**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-2105460**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 7.37

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for [98-bis-e][123]HPUE\_PC1\_5\_n77\_n78

**Document for:** Information

# Introduction

This document summarizes the email discussion on topics related to Power Class 1.5 in Bands n77 and n78 in Agenda 7.37. Additionally, discusison on PC 1.5 in Band n79 in Agenda 7.40 is treated in this thread. The discussion is divided into two topics:

Topic #1: UE RF assumptions and requirements

Topic #2: RF exposure regulatory aspects for FWA

# Topic #1: UE RF assumptions and requirements

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2104893**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104893.zip) | Apple | Considerations for PC1.5 with band n79  **Observation 1:** PC1.5 is achieved via dual Tx chains as there is no 29dBm power amplifier deployed in UEs and requires higher power backoff compared to single Tx operation.  **Observation 2:** PC1.5 MPR was developed for single and dual layer UL-MIMO operation but not for TxD.  **Proposal 1:** PC1.5 TxD in band n79 for should only be enabled when the general discussion on TxD is finished in RAN4.  **Proposal 2:** If improvements for power backoff are considered for n79 then the relevant measurement assumptions (Antenna isolations of 10 dB, 4 dB post PA loss and 26dBm Tx chains) shall be reused to obtain reliable results. |
| [**R4-2104957**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104957.zip) | vivo | Discussion on PC1.5 with n79  **Proposal 1: The measurement and simulation assumption of n41 for MPR and A-MPR [3] is proposed to be baseline of n79.**  **Proposal 2: Reuse n41 PC1.5 duty cycle-based SAR mechanism.**  **Proposal 3: Release independent for PC 1.5 with 79 is proposed.** |
| [**R4-2104975**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2104975.zip) | LGE | MPR for PC 1.5 NR UE on n77/n78 or n79  **Proposals 1 and 2 relate to smartphone UE**  Proposal 1: RAN4 should consider above basic simulations assumptions in for MPR requirements for PC 1.5 UE at n77/n78 or n79 in Rel-17.  Proposal 2: If Proposal 1 is reasonable to derive n77/n78 or n79 MPR requirements for smart phone type UE, then RAN4 can reuse MPR requirement in Table 6.2.2-4 for PC1.5 UE with dual Tx in TS38.101-1.  **Proposal 3, 4, and 5 relate to FWA UE**  Proposal 3: RAN4 can consider default duty cycle ratio with [25~50%] since there was no impact to human body directly for PC1.5 FWA device using same IE.  *Moderator: This aspect can be discussed under topic 2.*  Proposal 4: RAN4 can derive MPR requirements based on the above simulations assumptions for PC1.5 FWA UE in n77/n78.  Proposal 5: The following proposal 3 & 4 can be applied for PC1.5 n79 FWA UE. |
| [**R4-2105012**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105012.zip) | CMCC | Discussion on the PC1.5 UE RF requirements of NR n79  **Proposal 1: The MOP and Tolerance are to be specified as 29dBm +2/-3 dB for band n79 of power class 1.5.**  **Proposal 2: Considering that n79 29dBm (power class 1.5) is a dual PA architecture, the value of ∆TRxSRS can reuse the value of ∆TRxSRS PC2.**  **Proposal 3: The MOP and Tolerance for UL MIMO are to be specified as 29dBm +2/-3 dB for n79 of power class 1.5.**  **Proposal 4: No changes to Maximum power reduction (MPR) for power class 1.5 with dual Tx (Table 6.2.2-4)**  **Proposal 5: Since no A-MPR issue for PC1.5 n97, No changes to section 6.2.3 are needed.**  **Proposal 6: The n79 power class 1.5 can be supported form Rel-15 by release independent manner.** |
| [**R4-2107317**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107317.zip) | Skyworks | Discussion on PC1.5 performance for FWA  **Observation: current PC1.5 MPR in 38.101-1 should apply to band n79 smartphone UEs as same antenna isolation can be assumed and there is no band specific regulation justifying an A-MPR.**  **Observation: based on previous reverse IMD measurements, the antenna isolation requires significant improvement to result in noticeable MPR gains.**  **Observation: In order to improve the MPR for an PC1.5 FWA implementation it is not sufficient to significantly improve the antenna isolation, the isolation between paths at PCB level should also improve significantly.** |
| [**R4-2107352**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107352.zip) | Qualcomm | PC 1.5 for FWA devices  **Proposal: Based on the feedback from FWA vendors, it is proposed to assume antenna isolation of 20 dB for FWA.**  **Proposal: PCB isolation effect can be neglected.**  **Proposal: Post-PA front-end loss assumed to be 4 dB per Tx chain.**  Baseline MPR proposal for FWA  Inner: No additional MPR compared to PC2  Outer: No additional MPR compared to PC2 for DFT-S-OFDM. Additional [2] dB for CP-OFDM except for 256QAM which is dominated by EVM.  Edge: Needs further study |
| [**R4-2107353**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107353.zip) | Qualcomm | PC 1.5 in Band n79  **Observation: With the significant MPR defined for PC1.5, it is not expected that the coverage enhancement expectations expressed in the WID can be met.**  **Proposal: PC 1.5 MPR needs to be further studied in the context of Band n79.**  **Observation: Most of the provided measurements and proposals for PC 1.5 indicate a smaller MPR than was eventually specified. There appears to be scant technical justification for the specified values.**  **Proposal: There is no current additional spurious emission requirement for Band n79. However, increasing the power level to 29 dBm may motivate the need to revisit UE coexistence protection to other bands and coexistence to other services such as radio altimeters.** |

## 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

*Sub-topic description:*

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

Can the MPR defined for PC1.5 in Band n41 be used for smartphone for n77, n78, and n79?

The MPR was derived based on UE capability, but is it acceptable from network deployment perspective if a UE only meets the minimum requirement?

The specified MPR for PC1.5 from Band n41 does not appear well aligned with provided measurements and proposals. How is it justified?

The MPR was derived from Band n41 component performance, but Band n79 is almost an octave in frequency higher. Does the difference in frequency impact the assumptions and therefore the MPR?

Can the MPR apply to UL MIMO (single and dual layer) as well as TxDiv?

**Issue 1-1: Smartphone MPR**

* Proposals
  + Option 1: Existing PC 1.5 MPR applies to Band n77, n78, and n79
  + Option 2: Existing PC 1.5 MPR applies to Band n77, n78, but further study needed to determine whether it can apply for Band n79
  + Option 3: Further study is needed to determine whether existing PC 1.5 MPR can be applied to Band n77, n78, and n79 or whether modifications are needed
* Recommended WF
  + TBA

### Sub-topic 1-2

For FWA, it is understood that the same assumptions as smartphone will not apply, for example, antenna isolation. However, how much impact will this make to the MPR? If it is only a small impact to MPR, then it isn’t justified to define a separate requirement for it. What assumptions should be used in evaluating FWA MPR?

**Issue 1-2: FWA MPR**

* Proposals
  + Option 1: Reuse smartphone MPR for FWA, no further study is needed.
  + Option 2: Evaluate FWA MPR to quantify the amount of improvement. Assumptions are antenna isolation = 20 dB, PCB isolation >75 dB, post PA loss = 4 dB
* Recommended WF
  + TBA

### Sub-topic 1-3

Other Band n79 UE requirements include maximum output power and tolerance, DT\_RxSRS, MOP and tolerance for UL MIMO, and A-MPR.

**Issue 1-3: UE RF requirements for Band n79**

* Proposal 1: MOP and tolerance is 29 dBm +2/-3 (agree or if not, what is your alternate proposal)
* Proposal 2: DT\_RxSRS is the same as PC2 (agree or if not, what is your alternate proposal)
* Proposal 3: MOP and tolerance for UL MIMO is 29 dBm +2/-3 (agree or if not, what is your alternate proposal)
* Proposal 4
  + Option 1: No A-MPR for Band n79
  + Option 2: Study whether A-MPR is needed for Band n79 for coexistence due to the higher Tx power
* Recommended WF
  + TBA

### Sub-topic 1-4

For smartphone SAR, can the same method identified for Band n41 also be used for Band n77, n78, and n79? If FWA uses a different method, how should this be indicated to the network? If a different method is used between smartphone and FWA, does the network need to know whether the device is smartphone or FWA?

**Issue 1-4: Smartphone SAR**

* Proposal 1: For smartphone, the same method as identified for Band n41 is also used for Band n77, n78, and n79. (agree or do not agree?)
* Proposal 2: If a different method is used between smartphone and FWA, then an indication is needed to inform the network (agree, disagree, or defer until after we decide how to manage RF exposure for smartphone and FWA)
* Recommended WF
  + TBA

### Sub-topic 1-5

Release independence to R15 for Band n77, n78, and n79

**Issue 1-5: Release independence**

* Proposal
  + Option 1: PC 1.5 for n77, n78, and n79 are release independent to R15
  + Option 2: Wait for specifications to be finished before making a determination on release independence due to possible need for signaling (SAR, FWA MPR, etc).
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1: Smartphone MPR

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| **Company** | **Comments** |
| Skyworks | **Issue 1-1:** Option 1: Existing PC 1.5 MPR applies to Band n77, n78, and n79 |
| T-Mobile USA | Issue 1-1: Option 1  Further input: We think that MPR defined in the n41 PC1.5 WI is overly conservative. We would support improved MPR for n77, n78 and n79 that would also be available for PC1.5 in all bands including n41 and signalled via modifiedMPRbehavior. |
| LGE | **Issue 1-1: Option 1 or option 3 is OK** |
| CMCC | Issue 1-1: MPR is a general requirements, The same MPR should be applied to the NR band of n77 n78 and n79, We agreed to re-evaluate the MPR requirements if there is room to tighten it.  We prefer option3. |
| Qualcomm | Issue 1-1: We think the MPR even for smartphone should be improved to be able to obtain the benefit from PC1.5. Therefore, we support option 3. |
| HW | Issue 1-1: Option 1 |
| Verizon | **Issue 1-1:** Option 3  New isolations in requirement have been considered and discussed by companies. RAN4 needs to study more for the UE RF assumption and improve the A-MPR and MPR for the 29dBm smartphone. |
| Apple | Issue 1-1 Option1: The MPR for PC1.5 applies to Band n77, n78 and n79 |
| Vivo | **Issue 1-1:** Option 1 |

Sub topic 1-2: FWA MPR

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| **Company** | **Comments** |
| Skyworks | Issue 1-2: in order to assess MPR reuse or nor. Or even if the improvement is worth the effort, Assumptions for FWA should be discussed and agreed |
| T-Mobile USA | Issue 1-2: ~~Option 1~~ Option 2. FWA can have different assumptions than a smartphone. |
| LGE | The detail parameters shall be determined based on RAN4 consensus. |
| Qualcomm | Option 2. An FWA is different from a smartphone, so the same assumptions and conclusions should not be blindly applied, especially when the potential impact to performance is so large. |
| HW | Issue 1-2: Option 1. MPR is allowance and it does not cap the UE performance. Option 1 has the benefit of enabling a broad range of design options for a variety of use cases and potentially reaching out to more users. |
| Verizon | **Issue 1-2:** Option 2  New isolations in requirement have been considered and discussed by companies. RAN4 needs to study more for the FWA RF assumption and improve the A-MPR and MPR for the 29dBm FWA. |
| Apple | Issue 1-2: Option1: As FWA devices appear to the network similar to normal UEs the same MPR has to be reused. Also, a device does not have to use the MPR to its max but can use less if it is not limited by emission issues. |
| Vivo | Issue 1-2: Option 1 |

Sub topic 1-3: UE RF requirements for Band n79

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| **Company** | **Comments** |
| Skyworks | P1 and 3: Agree  P2: If 2T/4R is assumed this should be the case.  P4: need to agree which coexistence requirement is an issue?: radio altimeter in 4-4.2GHz? coex with n77? |
| LGE | Issue 1-3: Support Moderator proposal 1,2 and 3. For the P4, the RAN4 can study whether or not define additional coexistence requirements based on the regional regulation, if needed. It should be provided the detail additional requirements from proponent. |
| CMCC | Support P1, P2 and PC3  For P4, prefer option 1: No A-MPR for Band n79 |
| Qualcomm | Agree with proposals 1, 2, and 3. For proposal 4, it would be better to study to make sure there are no issues due to the higher power. |
| Huawei | Issue 1-3: P1, 2 and 3 are agreeable. As for P4, A-MPR could always be requested if coexistence issue is identified later. |
| Apple | Issue 1-3:  Proposal 1: Agree  Proposal 3: Agree  Proposal 4: Regarding the current coexistence requirements for n79 the closest protected region is band 42. If new coexistence requirements shall be introduced, then A-MPR might be needed. |
| Vivo | Support P1, P2 and P3. |

Sub topic 1-4 : Smartphone SAR

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| **Company** | **Comments** |
| Skyworks | Issue 1-4: Agree Proposal 1 |
| T-Mobile USA | Issue 1-4: Agree Proposal 1.  Further input: For Proposal 2, we would need to see the different method before deciding if the network needs to be infiormed. For instance, depending on the existing mechanism. The same signalling may suffice. For instance, 100% duty cycle supported may apply to the new mechanism without the network knowing if the UE is FWA or a smartphone. |
| LGE | Support moderator proposal 1 and 2 |
| CMCC | Issue 1-4: Agree Proposal 1 |
| Samsung | We support moderator’s proposals. Either proposal 1 or proposal 2 can be taken after we decide how to handle the MPE for FWA |
| Qualcomm | Support proposal 1. For proposal 2, we can wait for the outcome of FWA MPE to see if anything is needed. |
| Huawei | Issue 1-4: P1 is agreeable. P2 is subject to further discussion. |
| Apple | Issue 1-4: Proposal 1 |
| Vivo | Issue 1-4: Agree Proposal 1 |

Sub topic 1-5: Release independence

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| **Company** | **Comments** |
| Skyworks | Issue 1-5: this may differ for smartphone or FWA. |
| LGE | Prefer option 2 |
| CMCC | Referring to the description of NR UE power class in TS38.307, the feature of TDD power class 1.5 can be supported form Rel-15 by release independent manner.  Support option 1: PC 1.5 for n77, n78, and n79 are release independent to R15 |
| Qualcomm | Option 2. There is no urgency to conclude on release independence now at this meeting. |
| Huawei | Issue 1-5: Option 1. |
| Verizon | Issue 1-5: Option 2 |
| Apple | Option 2 |
| Vivo | Prefer option 2. |

### CRs/TPs comments collection

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

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| **CR/TP number** | **Comments collection** |
| [**R4-2105013**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105013.zip)  Draft CR on PC1.5 UE RF requirements of n79 in Rel-17 TS 38.101-1 (CMCC) | Company A |
| Company B |
|  |
| [**R4-2105010**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105010.zip)  Draft CR on PC1.5 HPUE SAR issue into Rel-16 TS 38.101-1 (CMCC) | *Moderator note: This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.*  *Suggest “not treated”* |
| [**R4-2105011**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105011.zip)  Draft CR on PC1.5 HPUE SAR issue into Rel-17 TS 38.101-1 (CMCC) | *Moderator note: This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.*  *Suggest “not treated”* |

## 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**  Smartphone MPR | The views are split between whether to reuse MPR from PC 1.5 in Band n41 and apply it to PC 1.5 in Band n77, n78, and n79, or to re-evaluate for tightening. All of the operators interested in PC 1.5 have requested re-evaulation of PC 1.5 MPR to see if there is opportunity to improve it. Four vendors prefer to simply re-use the n41 MPR, one vendor is ok either way, and one vendor also suggests to re-evaluate the MPR.  *Tentative agreements:*  In recognition of the request of the operators who are the ones asking for PC 1.5, the moderator suggests the following  As a package,   * the MPR for PC 1.5 will be re-evaluated * The MPR will apply to n41, n77, n78, and n79   *Candidate options:*  *Recommendations for 2nd round:*  Develop a WF on how to perform the re-evaluation. Target areas for improvement or further study. |
| **Sub-topic #1-2**  FWA MPR | No company disagreed with the observation that FWA can have different assumptions than a smartphone. However, there were different views on whether MPR should be different and if/how the network could benefit from that.  *Tentative agreements:*  FWA can have different assumptions than a smartphone  *Candidate options:*  *Recommendations for 2nd round:*  Discuss and develop a WF to include the following two points   * What are the assumptions for FWA? * Operators to describe how the network can benefit from improved MPR specification, considering that the specification is an upper bound and devices are free to use lower MPR if they are able to meet all the requirements? |
| **Sub-topic #1-3**  UE RF requirements for n79 | All companies could agree or at least not disagree to P1, 2, and 3. For proposal 4, some companies suggested further study on coexistence.  *Tentative agreements:*   * MOP and tolerance is 29 dBm +2/-3 * DT\_RxSRS is the same as PC2 (assuming 2T/4R) * MOP and tolerance for UL MIMO is 29 dBm +2/-3   *Candidate options:*  *Recommendations for 2nd round:*  If possible this week, identify which requirements for coexistence need further study for potential A-MPR |
| **Sub-topic #1-4**  Smartphone SAR | All companies could agree with Proposal 1. Proposal 2 is subject to further discussion depending on the outcome of FWA MPE.  *Tentative agreements:*   * For smartphone, the same method as identified for Band n41 is also used for Band n77, n78, and n79. * Whether separate signaling is needed for FWA is FFS.   *Candidate options:*  *Recommendations for 2nd round:*  No further discussion for this meeting. Capture the above agreement in a WF that also includes FWA MPE agreements from below. |
| **Sub-topic #1-5**  Release independence | Five companies preferred to wait for specifications to be completed or need more study before deciding on release independence, two companies preferred to agree now. There is no consensus to make agreement now.  *Tentative agreements:*  None  *Candidate options:*  *Recommendations for 2nd round:*  No further discussion for this meeting. |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

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

## Discussion on 2nd round (if applicable)

Sub topic 1-1: Smartphone MPR

How should the re-evaluation of MPR be performed? Identify target areas for improvement or further study.

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| **Company** | **Comments** |
| Skyworks (from email) | Regarding revisiting MPR for smartphone it is not clear to me that there is a majority of companies that supports doing this. Although it is OK to have further discussion on this, unless there is an agreement to significantly revisit the assumptions, I think it will be a lot of effort for little gain. Also this will be a ripple effect to all the cases where we have agreed similar assumptions like antenna isolations and PA calibrations. I guess the few companies that are able to provide RIMD measurements should prepare themselves for a few months of work. Finally anytime we revisited such things we ended up with the same or more relaxed numbers. Since MPR is an allowance optimized solutions are feasible in real products so it would be better to focus our effort on the FWA case |
| Apple (from email) | according to the current discussion FWA and smartphones have different requirements for antenna and and maybe PCB isolation. To my understanding the measurements done for FWA cannot be reused for smartphones. It is true that there are mutual benefits as the specific testbench for rIMD is already setup. But measurements would have to be done once for FWA and its requirements and once for UE and its requirements. This would at least double the measurement effort. As smartphone measurements do not seem to be a simple byproduct of FWA measurements, the argument from Dominique [Skyworks] is correct. It would result in considerable work to revisit the smartphone MPR. It is not overwhelming but would be a commitment for some month of measurements. And currently we do not prefer to re-do the work for smartphones. |
| LGE (from email) | We are same view with Dominique [Skyworks] and Daniel [Apple] for revisit of MPR requirements for smartphones.  And the majority view is to reuse the MPR for PC1.5 n41 UL-MIMO UE.  All UE vendor support reuse the existing MPR from n41 PC1.5 UE. for n77/n78/n79 smartphone UE.  So, we prefer only need to MPR evaluation for FWA device type for PC1.5 in n77/n78/n79. |
| Qualcomm (from email) | Actually, I understand and sympathize with the points you guys are making. It was Skyworks, Apple, LGE, and Sprint with Qorvo who did the bulk of the work providing measurements when we originally derived PC 1.5 MPR for Band n41. And I understand how you would not like to repeat that work.  However, it is clear to me that all of the operators are not satisfied with the current specification and are seeking re-evaluation. And looking at the final result, I can see why it would be unsatisfactory since the large MPR’s provide no or very little gain relative to PC2. As I studied the data and conclusions myself, I also found many questions about the final result and opportunities for improvement. For these reasons, Qualcomm supports the proposal to reconsider the MPR as requested by the operators. I believe that Skyworks, Apple, LGE are also motivated to support the operators requests as best as possible, as evidenced by how much work you’ve already put into it.  For the aspect of additional workload, we are all sensitive to that. However, it is my opinion that the incremental work is manageable if you will already be doing a similar study for FWA. You already have to get your lab bench set up and calibrated, so taking additional sets of measurements is certainly not twice the work if you do it right. That being said, I also don’t believe Skyworks, LGE, and Apple will have to redo much of the work since you already have data available from your last effort. I believe much of that can be reused, but maybe supplemented with additional data.  I encourage companies to help in this effort, but Skyworks, Apple, and LGE could certainly be forgiven if they choose to limit their participation in the work. |
| Huawei | In view of Qualcomm’s comments above, it seems that they’re challenging the validity of the existing PC1.5 MPR. Since the same rigorous 3GPP process has been applied when defining the MPR, I doubt major flaws or in other words “opportunities for improvement” could be found.  Currently, PC1.5 assumes dual-PA/antenna architecture. This could be a main factor that the lower bound of the max Tx power after considering the MPR is not much improved compared with that of PC2. As pointed by Skyworks, there’re no changes in the RF assumptions and hence re-run the measurements wouldn’t yield much different results.  In summary, we do not think it’s necessary to revisit the PC1.5 MPR for handheld devices. |
| CMCC | Let's review the process of defining MPR in PC1.5 n41, and we thank Bill and the many companies for their contributions and efforts in the first PC1.5 band on n41, However, in view of the urgency of CR approval and WID completion, we believe that there is still room for improvement of MPR requirements in RAN4. Even in the PC1.5 A-MPR stage, we still carried out some optimization method. From the perspective of China Mobile, the current PC1.5 power fal lback (MPR) does not bring gain to HPUE. Operators and the industry all want such UEs to have better applicability and popularity. Obviously, the current MPR requirements cannot meet the application of PC1.5 UE. We believe that RAN4 has a responsibility to assess whether a requirement that lacks application value can be further optimized, |
| Nokia | We understand opinions not positive to revisit the values. But still we believe it is beneficial for companies specifically who provided data and contributions for n41 PC1.5 to check the respective observations that Qualcomm shared in their contribution of R4-2107353. Maybe QC can make a list. And QC would provide further evidence with data and proposals on how the MPR should have been in the past if there were MPR values mistakenly or inncorrectly adopted. |
| Verizon | We support Qualcomm!  Yes, operators don’t satisfy the current MPR requirements as it constricts the gain and behaviour of PC2 device under the defined band, channel bandwidth, resource blocks and modulation depth. This is one of reason the power class is raised up higher and higher under the regulation limits.  We would like RAN4 to re-evaluate or assess the related requirements further. Also, we encourage companies to be involve in this for better device performance. |
| DISH Network | We support re-evalution as well. We understand that often RAN4 process may result on a bit conservative requirements, because many things are accounted in parallel. 3GPP requirements are minimum requirements, but still RAN4 should also account that these minimum requirements should be meaningful. MPR specifications for allocations where PC1.5 does not offer any benefit over PC2 are not meaningful. PC1.5 is develop to improve the coverage, it is a new feature and with new feature the implementation technology evolves as has happened with every other feature in RAN4. RAN4 should perhaps squeeze in some of the margins in MPR assumptions to make PC1.5 better than PC2 also in 3GPP. In real devices the MPR will probably be optimized further, but 3GPP requirements should also show benefit of PC1.5 over PC2. |
| vivo | MSD as the minimum requirement, it doesn’t exclude any improvement. We don’t think it’s necessary to revisit smartphone MPR either. Maybe we could improve this by other method, not focusing on MSD revisit, which has too much controversy. |
| AT&T | We support the views raised by Qualcomm, Nokia, and operators. PC1.5 performance should show sufficient improvement over PC2 to justify the incremental cost and power consumption. The justification listed in the WID indicates that RAN4 would define RF requirements to enhance both UE mobile and FWA uplink efficiency and coverage. Nokia’s suggestion to list specific items for review should assist in limiting the scope of the re-evaluation. We also believe that the objective in the WID that the PC1.5 specifications are applicable to both handset and FWA form factors may need to be revisited to allow for further optimization of FWA form factor devices. Perhaps, we consider that the PC1.5 MOP without MPR is equivalent for handset and FWA form factors while MPR is dependent on device type.  FWA form factors are not typically battery power limited and physically constrained as is the case with handset form factors. RAN4 should consider targeting specific FWA assumptions to include the items identified in the draft WF on PC1.5 MPR as well as possible higher linearity single-PA and/or dual-PA architectures. |
| T-Mobile USA | We think that the existing MPR is very conservative, based on conservative assumptions of antenna isolation and but also because much of the data with those conservative assumptions showed that less MPR is needed than was agreed to. While we know that MPR is a maximum and vendors can always take less, the reality is that implementors often just take the amount allowed in the specs. We know it is very time consuming to do a full measurement campaign and we are very appreciative of all the work that has been done in the past, but it would be good to re-evaluate MPR based on past data and any new data to see if more of the potential benefit of PC1.5 can be realized. |
| Skyworks | As discussed in emails, we need to focus where the gain is of higher impact and can be enabled when the requirement limiting the output power is relative. For cases limited by absolute power/PSD levels, the output power can only be reduced compared with the PC2 power regardless of the antenna isolation assumed. Even if some Edge or outer MPR may be improved it will not allow PC1.5 power so we better concentrate our efforts on inner allocation which are the only one that have relative requirements (EVM, IBE or in some cases ALCR) and thus can get closer to 29dBm |
| Qualcomm | We continue to support the request from the operators to reconsider the MPR. We think that all waveforms (inner, outer, edge) can be reconsidered since the PC1.5 gain is so poor with the current specification, but we do acknowledge that different waveforms will have different likelihood to see large improvement. We would not like to exclude any waveform for potential improvement at this time. |

Sub topic 1-2: FWA MPR

FWA assumptions are antenna isolation = 20 dB, PCB isolation >75 dB, post PA loss = 4 dB. Are the FWA assumptons agreeable? If not, why not?

Operators to describe how the network can benefit from improved MPR specification, considering that the specification is an upper bound and devices are free to use lower MPR if they are able to meet all the requirements?

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| **Company** | **Comments** |
| Huawei | We propose to use the following assumptions for FWA as baseline: antenna isolation = 10 dB, PCB isolation = 60 dB, post PA loss = 4 dB.  The form factor of a FWA CPE could vary a lot. Those installed on the rooftop or in the loft of a house may be bulky, but those sitting on the window sill of a flat/apartment prefer to be small, let alone USB dongle types. By choosing relatively conservative assumptions, we could allow a wider range of design options. Bearing in mind, MPR is an allowance, different implementations are free to decide whether to use it. It does not cap the UE performances. For the FWA devices that are located at the cell edge (i.e. tight on link budget), attaching a high gain antenna might be an easier solution than squeezing maybe one more dB power from the RF module. |
| LGE | We prefer with antenna isolation =15dB, PCB isolation is FFS for FWA, post PA loss = 4 dB. Need to revise WF based on 2nd round agreements. |
| Verizon | We support following assumptions for decision of FWA MPR,   * antenna isolation = 20 dB, * PCB isolation >75 dB, * Post PA loss = 4 dB.   For operators, both the transmit power level (or improve the coverage range) and power efficiency for FWA device are major concerns. The assumptions could enhance the MPR requirements. |
| DISH network | We support moderator proposal on assumptions. |
| AT&T | We support the moderator assumptions with the additional request that RAN4 consider higher linearity single-PA and/or dual-PA architectures for FWA form factor. |
| T-Mobile USA | We support the moderator’s proposal on assumptions. |
| Skyworks | We will evaluate the proposed case by the moderator but we do not think we can agree yet this is the agreed assumption for the requirement yet. |
| Qualcomm | We support the moderator’s proposal since the assumptions came from direct feedback from FWA manufacturers. Additionally, if we observe that handset isolation is assumed to be 10 dB and handset includes low frequency bands, we think that 20 dB is entirely reasonable (it is probably too conservative even but it was the feedback received) as an assumption for FWA form factor where FWA is being considered for frequencies at 2.4 GHz, 3.5 GHz, and 4.5 GHz. In the end, it will not be these assumptions that will be specified in 3GPP, but only the MPR. So these should be interpreted as agreed assumptions for MPR study so that comparison of results is possible. This is the standard approach in RAN4. If companies want to additionally study assumptions outside of this agreement, of course, they are free to do so. We can agree to the 15 dB and 20 dB assumption for antenna isolation because 15 dB was reported by one FWA OEM, but we cannot agree to 10 dB. We also do not agree to PCB isolation “to be declared”, but if companies feel that neglecting PCB isolation is premature, then we suggest assuming 80 dB as this reflects the feedback from the FWA OEM’s. |
| Huawei | Huawei is also a vendor of FWA devices. Our products range from outdoor CPE to indoor CPE as well as mini-sized MiFi. The MiFi product is a battery powered wireless router connected to the cellular network and is targeted for the entry-level market. Partnered with 15 other module/terminal vendors, Huawei offers a comprehensive FWA industry catalogue (search “4G/5G FWA Industry Catalogue” for more details).  Apologies for the above commercial like statements. Just to prove a point that we care about FWA. Considering the broad range of our products, we cannot agree that 10 dB is excluded from the evaluation assumption for antenna isolation. We also believe that it’s not justified to ignore the PCB isolation, for which 60 dB is a good starting point. We’re not insisting that a single value is used for evaluation. Rather, we’re recommending that a range of values should be studied. And 10 dB and 60 dB are the starting points of those ranges we suggest for antenna isolation and PCB isolation, respectively. Similar to Skyworks’ view, we think down-selections/compromises may become possible/apparent after the initial evaluation results are available. |

Sub topic 1-3: UE RF requirements for Band n79

Can we identify which coexisstence requirements and their values might require A-MPR?

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| **Company** | **Comments** |
| LGE | A-MPR is depend on regional regulatory requirements. So it can be further discussed based on proponent request considered with their real deployment plan and scenarios. |
| Skyworks | It might be useful coexistence aspects at PC1.5 level but this is also a valid concern for n77 or n78 implemented with n77 filter (which given the BW is even more challenging than n79 filter). We will provide input on this next meeting. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2105013**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105013.zip)  Draft CR on PC1.5 UE RF requirements of n79 in Rel-17 TS 38.101-1 (CMCC) | Company A |
| Company B |
|  |
| [**R4-2105010**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105010.zip)  Draft CR on PC1.5 HPUE SAR issue into Rel-16 TS 38.101-1 (CMCC) | *Moderator note: This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.*  *Suggest “not treated”* |
| [**R4-2105011**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105011.zip)  Draft CR on PC1.5 HPUE SAR issue into Rel-17 TS 38.101-1 (CMCC) | *Moderator note: This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.*  *Suggest “not treated”* |

## Summary for 2nd round

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1-1**  Smartphone MPR | Seven companies supported revisiting the MPR for PC1.5, while five companies preferred to use the existing MPR previously defined when PC1.5 Band n41 was completed. Of the seven companies supporting, all of the operators (CMCC, DISH network, T-Mobile USA, AT&T, Verizon) who are requesting PC 1.5 are asking for reconsideration of the MPR since the current specifications do not meet their needs and expectations for PC1.5. On the other hand, the companies opposed to reconsideration cite the extensive work that had been done previously and expressed skepticism whether improvement could be found. |
| **Sub-topic #1-2**  FWA MPR | In the second round of discussion, companies focused on the set of assumptions that could be taken to derive FWA MPR. The majority of companies and all of the operators (Verizon, DISH network, T-Mobile USA, and AT&T) supported the moderator’s proposal for 20 dB antenna isolation, >75 dB PCB isolation, and 4 dB post PA loss. One company suggested lower values to enable a wider range of devices with a proposal to consider 10 dB antenna isolation and 60 dB PCB isolation at the low end, but this view was not supported by any other company. |
| **Sub-topic #1-3**  UE RF requirements for n79 | Further discussion on coexistence requirements for PC1.5, for n77, n78, and n79, is expected for the next meeting. |
| **Sub-topic #1-4**  Smartphone SAR | No second round discussion on this topic. |
| **Sub-topic #1-5**  Release independence | No second round discussion on this topic. |

# Topic #2: RF exposure aspects for FWA

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2105035**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2105035.zip) | Samsung | MPE handling for high power FWA devices  **Observation 1: The method of evaluating RF exposure to human body is highly dependent on the device type and deployment scenarios.**  **Observation 2: For UEs for FWA operations, the device can be determined as maintained 20 cm separation distance to the body at least, and the MPE criteria are applied as the evaluation parameters.**  **Observation 3: A FWA device having a lower antenna gain might meet the RF exposure regulation in general without the duty cycle scheme nor other solutions.**  **Observation 4: RAN4 should have further discussion on the for the FR1 MPE handling mechanism given the definition gap between UE power class and MPE regulatory requirements.** |
| [**R4-2107264**](http://ftp.3gpp.org/TSG_RAN/WG4_Radio/TSGR4_98bis_e/Docs/R4-2107264.zip) | Huawei, HiSilicon | On the RF exposure limit for FWA PC1.5  **Observation 1**: Power class 1.5 FWA devices are likely to exceed relevant MPE regulations. However existing mechanisms such as P-MPR and/or duty cycle can be reused to facilitate MPE compliance.  **Observation 2**: The MPE compliance in FR1 has not been defined in 3GPP specs. The existing evaluation period for SAR (FR1) or MPE (FR2) is much shorter than the one specified in the FCC MPE regulation.  **Proposal 1**: Reuse the existing P-MPR and/or duty cycle mechanisms for facilitating FWA MPE compliance.  **Proposal 2**: A longer evaluation period for the duty cycle solution should be considered. |

## Open issues summary

Both paper submitted on this topic use the same equation for MPE but arrive at different conclusions.

### Sub-topic 2-1

*Sub-topic description:*

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

**Issue 2-1: FWA MPE approach**

* Proposals
  + Option 1: Duty cycle reporting is not used. Instead, focus on G\_tx assumption.
    - If actual G\_tx is larger than assumed G\_tx, then conducted power is reduced (P-MPR? Other?)
  + Option 2: Duty cycle approach is used with possible longer evaluation period.
  + Option 3: Other (please provide suggestion)
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1: FWA MPE approach

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Need further discuss to open all candidate solutions |
| CMCC | Not sure if it is necessary to define SAR for FWA and need to clarify the difference between FWA and Smart UE in SAR testing so that companies can see if RAN4 need to define a new SAR method for FWA |
| Samsung | We support Option 1. However, unless a concrete method using the G\_tx can be proposed and/or agreed in the next meeting, we are also fine to reuse the existing SAR solution for the smartphone, 25% dutycycle. |
| Qualcomm | Agree with LGE, we aren’t ready to dismiss either option yet. Perhaps some elements of both can be used in the end, rather than either/or. |
| Huawei | Issue 2-1: FWA MPE  Similar to SAR issue, MPE compliance is UE’s responsibility. Hence the P-MPR method should be the baseline and mandatory, while duty-cycle or other schemes are optional and need further study. |
| Verizon | Agree with LGE! |
| Vivo | We don’t see the reason to exclude duty cycle solution. When actual G\_tx is larger than assumed G\_tx, both P-MPR and duty cycle approach are optional approaches for MPE. |

### 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** |
|  | Company A |
| Company B |
|  |
|  | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#2-1: FWA MPE approach** | Companies were not ready to exclude either G\_tx or duty cycle approach, while it was also suggested that the two approaches could be merged or tiered in priority. P-MPR was also suggested to be the baseline solution with other approaches as optional.  *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:*  No further discussion in this meeting. WF is developed with the above guidelines to frame the work for the next meeting where details can be proposed. |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

Sub topic 2-1: FWA MPE approach

Any further comments on how to merge the two approaches, suggestions on details, values to help progress the work for the next meeting?

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | We prefer both P-MPR and dutycycle approach. The draft WF is agreeable to us |
| Huawei | I have some questions for clarification on the antenna gain (G\_tx) approach. 1) Would a G\_tx threshold be defined in the spec, or is it up to UE implementation? 2) How is the antenna gain approach different from the P-MPR method if both are UE centric? 3) The example calculations in the proponent’s paper R4-2105035 do not consider the tolerance of conducted power or antenna gain. If included, the results could be quite different. |

## Summary for 2nd round

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#2-1: FWA MPE approach** | It is expected that further details and proposals for G\_tx and duty cycle will be provided and discussed next meeting. |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on MPR for PC 1.5 | [T-Mobile USA] | Includes both smartphones and FWA (separately) |
| WF on UE RF requirements for PC 1.5 in Band n79 | CMCC |  |
| WF on RF exposure mitigation approaches for PC 1.5 | Samsung | Includes both smartphones and FWA (separately) |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| **R4-2104893** | Considerations for PC1.5 with band n79 | Apple | Noted |  |
| **R4-2104957** | Discussion on PC1.5 with n79 | vivo | Noted |  |
| **R4-2104975** | MPR for PC 1.5 NR UE on n77/n78 or n79 | LGE | Noted |  |
| **R4-2105012** | Discussion on the PC1.5 UE RF requirements of NR n79 | CMCC | Noted |  |
| **R4-2107317** | Discussion on PC1.5 performance for FWA | Skyworks | Noted |  |
| **R4-2107352** | PC 1.5 for FWA devices | Qualcomm | Noted |  |
| **R4-2107353** | PC 1.5 in Band n79 | Qualcomm | Noted |  |
| **R4-2105013** | Draft CR on PC1.5 UE RF requirements of n79 in Rel-17 TS 38.101-1 | CMCC | Postponed |  |
| **R4-2105010** | Draft CR on PC1.5 HPUE SAR issue into Rel-16 TS 38.101-1 | CMCC | Not pursued | *This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.* |
| **R4-2105011** | Draft CR on PC1.5 HPUE SAR issue into Rel-17 TS 38.101-1 | CMCC | Not pursued | *This is a Rel-16 correction, not on the agenda for RAN4 #98-bis-e.* |
| **R4-2105035** | MPE handling for high power FWA devices | Samsung | Noted |  |
| **R4-2107264** | On the RF exposure limit for FWA PC1.5 | Huawei, HiSilicon | Noted |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-2105380 | WF on MPR for PC 1.5 | T-Mobile USA | GTW |  |
| R4-2105381 | WF on UE RF requirements for PC 1.5 in Band n79 | CMCC | Agreeable |  |
| R4-2105382 | WF on RF exposure mitigation approaches for PC 1.5 | Samsung | Agreeable |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents