DC MPR? I’m also worried that this MPR improvement will consider only one specific band scenario, not general. In addition, I would like to remind us all that we are here to benefit the entire industry, not just a certain group or a company. |
| Intel | **Issue 1-1: Is Can PC2 A-MPR be re-used for PC 1.5?**   * Proposals   + Option 2: Agree that separate A-MPR is needed for PC 1.5 EN-DC   The reason is existing spec for PC3 and PC2 is per UE power class. Now we have different PC 1.5.  [update]: After checking the existing 38.101-3 “ the backoff is relative to 26dBm for a power class 2 cell group ” , Option 1 is ok.  **Issue 1-2: A-MPR improvements**   * Proposals   + Option 4: Merge proposals. Previous proposals from Skyworks, Intel and Sprint can be considered.   Intel previous contribution R4-1911029 - Take values with 10dB antenna isolation |
| Sprint | **Sub topic 1-1:**  We explained in the draft of R4-2000425 why we believe that the per-RAT PC2 A-MPR can be re-used for PC1.5. In fact, the LGE proposal in R4-2001239 compares the LG proposed A-MPR to the 3GPP A-MPR. So, if the PC2 A-MPR can’t be re-used for PC1.5, why compare the PC1.5 proposal to the PC2 A-MPR in 38.101-3? And if there was some fundamental difference between PC1.5 A-MPR and PC2 A-MPR, how come LGE is proposing less A-MPR small values of B and for large values of B, but more A-MPR only mid-range values of B? Why would PC1.5 require more A-MPR at the middle of the curve, but less A-MPR at the near and far ends of the curve compared to PC2?  Can we agree that the PC2 A-MPR curves can be reused for PC1.5 since PC1.5 uses two PC2 PAs?  We do agree that the spec needs to be clearer about which A-MPR applies under which circumstances. We proposed such clarification in Chengdu, but others felt it was no necessary. This is how we believe A-MPR for each side should be applied:   |  |  |  |  |  |  |  | | --- | --- | --- | --- | --- | --- | --- | | EN-DC PC | LTE PA | A-MPR | relative to | NR PA | A-MPR | relative to | | PC3 or PC2 | PC3 | PC3 | 23 dBm | PC3 | PC3 | 23 dBm | | PC3 or PC2 | PC2 | PC3 | 23 dBm | PC3 | PC3 | 23 dBm | | PC3 or PC2 | PC3 | PC3 | 23 dBm | PC2 | PC3 | 23 dBm | | PC3, PC2 or PC1.5 | PC2 | PC2 | 26 dBm | PC2 | PC2 | 26 dBm |   There was a statement from above from LGE that says “Currently, there is at least one company…” We assume the company is Sprint. ☺ We would prefer to defend something that we actually said, rather than an attempted paraphrase of what we said. We think there should be plenty of material in R4-2000425 to quote and challenge if we are mistaken about anything. Please let us know what we missed.  Sprint never said that a PC2 UE could transmit at 26 dBm on each PA simultaneously. What we said was that measurements were made with two 26 dBm PAs and, as anyone can read in the 38.101-3, the A-MPR for PC2 EN-DC is defined per cell group and relative to 26 dBm on each RAT for each 26 dBm cell groups, and relative to 23 dBm for 23 dBm cell groups:  “A-MPR in this clause is relative to 26 dBm for a power class 2 Cell Group. The same A-MPR is used relative to 23 dBm for a power class 3 Cell Group.”  For the existing Rel-15 A-MPR curves there is at least 6 dB of A-MPR, meaning a PC2 EN-DC UE with two 26 dBm PAs taking the maximum A-MPR could transmit at 20+20=23 dBm. So, a PC1.5 UE could also use the same A-MPR and transmit at 20+20=23dBm. Even with the proposal from LGE for -13 dBm A-MPR above the minimum A-MPR would be 4 dB, so 22 dBm + 22 dBm =25 dBm, which also could apply to PC2 or PC1.5 as LGE notes.  So, it seems like the real issue is stated by LGE above “The current Rel-15 A-MPR for PC2 can’t satisfy the emission requirements based on our measurement and we keep telling that some specific range needs to be relaxed in order to meet the requirements.” So regardless of PC2 or PC1.5 it seems like LGE would like to have relaxed A-MPR defined. Is this correct?  **Sub topic 1-2:**  We support the Apple Proposal for modified A-MPR. We appreciate LGE’s effort to provide improved A-MPR for part of the curves, but cannot support the LGE proposal for A-MPR relaxation in other parts of the curves. We don’t understand why LGE says that their new proposed curve could apply to both PC1.5 and PC2, but also that new curves are needed for PC1.5. Is the new A-MPR really needed for both PC2 and PC1.5 for the LGE tested devices?  **Sub topic 1-3:**  Sprint doesn’t have a strong interest in MPR because we always use NS\_04, but we were encouraged to propose the same “allocation aware” improvement for MPR as we have already gotten into the specs for NS\_04 A-MPR. We brought a draft CR to RAN4#93 and only received one comment about a section heading. Since we went through the trouble of writing this CR for the benefit of other operators and not Sprint, we would appreciate the CR being agreed.  On the comment from LGE above, “In addition, I would like to remind us all that we are here to benefit the entire industry, not just a certain group or a company.” I’d like to remind LGE that Sprint will not ever use MPR for B41/n41, so this CR was written precisely to benefit the industry, and not in any way to benefit Sprint. ☺ |
| Apple | Sub topic 1-1  We agree that the A-MPR values we are defining now for 2x26dBm Tx chains can be used for PC2 as well as for PC1.5 as the same Tx chains are used for this power class. Hence, for 2x26dBm Tx chains the separation of PC2 and PC1.5 won’t hold any benefit.  From the discussion I get the impression that there is an interest in using different configurations like 2x23dBm Tx chains or chains with asymmetric power. But using a different configuration would result into another measurement campaign for these configurations. The WF(R4-1910306) states that: “*New A-MPR curve will be associated with Modified MPR bits and thus would be optional.”* Could we eventually use modified MPR bits to signal certain A-MPR configurations? This would need a separate WF of course.  Sub topic 1-2   1. We are fine with including previous proposals as they are part of the definition process 2. Our proposals use IM3 and ACLR. We observed that small aggregated allocation sizes are limited by IM3 but larger sizes are limited by ACLR. As the UE has to comply to all spectral requirements ACLR has to be used for larger aggregated allocation sizes. We propose to consider this issue as some contributions seem to only have regarded IM3 for their proposals. 3. Due to LGE strengthened their position on higher A-MPR need for certain allocation sizes we conducted further measurements to close some gaps in our proposal. Additional measurements showed that some allocation sizes indeed need higher A-MPR as Rel-15 baseline. To correct this we would like to update our proposal:  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **-13dBm/MHz** | | | | | | **MA =** | **11 :** | **0** | **< B <** | **0.54** | |  | **10 :** | **0.54** | **< B <** | **1.08** | |  | **9 :** | **1.08** | **< B <** | **2.16** | |  | **8 :** | **2.16** | **< B <** | **5.4** | |  | **6 :** | **5.4** | **< B <** | **11.88** | |  | **6 :** | **11.88** | **< B <** | **25.2** | |  | **6 :** | **25.2** | **< B <** | **-** |  |  |  |  |  |  | | --- | --- | --- | --- | --- | | **-25dBm/MHz** | | | | | | **15 :** | **0** | **< B <** | **1.08** | | **14 :** | **1.08** | **< B <** | **5.4** | | **12 :** | **5.4** | **< B <** | **25.2** | | **10 :** | **25.2** | **< B <** | **-** |   Sub topic 1-3  Allocation aware MPR proposal seems fine for us.  Only the equations in 6.2B.2.2.1 seem to have errors with the variable naming. The variables with FIM3,xxx have to be corrected. |
| Qorvo | Sub topic 1-1  We believe it is important to reiterate/confirm that PC2 capable PAs were utilized for all previous PC2 intra-band EN-DC measurements used to develop PC2 A-MPR, with each RAT measurements starting at 26dBm. This would be the same setup and measurements for evaluating A-MPR for PC1.5, and therefore, we believe that the same A-MPR would apply for PC1.5.  Further, the same PA chains being implemented in handset today for support of PC2 B41\_n41 are both PC2 capable, and would not likely change design for implementation of PC1.5 in handsets moving forward. The only difference is the power limit due to PPowerClass,EN-DC, which become 29 dBm instead of 26 dBm. |
| Skyworks | We also support that AMPR are the same for PC2 and PC1.5 when these are implemented with two PC2 PAs. There is obviously no difference in the emission levels when the two PAs have the same back-off in both PC2 and PC1.5 cases. This is ensured because the backoff applies with a reference to each PA capability. AMPR thus defines the Minimum Allowed power but the maximum is only bounded by the power class so the total power is limiter to 26dBm for PC2 and 29dBm for PC1.5 (this actually works as we have demonstrated in most of our measurements where various LTE and NR power ratios are used (not only equal PSD of equal power).  Regarding evaluation aspects, Skyworks has always measured ACLR, SEM mask and individual IMD levels to assess the required back-off. Moreover we have shown some ACLR corner cases for different power ratios which justified that large allocations needed some back-off margin.  Answer to LGE: although equal back-off was agreed as baseline for evaluation, Skyworks has systematically verified it’s a-MPR proposal across different power ratios. |
|  |  |

### 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** |
| [**R4-2000423**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000423.zip) | Skyworks: agree that allocation aware MPR is beneficial for NS01. May be it is not very useful to have a specific case for -25dBm/MHz in NS01 (only 5MHz worth of BW) and merge it with -30dBm/MHz, this would result into only 2 curves for NS01. Note that for contiguous ULCA inner outer definitions could further apply for intra-band contiguous EN-DC. |
| Sprint: We can agree to Skyworks’s proposal eliminate -25 dBm/MHz case and merge that with -30 dBm/MHz if other companies agree with that approach. |
| LG Electronics: RAN4 hasn’t been discussed in details for the assumptions about general intra-band EN-DC. We think it is early to agree this CR at this time. |
| Sprint: As a reply to LGE, this actually has been discussed in detail. This nearly the exact same proposal that was discussed in Reno as a Draft CR [**R4-1915418**](file:///D:\RAN4\TSGRAN4_93\Docs\R4-1915418.zip). I know that LGE read the document and was present for the discussion because the only comment recorded in the meeting report was:  *LG: What is the intension to put 26dBm in the title?*  In the CR we removed 26 dBm from the section title as requested. It is important to keep in mind that Sprint will not benefit in any way from this CR because we will always be using NS\_04 A-MPR and not MPR. We wrote this CR as a favor to operators from other countries to allow them to benefit from the same allocation awareness improvement for MPR as was introduced for NS\_04. A-MPR. So, while we thought it was the right thing to do for the industry to bring this CR to RAN4, we are not going to bring it back again if it doesn’t get approved at this meeting. We are willing to do our part, but we’re not willing to keep bringing the same CR back for something that we won’t even benefit from. |
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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#1-1** | **Can PC2 A-MPR be re-used for PC 1.5**  *Tentative agreements:*  *Candidate options:*  *o Option 1: Agree that PC2 EN-DC A-MPR also applies to PC 1.5 EN-DC: Skyworks, Intel, Sprint, Apple, Qorvo*  *o Option 2: Agree that separate A-MPR is needed for PC 1.5 EN-DC: LGE, Huawei*  *o Option 3: Approve a Way Forward*  *Recommendations for 2nd round:*  1) Sprint to revise R4-2000425 to help convince companies that PC2 A-MPR can be reused for PC1.5.  2) Create a Way Forward to clarify the language for A-MPR power class applicability. |
| **Sub-topic#1-2** | A-MPR improvements  *Tentative agreements:*  *Candidate options:*  *o Option 1: Apple: A-MPR Proposal for B41/n41 EN-DC*  *o Option 2: LGE: New A-MPR curves for 29dBm HPUE B41/n41 EN-DC: LGE, Huawei*  *o Option 3: Keep the A-MPR curves as they are.*  *o Option 4: Merge proposals. Previous proposals from Skyworks, Intel and Sprint can be considered: Intel, Apple, Sprint*  *Recommendations for 2nd round:*  *Way forward on merging intra-band MPR/A-MPR curve proposals including previous proposals and new data from Apple.* |
| **Sub-topic#1-3** | Allocation aware MPR  *Tentative agreements:*  *Candidate options:*  *o Option 1: Agree the CR in R4-2000423: Sprint*  *o Option 2: Note the CR: LGE*  *Recommendations for 2nd round:*  1) Sprint to revise R4-2000423 as follows: Merge -25 and -30 dBm as per Skyworks proposal. Also, as per Apple correct the equations in 6.2B.2.2.1 which seem to have errors with the variable naming. The variables with FIM3,xxx have to be corrected.  2) Companies discuss any assumptions and technical concerns about the CR or consider whether they can accept the CR or not.  Note: Sprint will likely not bring the CR back at the next meeting if it is not agreed. Someone else will need to volunteer if there is interest in allocation aware MPR. |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1-1 | Way Forward on the clarification of A-MPR for different CG and EN-DC power classes | Sprint (Bill) |
| #1-2 | Way Forward on intra-band MPR/A-MPR curves | Sprint (Mike) |
| #1-3 | Revised toc number needed for R4-2000423 to make the change from Skyworks and the error flagged by Apple. | Sprint (Bill) |

### 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** |
| R4-2000423 | *One objection from LGE. LGE being asked to provide technical concerns if the CR can’t be agreed.* |

## Discussion on 2nd round (if applicable)

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| **Topic** | **Comments** |
| 1-1 Revision of R4-2000425 | Sprint: Revision in the draft inbox  Company A: |
| 1-1 Way forward on A-MPR and Power Class |  |
| 1-2 WF on MPR/A-MPR curves |  |
| 1-3 Revision of R4-2000423 |  |

## 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: Issues specific to 29 dBm HPUE

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2000111**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000111.zip) | Qualcomm | Discussion on TX diversity enabling 29 dBm power class  Observation 1: In RAN4 language antenna port is the logical antenna port that is used for configuring UE with e.g. codebook based transmissions and antenna connector is the physical antenna connector from which the signal in an UE comes out.  Observation 2: Current UL MIMO specification can not be re-used for TX diversity since the different assumptions for PA power capability  Observation 4: 29 dBm with two 26 dBm application likely provides benefits in low uplink signal BW applications.  Proposal: Enable TX diversity for 29 dB power class in RAN4 specifications by defining reference plane for all powers including emissions as summed from all TX antenna ports. |
| [**R4-2000112**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000112.zip) | Qualcomm | Draft CR to enable tx diversity for 29 dBm power class |
| **[R4-2000424](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000424.zip)** | Sprint | New SIB parameter to allow 29 dBm operation for LTE  Observation 1: For NR there is agreement that a 29 dBm capable UE can transmit at 29 dBm unless a lower P-Max is broadcast in the SIB. (Moderator note: Should have said “For NR and EN-DC”)  Proposal 1: Introduce a new parameter P-MaxR that would be used to enable the network to allow LTE UE transmit power of greater than 26 dBm while not impacting the calculation of Pcompensation for legacy LTE UEs.  Proposal 2: RAN4 should ask RAN 2 if P-MaxR could be introduced into the RAN2 specs in a backwards compatible manner back to Release 13. |
| [**R4-2000426**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000426.zip) | Sprint | 29 dBm HPUE Power Class logic  Proposal 1: Agree to the proposed text v2 for PC 1.5 power control in 38.101-1. (Moderator note: tdoc said 38.101-3, but should have been 38.101-1)  Proposal 2: Agree to the proposed text for PC 1.5 intra-band EN-DC in 38.101-3. |
| [**R4-2000905**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000905.zip) | CMCC | Proposal on 29dBm P-Max issue for NR and LTE  Proposal 1:For 5G NR 29dBm UE, the requirements for 29dBm should apply If p-MAX is absent.  Proposal 2: For LTE 29dBm UE if P-max is absent，the corresponding requirements for 29dBm UE shall apply, and operator can set the p-max as 23dBm/26dBm to avoid the use of HPUE in some countries with HPUE regulatory limitation. |
| [**R4-2001547**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001547.zip) | Skyworks | [29dBm] EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability  Observation on EVM:  • For QPSK to 64QAM the RIMD3 budget is >3% (~30 dB) which is reasonable  • For 256QAM the RIMD budget is slightly more than 1% (40 dB)  Observations for full 29 dBm power:  • At the agreed antenna isolation assumption of 10 dB:  o CP-OFDM can only support QPSK  o DFT-s-OFDM can only support 16QAM  o Note that in most case there is MPR for CP-OFDM and higher order modulations so RIMD3 level will reduce for those cases  o It seems reasonable that with the allowed MPR would enable up to 64QAM transmissions but 256QAM with >5 dB MPR would need to be verified  • Note that the gain on IMD3 power is small when isolation is increased by 1 dB  • At >13 dB isolation and accounting for the allowed MPR up to 256QAM should be feasible  Observations for two PC2 linear PAs and 10dB antenna isolation:  • QPSK is feasible at full power  • 16QAM is feasible starting from 1 dB MPR  • 64QAM is feasible starting from 2 dB MPR  • 256QAM is feasible starting from 6 dB MPR  • Note that this is a best case compared to PAs using ET or APT but provides a first feel for where problems may occur.  Observation: Based on linear PA measurements only and needing further study for ET and APT PAs:  • No additional MPR may be needed for PC2 implemented with two PC2 PAs  • Depending on waveform and allocation types, some small additional MPR may be needed for PC1.5  • For PC2 implemented with two PC3 PAs, depending on waveform and allocation types some small additional MPR may be needed  • For PC3 implemented with two PC3 PAs, no additional MPR may be needed |
| [**R4-2002138**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002138.zip) | Sprint | Draft CR for 38.101-1: Introduction of Power Class 1.5 |
| [**R4-2002140**](file:///C:\Users\ne087952\OneDrive%20-%20Sprint\3GPP\RAN4\TSGR4_94_eMeeting\Docs\R4-2002140.zip) | Sprint | Draft CR for 38.101-3: Introduction of Power Class 1.5 |
|  |  |  |

## Open issues summary

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

An agreement is needed on the UE power class requirements are for a PC 1.5 capable UE when P-Max is not signalled. Also, there is not yet agreement on the requirements for PC 1.5 transmit diversity. The HPUE Power Class logic has not yet been discussed but needs to be agreed. A new issue of the impact of reverse IMD3 impact on UL modulation order capability.

### Sub-topic 2-1: PC 1.5 behavior when P-Max is not present

Currently there is agreement that PC 1.5 will be allowed P-Max is not present for NR and EN-DC. There is currently a standoff between some operators related to PC1.5 (29 dBm) operation for LTE when P-Max is absent. CMCC would like UEs to be able to operate at 29 dBm when P-Max is not present. They are concerned of the impact on cell selection if P-Max is sent. They would prefer operators set P-Max to 23 or 26 dBm where 29 dBm operation is not allowed. KDDI and Softbank say that 29 dBm operation is currently not legal in Japan, and it is not reasonable to have them reconfigure tens of thousands of LTE eNBs to transmit P-Max.

**Issue 2-1: Power Class 1.5 behaviour when P-Max is not present**

* Proposals
  + Option 1: Add a new SIB parameter to allow 29 dBm operation in LTE as proposed in R4-2000424.
  + Option 2: Allow 29 dBm operation when P-Max is not present as proposed in R4-2000905.
  + Option 3: Only allow 29 dBm operation in NR and EN-DC for now, and not in LTE so that the Work Item can be completed. If an arrangement can be found in the future, then PC 1.5 may be enabled for LTE at that time.
* Recommended WF
  + Option 3: Only allow 29 dBm operation in NR and EN-DC for now, and not in LTE so that the Work Item can be completed. If an arrangement can be found in the future, then PC 1.5 may be enabled for LTE at that time.

### Sub-topic 2-2: Transmit diversity

Transparent Tx Diversity for PC1.5 operation was added to the scope of the WID in December.

**Issue 2-2: Transmit Diversity**

* Proposals
  + Option 1: Enable TX diversity for 29 dB power class in RAN4 specifications by defining reference plane for all powers including emissions as summed from all TX antenna ports as described in R4-2000111 and R4-2000112.
  + Option 2: ?
* Recommended WF
  + Agree to Option 1

### Sub-topic 2-3: 29 dBm HPUE Power Class Logic

The logic for which power4 class applies in different scenarios including if P-Max is present, the value of P-Max, the UE capability and the NR duty cycle and the LTE UL/DL configuration (for EN-DC).

**Issue 2-3: 29 dBm HPUE power class logic**

* Proposals
  + Option 1: Approve the logic proposed in R4-2000426 for NR and EN-DC.
  + Option 2: Approve the logic proposed in R4-2000426 with modifications
* Recommended WF
  + Agree to Option 1.

### Sub-topic 2-4: EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability

There is a discussion document on [29dBm] EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability in R4-2001547.

**Issue 2-4: EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability**

* Proposals
  + Option 1: Review the document and see if there are any comments. Companies are encouraged to consider the issue of RIMD3 related EVM.
* Recommended WF
  + Please review the document and consider looking into this issue. Comments welcome.

### Sub-topic 2-5 Draft CRs

Two Draft CRs for PC1.5 have been submitted in R4-2002138 and R4-2002140. These are not for endorsement, only for discussion and feedback.

**Issue 2-5: Documents for discussion**

* Proposals
  + Option 1: Review the draft CRs and provide feedback.
* Recommended WF
  + Please review the documents and comments are welcome.

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| Skyworks | Sub topic 2-1:  Sub topic 2-2:  Support enabling TX diversity in the spec but need to understand if totally transparent: MPR for edge allocations, potential EVM/modulation order limitation due to RIMD (see our input). WF is OK if studies are done by more companies on MPR and how MPR/EVM would apply.  Sub topic 2-3:  Sub topic 2-4:  Due to lack of time we did not submit further input on Edge allocation MPR but this needs to be considered for PC1.5  Sub topic 2-5:  ….on R4-2002138 ACLR is put in dBM and should be dB  Others: |
| Qualcomm | Issue 2-3: Do the proposed simplifications for the PC2 part change the logic, or the same logic remains but only simplified? Proposed extensions of the logic to PC1.5 look fine.  Sub topic 2-4: Some of the analysis may give very optimistic view on the expected performance since the calibration is not against the zero margin point but a floating 26 dBm / PA. We would propose to agree a WF with clear assumptions for emissions and architectures given that other agenda items are proposing to revisit MPR’s for 2 PA solutions (R4-2002037) to avoid possible conflicts. |
| Huawei | Sub topic 2-1:  Prefer Option 3: Only allow 29 dBm operation in NR and EN-DC for now  Sub topic 2-2:  The term of “reference plane” is ambiguous in the specification, and the change is not necessary. Regarding the change in the general clause for the specific 29dBm power class, we see similar discussion also is undergoing for the UL MIMO requirements. Once the changes for UL MIMO are finished, the issue for 29dBm power class can be solved as well. Even Tx div was added in the WID as an objective, the requirements which can enable Tx div should be general in the specification as the common understanding is that Tx div is spec transparent. |
| Intel | Sub topic 2-1:  Option 3  Sub topic 2-2:  Sub topic 2-3:  Sub topic 2-4:  Understanding based on this EVM measurement: 10dB antenna isolation with proper MPR allows high order modulations.  Sub topic 2-5: |
| Sprint | Sub-topic 2-1: We support Option 3.  Sub-topic 2-2: We support the Qualcomm proposal for enabling Tx diversity  Sub-topic 2-3: We support Option 1  Reply to Qualcomm: The tests for conditions that always have to be false because of previous steps and have no defined behavior if they are true were not included in the proposed logic for PC1.5. |
| CMCC | Sub topic 2-1: Prefer Option 3. We agree to allow 29dBm in NR and EN-DC first, and then the solution of 29 dBm LTE can be postponed until we find an acceptable way for LTE 29dBm case.  Sub topic 2-2: We support Option1.  Sub-topic 2-3: For 29dBm NR and EN-DC UE, consider keeping PC2 and PC3 NR and EN-DC behaving consistently, we recommend the requirements for 29dBm NR and EN-DC should apply If p-MAX is absent. |
| OPPO | Sub topic 2-1: OK with Option 3.  Sub topic 2-2: Understand the intention, and also support the view that this PC1.5 could be achieved by two 26dBm PAs. For clarification, to enable two 26dBm PA implementation, does Tx diversity is the only choice or not?  Besides, Tx diversity has been discussed in Rel-15 without conclusions. Some issues were pointed out like the RAN5 testability, etc. and RAN5 have LS to RAN4 regarding this issue. It would be better to handle these as a package and get a whole picture of this feature. |

### 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#2-1** | PC 1.5 behavior when P-Max is not present  *Tentative agreements:*  *Consensus on Option 3*  *Candidate options:*  *o Option 1: Add a new SIB parameter to allow 29 dBm operation in LTE as proposed in R4-2000424.*  *o Option 2: Allow 29 dBm operation when P-Max is not present as proposed in R4-2000905.*  *o Option 3: Only allow 29 dBm operation in NR and EN-DC for now, and not in LTE so that the Work Item can be completed. If an arrangement can be found in the future, then PC 1.5 may be enabled for LTE at that time: Huawei, Intel, Sprint, CMCC, OPPO*  *Recommendations for 2nd round:*  Prepare a Way Forward based on Option 3 |
| **Sub-topic#2-2** | Transmit Diversity  *Tentative agreements:*  *Candidate options:*  *o Option 1: Enable TX diversity for 29 dB power class in RAN4 specifications by defining reference plane for all powers including emissions as summed from all TX antenna ports as described in R4-2000111 and R4-2000112: Skyworks, Sprint, Qualcomm, CMCC*  *o Option 2: Need to wait for general requirements being discussed for UL MIMO (Proposed by Huawei)*  *Recommendations for 2nd round:*  Discuss if the changes can be agreed to at this meeting or if we need to wait for general requirements for UL MIMO. |
| **Sub-topic#2-3** | 29 dBm HPUE power class logic  *Tentative agreements:*  *Need to clarify that proposed logic applies EN-DC and NR, but no change to LTE PC logic in 36.101. Need to check with our RAN2 delegates to see if logic change would impact RAN2.*  *Candidate options:*  *o Option 1: Approve the logic proposed in R4-2000426 for NR and EN-DC.*  *o Option 2: Approve the logic proposed in R4-2000426 with modifications*  *Recommendations for 2nd round:*  *Revise R4-2000426 based on feedback above. Check with RAN2 colleagues on impact to RAN2 specs.* |
| **Sub-topic#2-4** | EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability  *Tentative agreements:*  *Need to clarify assumptions for emissions and architectures*  *Candidate options:*  *o Option 1: Review the document and see if there are any comments. Companies are encouraged to consider the issue of RIMD3 related EVM.*  *Recommendations for 2nd round:*  Work on Way forward with clear assumptions for emissions and architectures given that other agenda items are proposing to revisit MPR’s for 2 PA solutions (R4-2002037) to avoid possible conflicts. |
| **Sub-topic#2-5** | Documents for discussion  *Tentative agreements:*  *R4-2002138 ACLR is in dBM and should be dB.*  *Candidate options:*  *o Option 1: Review the draft CRs and provide feedback.*  *Recommendations for 2nd round:*  Draft CR for discussion, so no revision needed at this meeting |

*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #2-1 | Way Forward on PC 1.5 behavior when P-Max is not present | [KDDI] |
| #2-4 | Way Forward on EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability | [Qualcomm] |

### 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)

|  |  |
| --- | --- |
| **Topic** | **Comments** |
| 2-1 PC1.5 behavior when P-Max is not present | *Draft Way Forward from KDDI is in the draft inbox*  Company A:  OPPO: Support the WF with changes from “should” to “shall” in the sub-bullet |
| 2-2 Transmit diversity | *Discuss if the changes can be agreed to at this meeting or if we need to wait for general requirements for UL MIMO.*  Company A:  OPPO: Prefer to wait for the outcome of the Rel-15 power class discussion. |
| 2-3 Power Class logic | *Need to revise R4-2000426 based on feedback above*  Company A: |
| 2-4 EV Impact of RIM3 on UL MIMO | *War Forward on EVM Impact of Reverse IMD3 on UL MIMO Modulation Order Capability*  Company A: |

## 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”* |