**3GPP TSG-RAN WG4 Meeting # 100-e R4-211XXXX**

**Electronic Meeting, 16th – 27th August, 2021**

**Agenda item:** 9.3.1

**Source:** Moderator (Huawei, HiSilicon)

**Title:** Email discussion summary for [100-e][127]NR\_RF\_FR1\_enh\_Part\_1\_HPUE\_ULMIMO

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

Thread [127] includes following topics:

1. Topic #1: Intra-band contiguous UL CA for FR1 power class 2 which is for agenda 9.3.2.4
2. Topic #2: Intra-band NC UL CA for FR1 power class 2 which is for agenda 9.3.2.5
3. Topic #3: Intra-band UL contiguous CA for UL MIMO which is for agenda 9.3.2.6
4. Topic #4: solution for Scell dropping which is for agenda 9.3.2.7.2
5. Topic #5: UL MIMO Bands which is for agenda 8.41

# Topic #1: PC2 intra-band contiguous UL CA

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2114493 | Huawei, HiSilicon | ***Observation 1: At least, the same MPR can be applied for contiguous CA with 1PA and 2PA architectures, if only forward IMD is considered.***  ***Proposal 1: For PC2 intra-band UL contiguous CA with 2PA architecture, adding 0.5dB delta MPR on outer1 and outer2 allocation based on the MPR defined for PC2 contiguous CA with 1PA architecture.***  ***Proposal 2: Adding the MPR value for intra-band contiguous CA with 2PA architecture with following style:***  ***Adding NOTE 2 for MPR table 6.2A.2.1-1a: For Bandwidth class C, MPR is increased by 0.5dB for outer allocation when UE indicates IE dualPA-Architecture supported.***  ***Adding NOTE 2 for MPR table 6.2A.2.1-3a: For Bandwidth class C, MPR is increased by 0.5dB for outer1 and outer2 allocation when UE indicates IE dualPA-Architecture supported.*** |
| R4-2114498 | Huawei, HiSilicon, Skyworks | Big CR for PC2 intra-band UL contiguous CA |

## 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: PC2 contiguous CA with 2PA architecture

*Sub-topic description:*

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

**Issue 1-1-1: MPR for PC2 contiguous UL CA with 2\*(23dBm/200MHz) PAs and 1LO**

* **Proposals：**
* **Option 1:**
* For inner allocation, reuse the MPR defined for PC2 contiguous CA with 1PA architecture
* For outer allocation(outer1 and outer2 for NC allocation, outer for C allocation), MPR is increased by 0.5dB.

Table 6.2A.2.1-1a: Contiguous RB allocation for Power Class 2 with 1Tx

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modulation | | MPR for bandwidth class B(dB) | | MPR for bandwidth class C(dB) | |
|  | | inner | Outer1 | inner | Outer2 |
| DFT-s-OFDM | Pi/2 BPSK | 2.0 | 4.01 | 2.5 | 7 |
|  | QPSK | 2.0 | 4.01 | 2.5 | 7 |
|  | 16QAM | 2.5 | 4.01 | 2.5 | 7 |
|  | 64QAM | 3.0 | 4.51 | 5 | 7 |
|  | 256QAM | 5.5 | 6.0 | 7 | 7.5 |
| CP-OFDM | QPSK | 2.5 | 5.01 | 3.5 | 8 |
|  | 16QAM | 3.0 | 5.01 | 3.5 | 8 |
|  | 64QAM | 3.5 | 5.01 | 5 | 8 |
|  | 256QAM | 6.5 | 6.5 | 7 | 8 |
| NOTE 1: When 1 RB or 2 RB are allocated at the lower edge of lowest CC or upper edge of upper CC, MPR for outer is [5.5] dB.  NOTE 2: For Bandwidth class C, MPR is increased by 0.5dB for outer allocation when UE indicates IE dualPA-Architecture supported. | | | | | |

Table 6.2A.2.1-3: non-contiguous RB allocation for Power Class 2 with 1Tx

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Modulation | | MPR for bandwidth class B(dB) | | | MPR for bandwidth class C(dB) | | |
|  | | inner | Outer1 | Outer2 | inner | Outer11,2 | Outer22 |
| DFT-s-OFDM | Pi/2 BPSK | 31 | 6.5 | 13 | 31 | 7.5 | 13.5 |
|  | QPSK | 31 | 6.5 |  | 31 | 7.5 |  |
|  | 16QAM | 31 | 6.5 |  | 31 | 7.5 |  |
|  | 64QAM | 5 | 6.5 |  | 5 | 7.5 |  |
|  | 256QAM | 6.5 | 7 |  | 6.5 | 7.5 |  |
| CP-OFDM | QPSK | 3.51 | 7 | 14 | 3.51 | 8 | 14.5 |
|  | 16QAM | 3.51 | 7 |  | 3.51 | 8 |  |
|  | 64QAM | 5 | 7 |  | 5 | 8 |  |
|  | 256QAM | 7.5 | 7.5 |  | 7.5 | 8 |  |
| NOTE 1: the allowed MPR is [4]dB for aggregated allocation bandwidth < [2MHz].  NOTE 2: For Bandwidth class C, MPR is increased by 0.5dB for outer1 and outer2 allocation when UE indicates IE dualPA-Architecture supported. | | | | | | | |

* **Option 2:**

Others

* Recommended WF
  + TBA

**Issue 1-1-1: MPR requirement for PC2 contiguous UL CA with 2\*(23dBm/200MHz) PAs and 1LO**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We are the proponent of option 1.  For inner allocation, we think the IM3 will not fall into the ACLR region, so we think RIMD has no contribution for inner allocation. |
| Skyworks | As already demonstrated in our single CC measurements, some of the underlying assumptions about inner should be revisited for PC2 and especially for 2CC:  It is not true that RIMD can be ignored in some case because:  Contiguous outer allocations are ACLR limited and needs additional MPR to compensate for RIMD and PC3 intrinsically 1dB lower ACLR capability.  Contiguous inner allocations corner cases (maximum LCRB inner) can be ACLR limited and may needs additional MPR to compensate for RIMD and PC3 intrinsically 1dB lower ACLR capability.  For non-contiguous allocation all allocations including inner are SEM limited (either from IMD5 or IMD3) and thus additional MPR is needed to compensate for RIMD and lower intrinsic PA linearity.  In fact where we need to be most careful is for the lower MPR values since they are the one most affected by RIMD.  The text is also ambiguous about class C: is it that only class C is specified for 2Tx (with what fall back to class B?) or that only class C is subject to the issue. As explained above in fact, class B may see more impact because of lower MPR to start with.  The above points must be further discussed ensure the delta MPR is properly accounted for all types of allocations |
| Qualcomm | 0.5 dB is not needed. This was settled in PC3 part. It is a little surprising to see this proposals since WF **R4-2105388** did not mention anything about discussing this option. Also, using notation 1Tx mixed with dualPA IE creates confusion since we just told ran2 that dual PA means reporting two LO’s. |
| LGE | Option1. LGE can allow 0.5dB additional MPR in outer regions for Bandwidth class C for dual PA architecture. |

### Sub-topic 1-2: Spec architecture

*Sub-topic description*

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

**Issue 1-2-1: Spec architecture for PC2 contiguous CA with 2PA**

* Proposals
  + Option 1:
* Define MPR for PC2 CA with 2PA in subclause 6.2A.2 of TS 38.101-1(UE maximum output power reduction for CA)
  + Adding a Note in the MPR tables for 2PA architecture
  + Option 2: Other
* Recommended WF
  + TBA

**Issue 1-2-1: Spec structure for PC2 contiguous CA with 2PA**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We are the proponent of option 1. |
| Skyworks | We are fine with a delta MPR approach but may need to be two values depending on allocation type and modulation order. |
| Qualcomm | 2PA MPR and 1PA MPR should be in the same table and same MPR should apply. |
| LGE | Option 1. Same MPR table and requirements for 2PA and 1PA. Support to add Note for dual PA architecture. |

## Companies views’ collection for 1st round

### Open issues

Collect in 1.2.

### 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** |
| R4-2114498 | Qualcomm: Notation “1Tx” can not be in table 6.2A.2.1-1a. |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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”.*

# Topic #2: PC2 intra-band NC UL CA

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112022 | Nokia | **Observation 1: With 35 dB LO suppression the back-off envelope approaches the envelope of the reference scenario where LO is excluded.**  **Observation 2: With 37 dB LO suppression the back-off, considering all simulated allocations, approaches the envelope of the reference scenario where LO is excluded.**  We expect this LO effect to be similar also in asymmetric combinations.  In addition, regarding asymmetric CA combinations, it was observed that  **Observation 3: The ACLR effect of IQ image in asymmetric NC CA combinations depends on the CC allocations.**  **Observation 4: With unfavourable allocations, such as 1+100 RB in case of 20+40 MHz NC CA, IQ suppression of up to 32 dB can be necessary in order to achieve moderate MPR.**  Furthermore, it was observed that  **Observation 5: Relaxing the ACLR requirement could have a detrimental effect on the system performance as a whole**. |
| R4-2112893 | LGE | **Observation 1: For Case 1, it is not general use case for intra-band NC CA operation when NW is deployed in co-located scenarios (MRTD is less than 10~15 us).**  **Observation 2: For Case 2, it is corner case to configure Scell with maximum transmission power since the NW expected that the UE is located in cell boundary. So the Scell can be released.**  **Proposal 1: RAN4 do not need to define the additional swapping time requirements for #4 RF architecture (1x23dBm + 1x26dBm with 2LOs) for PC2 intra-band NC-CA UE.**  **Proposal 2: RAN4 will specify the one MPR Table to support the PC2 simultaneous UL CA + UL MIMO with 2 transmit for 1 LO RF architecture.**  **Proposal 3: RAN4 will specify the one MPR Table to support the PC2 intra-band NC-CA UE for 2 LOs RF architecture based on the #4 RF architecture.**  **Proposal 4: The required MPR values would ensure that the PC2 intra-band NC-CA UE is better performance than PC3 intra-band NC-CA UE.** |
| R4-2114494 | Huawei, HiSilicon | ***Observation 1: UEs with enhanced Image/leakage ability can reach in-gap requirement with reasonable MPR value. For gap BW which is less or equal to CBW1+CBW2, no MPR for image falling is needed.***  ***Proposal 1: No OOBE exception requirement for architecture #2 and #3, UE support intra-band NC CA with 1PA architecture can solve in-gap issue with additional MPR to reach the in-gap requirement which is less than or equal to 13dB for worst case***  ***Proposal 2: 15us of PA swap time for architecture #4 can be considered, the swap time is only allowed for the switching of:***   * ***case1 and case2/3,*** * ***case2 and case3***   ***where:***   * ***Case1 is that the transmission power for both CCs are ≤23dBm.*** * ***Case 2 is that the transmission power for CC1 is larger than 23dBm and for CC2 is ≤23dBm, while case 3 is that the transmission power for CC2 is larger than 23dBm and for CC1 is ≤23dBm.***   ***Proposal 3: It is proposed to use the worst case value across architectures to define MPR for non-contiguous CA.*** |
| R4-2114571 | Skyworks | **Proposal on architecture requiring in-gap exceptions:**   * **In-gap exceptions are only allowed for CC configurations where the gap bandwidth is less or equal than the two CC aggregated bandwidth thus SEM is -13dBm/MHz in gap and shall be met** * **3dB ACLR in gap relaxation is allowed and assumes** * **In-gap exceptions are only allowed for UEs also supporting UL MIMO or TxD together with NC UL CA** * **This architecture will use separate MPR values in the specification (table or delta) and address both TxD and UL MIMO modes.** * **FFS if carrier leakage may still need some management with -13dBm/MHz in gap SEM**   **Proposal on 2LO PC2+PC3 architecture requiring timing exceptions:**   * **A maximum swap time of 15us – MRTD is allowed** * **Both SCC and PCC shall be able to reach maximum power for equal PSD case with large allocation difference** * **General MPR table is based on the 2LO 2xPC2 PA architecture and a 1.5dB additional MPR allowed for 2LO PC3+PC2 architecture** |

## Open issues summary

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

### Sub-topic 2-1: MPR comparison among architecture options

*Sub-topic description:*

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

*Copy the 4 architectures for intra-band UL NC CA under discussion:*

|  |  |
| --- | --- |
| Arch | description |
| #1 | 2x26dBm PA + 2LO with 100MHz BW |
| #2 | 1x26dBm PA + 1LO with 200MHz BW |
| #3 | 2x23dBm PA + 1LO with 200MHz BW |
| #4 | 1x23dBm+1x26dBm + 2LO with 100MHz BW |

**Issue 2-1-1: MPR comparison among architecture options**

*Data shown here also includes MPR proposed in the last meeting*

* Proposals

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **MPR** |  | **HW**  **R4-2114494** | | | | **Nokia**  **R4-2112022** | **LGE**  **R4-2109965** | | **Skyworks**  **R4-2104819** | | **Current**  **PC3**  **requirement** |
| IM3 region | B | **Archi#1** | **Archi#2** | **Archi#3** | **Archi#4** | **Archi#2** | **Achi#1** | **Achi#4** | **Achi#1** | **Achi#4** | **2PA Achi** |
| -30dBm/MHz | 0.72 | 14.5 | 15.1 | 15.6 | 14.7 | 14 | 15 | 16 | 5.1 | 7.1 | 15 |
| 1.44 | 11.3 | 12.8 | 13 | 11.4 | 14 | 15 | 4.9 | 6.7 | 14.5 |
| 2.88 | 11.2 | 12.5 | 12.5 | 11.4 | 14.4 | 12.5 | 14 | 4.3 | 6.3 | 13.5 |
| 5.76 | 10.7 | 11.2 | 11.3 | 10.8 | 12.5 | 10.5 | 12 | 3.5 @5.4M | 5.7@5.4M | 11.5 |
| 10.8 | 10.2 | 11 | 11.4 | 10.5 | 10.8 | 10 | 10.5 | 2.6 @11.52M | 4.9@11.52M | 10.5 |
| 23.04 | 9.2 | 10.5 | 10.7 | 9.5 | 6.7 | 8.5 | 9 |  |  | 9 |
| 46.08 | 8.8 | 9.4 | 9.7 | 8.9 | 5.6 | 4.7 | 6.8 |
| 92.16 | 8.5 | 8 | 8.3 | 8.7 | 4.78 | 1.7@77.7M | 4.5@77.7M |
| 97.92 | 8.3 | 8.9 | 9.3 | 8.5 | 4.67 |  |  |
| 103.68 | 8.1 | 9.5 | 9.9 | 8.3 | 4.57 |  |  |
| 116.64 | 7.5 | 8.3 | 8.7 | 7.8 | 4.33 |  |  |
| -13dBm/MHz | <0.54 | 7 | 8.5 | 8.3 | 7.2 |  |  | 9 |  |  | 9 |
| 0.54 | 6.8 | 8 | 7.5 | 7 |  |  | 8 |  |  | 8 |
| 1.08 | 6.5 | 8 | 7.5 | 6.8 |  |  | 7 |  |  | 7 |
| 2.16 | 6.5 | 7.5 | 7.2 | 6.6 |  |  | 6.5 |  |  | 6.5 |
| 3.24 | 6 | 7.3 | 7 | 6.3 |  |  | 5.5 |  |  | 5.5 |
| 5.4 | 5.5 | 6.4 | 5.7 | 5.8 |  |  | 4 |  |  | 4 |
| 10.8 | 3.2 | 4 | 3.8 | 3.3 |  |  | 4 |  |  | 4 |

**Question 1: Based on available MPR input, check whether to define one set of MPR requirement across 4 architectures?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | From the inputs above, at least for architecture #1 and #4, it is possible to define one set requirements to simplify the spec. And both cannot support UL MIMO this is also the common capability. |
| Huawei, HiSilicon | We don’t see much MPR difference between archi 1/4 and 2/3, if we consider in-gap requirement is solved by enhanced LO/image. Based on this, we think one set of MPR requirement across 4 architecture is acceptable. |
| Skyworks | It should be clear that absolute values the different architectures are easily covered by the rather generous AMPR values. We should focus on the measured difference between the architectures rather than an MPR number:  in our case show up to 2dB difference between Arch 1 and Arch 2 eating up most of the benefit of going to PC2 from PC3 and some evaluations of Arch 4 only use symmetrical allocation that does not show where additional MPR is needed. There is also confusion that co-located scenario is equal power where it is equal PSD/equal backoff.  For Arch 2 and 3 there is also a delta MPR of close to 2dB and it does not even cover the worst in gap cases where -30dBm/MHz (not -27dBm/MHz, the composite takes the most relaxed value of the two CC SEM not a power sum) SEM requirement.  It is not acceptable to us that the PC2 performance is dragged down by the worst case implementation that on top of that require additional exception to be enabled.  We had done measurements for Arch 2/3 but they were late and had calibration issues that would not have allowed enough accuracy to show differences between architectures. |
| Qualcomm | 1PA and 2PA will need different MPRs. Reason in IM5 for -30 dBm/MHz region. |
| Nokia | For this exercise to be beneficial we need power gain for PC2 compared to PC3, that may not happen if we have single set of MPR values based on worst architecture. We would like to see at least MPR which is optimized for Arch#1. |
| LGE | Our preference for MPR requirements is to make one set MPR for all #1,2,3,4 RF architecture.  But when we consider the characteristics of RF architecture, we can make two set MPR requirements.  One is MPR for #1,#4 RF architecture (2LOs) and the other is #2,#3 RF architecture (1LO) since RAN4 can make some different additional RF requirements such as in-gap emission requirements and/or swapping time according to architecture perspective. |

**Question 2: Can we choose the initial MPR value based on available input with the worst one?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Value from one company seems much smaller than other companies, better to get clarity on the difference. |
| Huawei, HiSilicon | It could be, but should be moderate enough to reach PC2 gain compared with PC3 MPR definition. |
| Skyworks | Our values have always been smaller as they use wideband APT PAs but for all the PC3 work we have been transparent on this and accepted higher MPR values with the detailed understanding of why other architectures like ET needs higher back-off and this is for the same reason that the only way to gage the architecture impact is to compare values within the same PA type thus the delta between architectures and not the delta vs PC3 values that are very generous. |
| Qualcomm | For 1PA architectures and 2PA architecture separately. |
| Nokia | As stated in Q1 we do not prefer one set of MPR if that is the question. But we do not understand question fully, what is meant with worst one, is it worst architecture average or worst company results for worst architecture. |
| LGE | If the output power by proposed MPR levels is better than PC3 NC CA UE, then we can compromise to choose the worst one. |

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Moderator note: Architecture handling is considered together with MPR comparison across architectures in section 2-2

* + TBA

**Issue 2-1-2: whether MPR requirements are separate defined for different architecture?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 is ok, and it can represent different UE capabilities like CA+UL MIMO |
| Huawei, HiSilicon | We prefer option 3. |
| Skyworks | Option 1 is also how single CC TxD and UL MIMO are treated and correspond to a different capability with exceptions for Arch2/3. For arch4 a delta MPR vs Arch1 is sufficient |
| Qualcomm | Neither of the options is feasible. Architecture #2 and #3 should have same MPR. For Option 1 arch #4 should not get any extra MPR compared to #1. Option 2, CA+ULMIMO should be handled in the part for UL CA + MIMO. In option 2 proposals 3, arch #1 should be baseline. #4 is pathological as explained in R4-2108799. Option 3, we should choose feasible architectures, not allow architectures that degrade the feature in ran1 level. MPR can be different based on dualPA and dualPA is coupled with number of LO’s. |
| Nokia | Agree with Qualcomm in that we should choose feasible architectures and four is too much in our opinion if network needs to be aware of that they exists. MPR should be reasonable and UE vendors should do products that meet that. Baseline assumptions should be such that we do not need to care if UE has 1 or 2 LOs. |
| LGE | Prefer option 3. For the option1, the 1.5dB MPR is the specific case as worst. Usually, 0.5dB difference is observed. So it is not right information for #4. We can compromise with option 2. |

### Sub-topic 2-2: Other requirement related to different architecture

**Issue 2-2-1: For 1x26dBm PA + 1LO with 200MHz BW and 2x23dBm PA + 1LO with 200MHz BW, how to handle in-gap requirement when LO or image fall inside?**

* Proposals
  + Option 1: No OOBE exception requirement for architecture #2 and #3, use moderateMPR to reach the in-gap requirement
    - Assume IQ suppression>=32dBc, LO leakage>=35dBc
  + Option 2:
    - **In-gap exceptions are only allowed for CC configurations where the gap bandwidth is less or equal than the two CC aggregated bandwidth thus SEM is -13dBm/MHz in gap and shall be met** *It means no exception is allowed?*
    - **3dB ACLR in gap relaxation is allowed and assumes**
    - **In-gap exceptions are only allowed for UEs also supporting UL MIMO or TxD together with NC UL CA**
* Recommended WF
  + TBA

**Issue 2-2-1: For 1x26dBm PA + 1LO with 200MHz BW and 2x23dBm PA + 1LO with 200MHz BW, how to handle in-gap requirement when LO or image fall inside?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Prefer Option 2. In-gap exceptions are only allowed for CC configurations where the gap bandwidth is less or equal than the two CC aggregated bandwidth. |
| H**uawei, HiSilicon** | Both option 1 and option 2 are OK for us. Considering regulatory requirement, we could assume better IQ and LO to reach moderate MPR. With this, ACLR can be reached in natural.  For option 2, we think it means no exception is allowed, because UE can meet the -13dBm/MHz emission with 11dB MPR for 1+1RB allocation assuming -28dBc image, because:  26dBm-28dBc=-2dBm image falling into the gap  And -2->-13, which requires 11dB MPR.  While for -32dBc image, only requires for 7dB MPR.  Both 11dB and 7dB MPR for 1+1RB allocation is less than the MPR defined for PC3 NC CA. |
| Skyworks | For Option 1 we have shown that some corner cases at (-30dBm/MHz) cannot be solved even for large MPR and with even with good transceiver impairments. Option two (without exception allowed for image and assuming better image rejection than default) is our preference. Given this option2 it may be feasible to have Arch2/3 to only have a delta MPR vs baseline 2xPC2 PA case which will also enable supporting BW > 200MHz with 2PC2 PA wo ULMIMO/TxDiv and BW<200MHz w ULMIMO. |
| Qualcomm | Option 1. Numbers apply only for simulations for that one scenario. Requirement for LO is still based on emission requirement. Could be -30 dBm/MHz and dBc values could be very high. |
| NTT DOCOMO, INC. | We prefer option 1, i.e., no OOBE (SEM, ACLR, spurious emission) exception.  For option2, our concern is:  Current Japanese regulation does not allow in-gap exception. No one know whether or not regulation can be changed in the future. If the regulation will not be changed, we cannot use UE with architecture #2 and #3 under our spectrum allocation where in-gap bandwidth is 80MHz and aggregated BW of 2CC is 180MHz. In addition, based on R4-2108799, we wonder this is also the case with regulation in other countries. |
| Nokia | We prefer option 1 in order to avoid relaxing ACLR. |
| LGE | Prefer option 2. For the option 1, it shall be further check the leakage levels for Option 1. |

**Issue 2-2-2: For 1x23dBm + 1x26dBm PA + 2LO with 100MHz BW, how to handle the swap time between Pas?**

* Proposals
  + Option 1: 15us only for:
* ***case1 and case2/3,***
* ***case2 and case3***

***where:***

* ***Case1 is that the transmission power for both CCs are ≤23dBm.***
* ***Case 2 is that the transmission power for CC1 is larger than 23dBm and for CC2 is ≤23dBm, while case 3 is that the transmission power for CC2 is larger than 23dBm and for CC1 is ≤23dBm.***
  + Option 2: RAN4 do not need to define the additional swapping time requirements for #4 RF architecture. (Because it is corner case to configure Scell with maximum transmission power since the NW expected that the UE is located in cell boundary.)
  + Option 3: A maximum swap time of 15us – MRTD is allowed

Both SCC and PCC shall be able to reach maximum power for equal PSD case with large allocation difference

* Recommended WF
  + TBA

**Issue 2-2-2: For 1x23dBm + 1x26dBm PA + 2LO with 100MHz BW, how to handle the swap time between Pas?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 3. |
| Huawei, HiSilicon | We prefer option 1, which clearly define the scenario that swap time is needed. |
| Skyworks | Option 3: it is not acceptable that one CC is capped in power or even that PCC is since this is based on collocated scenario and equal PSD is the target. It would mean that any strong allocation imbalance would result in one of the CC not being received |
| Qualcomm | Option 2. |
| Nokia | Option 2 if what LG paper states is true that cases needing swap are rare. |
| LGE | Option 2 |

## Companies views’ collection for 1st round

### Open issues

Collect in 2.2

### CRs/TPs comments collection

*Major close to finalize Wis and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going Wis, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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”.*

# Topic #3: Intra-band UL contiguous CA for UL MIMO

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112324 | ZTE | **Proposal 1: Requirements specified in the examples of 2 contiguous CCs are also aimed to be applicable to the higher orders, so the signalling design should account for higher order cases with more than 2 contiguous CCs.**  **Proposal 2: Introduce a separate bandwidth class capability for UL-MIMO.** |
| R4-2113024 | vivo | **Observation 1:** In current spec, UL-MIMO is a per-CC capability, which is independent with CA.  **Observation 2:** In currently capability definition, if UL-MIMO support were reported in the CCs for CA, theoretically CA and UL-MIMO should be supported simultaneously unless stated otherwise.  **Observation 3:** There exists some architecture, though not necessarily typical, can support CA and UL-MIMO respectively but not simultaneously. These implementations are somewhat contradicting with current signalling scheme.  **Observation 4:** Keep current signalling unchanged may preclude some implementations which is not typical.  Based on the current situation, there is the following proposal:  **Proposal:** Discuss whether there is a need to develop new signalling for support of CA + UL-MIMO and the two tentative options are:  **Option 1:** Yes. Incorporate implementations with narrowband PA.  **Option 2:** No. Preclude implementation with narrowband PA |
| R4-2113898 | OPPO | ***Observation 1: ca-BandwidthClassUL-NR is a per-band capability used to report the supported aggregated CBW for intra-band contiguous UL CA.***  ***Observation 2: The aggregated CBW capability could be different when UE works under CA mode or under CA+UL MIMO mode, however, with one ca-BandwidthClassUL-NR capability reported this cannot be differentiated.***  ***Observation 3: RAN2 didn’t touch the UE aggregated CBW capability limitation in CA+UL MIMO.***  ***Observation 4: RAN2 assumes all the UE capability should be reported within a single band combination entry, and NW is not required to derive UE capability based on multiple band combination entries.***  ***Observation 5: Reporting different aggregated CBW in two band combinations for CA only and CA+UL MIMO is not feasible, and may lead to scheduling errors in UE configuration.***  ***Proposal 1: It is proposed to report the UE supported aggregated CBW for UL CA+UL MIMO feature to NW.*** |
| R4-2114491 | Huawei, HiSilicon | ***Proposal 1: For PC3 intra-band UL contiguous CA with UL MIMO, adding 0.5dB delta MPR on outer1 and outer2 allocation based on the MPR defined for PC3 contiguous CA.***  ***Proposal 2: For PC2 intra-band UL contiguous CA with UL MIMO,*** ***adding 0.5dB delta MPR on outer1 and outer2 allocation based on the MPR defined for PC2 contiguous CA with 1PA.*** |
| R4-2114470 | Huawei, HiSilicon | CR on contiguous CA with UL MIMO for PC3 |
| R4-2114564 | Skyworks | **Observation: a SD-CDD delay of 600ns is used for 15 kHz SCS measurements**  **Proposal: This paper will be revised with analysis of the data as a late contribution for consideration with interested companies.** |

## 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 3-1: RF requirements

**Issue 3-1-1: MPR requirement for PC3 UL contiguous CA +MIMO with 2 PC3 PA+1LO**

* Proposals
  + Option 1: Adding 0.5dB delta MPR on outer allocation(outer1 and outer2 for NC allocation, outer for C allocation) based on the MPR defined for PC3 contiguous CA.
  + Option 2: Other
* Recommended WF
  + TBA

**Issue 3-1-1:**

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| --- | --- |
| **Company** | **Comments** |
| China Telecom | In CR R4-2114470, another option with no delta w.r.t. the MPR for PC3 contiguous CA without UL-MIMO is proposed, which is preferred by us. |
| OPPO | Option 1. |
| Huawei, HiSilicon | From measurements on PC3 CA+MIMO, we can meet with MPR defined for PC3 in 1PA. However, we agree that RIMD has contribution on MPR theatrically, but the impact is limited. We are OK with option 1 or just reuse the current MPR defined for PC3 assuming 1PA. |
| Skywork | Since this is PC3 with two PC3 Pas there is no need to compensate for lower PA linearity and since the only case where 1 PA would reach close to its power capability is for very unbalanced allocation, in most case Pas will have headroom for RIMD or will be in a case where one CC is much lower power thus reducing RIMD level. Given this (and like for one CC TxD) it is acceptable to reuse 1TX PC3 MPR at least as a starting point. |
| Qualcomm | Option 3: 0.5 dB MPR is not needed since the individual Pas are operating 3 dB lower operating point. |
| LGE | We can accept option 1 |

**Issue 3-1-2: MPR requirement for PC2 UL contiguous CA +MIMO with 2 PC2 PA+1LO or 2 PC3 PA+1LO**

* Proposals
  + Option 1: Adding 0.5dB delta MPR on outer1 and outer2 allocation based on the MPR defined for PC2 contiguous CA with 1PA.
  + Option 2: an additional 0.5 to 1dB MPR can be anticipated for PC2 contiguous UL CA realized with 1LO+2xPC3 PA compared to agreed MPR for 1LO/1PA PC2 case
  + Option 3: other
* Recommended WF
  + TBA

**Issue 3-1-2:**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. PC2 contiguous UL CA is still under discussion, the MPR for UL MIMO can be further discussed after the MPR defined there, but generally we think it is ok to align with PC3 case in issue 3-1-1, i.e. adding 0.5dB delta MPR on outer allocation. |
| Huawei, HiSilicon | We prefer Option 1. For inner allocation, IM3 product is not falling into the ACLR region, we don’t see the RIMD impact for inner allocation.  It seems option 1 and option 2(observation from measurement on SC), we think at least we can start from additional 0.5dB MPR for PC2 CA+MIMO agreed with bracket. |
| Skyworks | This is a duplicate of topic1 since same MPR is targeted for TxD and UL MIMO (like for single CC) we will not repeat here the arguments from topic 1 but it is not true that RIMD and lower PA linearity would only affect outer allocation in a 2CC case thus MPR should be further discussed for all allocation types. |
| Qualcomm | Option 3: 0.5 dB MPR is not needed since the individual Pas are operating 3 dB lower operating point. |
| LGE | As same with topic 1. We are fine with Option 1 |

*In WF R4-2107851, it is agreed to further discuss on UL timing alignment error and coherent UL MIMO requirements*

**Issue 3-1-3: UL timing alignment requirement**

* Proposals
  + This requirement applies as specified in 6.4D.3: The time alignment error (TAE) is defined as the average frame timing difference between any two transmissions on different transmit antenna connectors. For UE(s) with multiple transmit antenna connectors, the Time Alignment Error (TAE) shall not exceed 130 ns.
* Recommended WF
  + TBA

**Issue 3-1-3:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| China Telecom | OK to reuse the single CC requirement. Maybe we need to clarify the requirements is applied per CC? |
| OPPO | Ok with the proposal. |
| Huawei, HiSilicon | Considering gNB estimates/demodulates the UL signal for each CC, while UL timing alignment will have impact on MIMO performance on each CC. we are OK to define this requirement on each CC.  Revision as:  This requirement applies as specified in 6.4D.3: The time alignment error (TAE) is defined as the average frame timing difference between any two transmissions on different transmit antenna connectors for each CC. For UE(s) with multiple transmit antenna connectors, the Time Alignment Error (TAE) shall not exceed 130 ns. |
| LGE | We are fine to reuse UL-MIMO TAE of single carrier. Huawei revision is OK. |

**Issue 3-1-4: coherent UL MIMO requirement**

* Proposals
  + The coherent UL MIMO requirement are specified at each transmit antenna connector on each CC as in 6.4D.4.
* Recommended WF
  + TBA

**Issue 3-1-4:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| China Telecom | It seems the coherent UL MIMO requirement is applied per CC, but not per antenna connector? |
| OPPO | Not clear the reason of specifying coherent UL MIMO requirement based on each CC. Is there a case that UE cannot meet the coherent requirement in one CC but can meet in another CC?  And also the requirement is relative power and phase errors between different antenna ports, this doesn’t mean the requirement is specified at each transmit antenna connector, if we understand correctly. |
| Huawei, HiSilicon | According to the comments from CTC and OPPO, we revise the requirement as:  The coherent UL MIMO requirement are specified on each CC as in 6.4D.4. |
| Nokia | The outcome here may have to be aligned with that of R4-2112228. |
| LGE | Prefer to apply coherent MIMO requirements per CC |

### Sub-topic 3-2 signalling

*Sub-topic description*

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

**Issue 3-2-1: Is there problem with current signalling on CA+MIMO capability?**

* Proposals: *Please provide your view for each observed problem*
* 1: In currently capability definition, if UL-MIMO support were reported in the CCs for CA, theoretically CA and UL-MIMO should be supported simultaneously unless stated otherwise. Is this Observation true?
* 2: There is only one ca-BandwidthClassUL-NR capability reported for each BC entry, and RAN2 NW is not required to derive UE capability based on multiple band combination entries. Is this Observation true?
* 3: Reporting different aggregated CBW in two band combinations for CA only and CA+UL MIMO is not feasible. Is this Observation true?
* Recommended WF
  + TBA

**Issue 3-2-1:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| China Telecom | For Point 1, agree, the support of CA + UL-MIMO can be reported by the existing signalling of per band ca-BandwidthClassUL-NR and per CC maxNumberMIMO-LayersCB-PUSCH.  For Point 2 and 3, currently two example BCs, i.e., n41C and n78C, are in the scope, not sure if we need to consider other bandwidthclass such as class B. |
| OPPO | Agree with point 1/2/3.  For point 2: In RAN2 LS R4-2107621, it was informed that “*RAN2 would like to point out that UE capability signalling is considered per BC when deciding RRC configuration. Network is not required to derive UE configuration for a BC based on multiple band combination capabilities.*”  For point 3: If point 2 above is agreed then with current per band capability *ca-BandwidthClassUL-NR* reported, it is not possible to report different aggregated CBW in CA only case and CA+UL MIMO case. However, there is possibility that UE can support larger aggregated CBW in CA only with two PAs each support one CC, comparing to CA+UL MIMO that PAs can only support one same CC and leads to different aggregated CBWs in CA/UL MIMO. |
| Huawei, HiSilicon | For point 1, if UE indicate both CA and MIMO support in one CA combination entry, UE should support CA and MIMO simultaneously. If the UE only can support CA or MIMO in each time, UE can indicate CA+MIMO layer 1, and MIMO layer 2 for single carrier, respectively. So there is no reporting problem with point 1.  For point 2 and 3, not true. Firstly, RAN2 agreement applies only for , if feature support for parent BC, e.g. BC\_A+B+C indicates support, it is not expected to report feature not support for a fallback BC, e.g. not supported for BC\_A+B. Secondly, we agree with CTC, that currently two example BCs, i.e., n41C and n78C, are in the scope. |
| Qualcomm | #1: True For each CA combination, it is possible to signal whether each of the CCs support > 1L in UL  #2: Not sure about intent of question. We cannot force the network to derive ‘UE capability based on multiple band combination entries’, so we think the observation is true. Network is free to ignore any UE capability it chooses.  #3: There are multiple ways using existing signaling to indicate support of different CBW for 2 different band combos:   * + - 1. Same band combination, but differing featureset\_ids to cover the 1L and 2L differences       2. Multiple duplicate band combination, each with its unique limits on CBW   Perhaps proponents of new signaling can list specific examples that they believe is not covered by existing signaling. |
| ZTE | Point 1: Agree, but the current signaling design cannot represent different bandwidth class of the intra-band CA with or without UL-MIMO.  Point 2: Agree.  Point 3: As commented in Point 1, if bandwidth class is different between the cases with and without UL-MIMO, then a new capability signaling is needed. The reason is that one band has only one bandwidth class under current signaling design, no matter in UL-MIMO or non-UL-MIMO.  Response to QC’s advices:   1. Same band combination with different featureset\_id: aggregated bandwidth is a per-band capability, so this method won’t work 2. Duplicate band combination: in our understanding, for the same band, there is only one capability corresponding to this band, no duplicate allowed. |
| Nokia | For Point 1, we tend to agree with the observation. But not sure the part of “unless stated otherwise”. We are not sure how it is possible to state something with the current signaling.  For point 2 and 3, at this moment, we don’t think we need to introduce this capability. For this case mentioned in OPPO’s paper, Intra band UL CA aggregated bandwidth changes 100MHz from 200MHz in order to use UL MIMO simultaneously. We’re wondering what the benefit to implement this is. Single CC(100MHz) + UL MIMO can achieve the same, can’t it? |
| vivo | Point 1: Agree. These are existing signaling.  Point 2: The description itself was confirmed, though the intention is not tat clear.  Point 3: Agree. |

**Issue 3-2-2: Signalling proposals**

* Proposals
* Option 1: Introduce a separate bandwidth class capability for UL-MIMO
* Option 2: Report the UE supported aggregated CBW for UL CA+UL MIMO feature to NW
* Option 3: Whether develop new signalling for support of CA + UL-MIMO drives by implementation:
  + - * Yes. Incorporate implementations with narrowband PA.
      * No. Preclude implementation with narrowband PA
    - Option 4: Other
* Recommended WF
  + TBA

**Issue 3-2-2:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2.  Currently there is only one per band capability *ca-BandwidthClassUL-NR* reported, and it is not possible for UE to report different aggregated CBW in CA only case and CA+UL MIMO case. Thus it needs for UE to report the aggregated CBW for UL CA+UL MIMO to NW. |
| Huawei, HiSilicon | Option 4. We don’t think new capability is needed for CA+MIMO indication.  For option 1 and option 2, we provide our view in issue 3-2-1.  For option 3: if the implementation cannot support CA+MIMO simultaneously, it cannot support CA+MIMO, and it can indicate the CA or MIMO capability respectively in different entry. |
| Skyworks | Is there a reason why a UE could support ULMIMO for class B and not class C? or is it to encompasss the case where class C already requires two PAs? |
| Qualcomm | Option 4: It is not evident where existing signaling is deficient, perhaps specific examples would be useful.  For example, in the identified problem situation, what is the aggregated BW and number of CCs in single layer configuration? How does that change when UE wants to support 2L? Does BCS remain the same? Etc. Specifics like these will help demonstrate signalling deficiencies. |
| ZTE | Option 1 or 2.  The point here is that for an intra-band contiguous CA, if it can operate in a non-UL-MIMO mode, or in an UL-MIMO mode, whether or not the bandwidth class capability is identical. In our understanding, it could be different. For example, for a Band A, suppose it can support bandwidth class C (200MHz Aggregated BW) in non-MIMO mode, however, if enabling UL-MIMO, it may only support 100M Aggregated BW. Therefore, there is a need to differentiate these two different capabilities. |
| Nokia | Option 4: At this moment, we don’t need this signalling.  This generates quite unfortunate situation that UE supports intra band UL CA + UL MIMO, but if UE has an opportunity to use it, the available bandwidth becomes half. Then, what is the meaning to use it? Single CC + UL MIMO can achieve the same performance… |
| vivo | For option 3, if we deem UE implementation cannot support CA and UL-MIMO multi-layer simultaneously as not supporting CA+MIMO, it is also acceptable, but then we should admit that this implementation would be restricted to only enable one of the features.  For option 1 and 2, we also think extending the current bandwidth capability may be helpful, but whether the real deployment scenario need it still worth discussion. |

**Issue 3-2-3: LS to RAN2**

* Proposals:
  + Option 1: send LS as in R4-2113898
  + Option 2: revise the LS in R4-2113898 and send (Please provide your view on how to revise)
  + Option 3: Do not need to send the LS
* Recommended WF
  + TBA

**Issue 3-2-3:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. |
| Huawei, HiSilicon | Wait for the outcome of the before issues on signaling. |
| Qualcomm | TBD if necessary. We need to identify problem cases first. |
| ZTE | Need to settle open issues before making a decision. |
| Nokia | Option 3 |
| Vivo | Clarify the questions first. |

## Companies views’ collection for 1st round

### Open issues

Collect in 3.2.

### 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** |
| R4-2114470 | china Telecom: In general, the CR looks good. Need to clarify the Coherent UL MIMO requirement and TAE requirements are applied at per CC basis. |
| huawei, HiSilicon: To CTC, we can revise the TAE and coherent requirement accordingly :  UL timing alignment:  This requirement applies as specified in 6.4D.3: The time alignment error (TAE) is defined as the average frame timing difference between any two transmissions on different transmit antenna connectors for each CC. For UE(s) with multiple transmit antenna connectors, the Time Alignment Error (TAE) shall not exceed 130 ns.  Coherent MIMO requirement:  The coherent UL MIMO requirement are specified on each CC as in 6.4D.4. |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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”.*

# Topic #4: Scell dropping

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112383 | Apple | ***Observation 1****: There is a clear distinction between the conformance test and field operation under the maximum output power condition.*  ***Observation 2****: In conformance test, there is no UE power headroom (PHR) reporting back to the tester during the TPC “UP” processing.*  ***Observation 3****: In real network, the base station would adjust the TPC based on the UL signal SNR condition and UE’s PHR.*  ***Observation 4****: Even without the Pcell prioritization rule, there should be a mechanism for network to deactivate Scell to maintain the Pcell performance.*  ***Observation 5****: Scell deactivation by the network should be a better way to manage the network performance instead of leaving UE to drop Scell by itself where the Scell power scaling is essentially out of network’s control.*  ***Observation 6****: The new requirement as proposed in last RAN4 meeting by limiting the serving cell output power is virtually no difference with the existing TPC mechanism.*  ***Observation 7****: If the new requirement is to only solve the UL CA conformance test issue, it would not be necessary as it not only creates more RAN4 specifications workloads but also increases UE test burden.*  ***Proposal****: If Scell dropping in UL CA would be confirmed as a real field issue, RAN1 should be involved in any specification alteration on the intent to mitigate this issue.* |
| R4-2112826 | Ericsson | The solution proposed is applicable for all band combinations and both frequency ranges, its key characteristics:   * the configured maximum power Pcmax,f,c for the serving cells are modified by configured power limits, a ehaviororward change and RAN4 scope, no change of timing requirements or UE ehavior * no change of RAN1 specifications (including priority mechanism) * configured power limits are relative to account for the actual power back-off used (and the implementation- specific plane of reference for Pcmax,f,c for FR2), can be enabled/disabled by MAC/CE for fast adaptation to changing radio conditions and apply for concurrent transmissions * backwards compatible * the limits are under network control, can also be made absolute (similar to P-Max) * “equal” PSD can be achieved for the purpose of conformance testing   The solution requires RRC changes and a MAC-CE element for activating/deactivating the limits (RAN2 changes). |
| R4-2114468 | Huawei, HiSilicon | ***Observation 1: for FR1 inter-band and intra-band CA, mechanism to avoid scell dropping is needed when Pcmax,c1+Pcmax,c2>PCMAX,CA.***  ***Observation 2: For FR2 CA, it is not easy to limit UE output power on each CC in a relative accurate range in different directions. Solution for ‘scell dropping’ for FR2 CA could be studied in Rel-17, but is better with lower priority.***  ***Proposal 1: Adding new objective “solution to scell dropping for CA” into Rel-17 FR1 RF enhancement WI. FR2 CA is also studied within the scope, but with lower priority.***  ***Proposal 2: RAN4 should avoid to add additional test case when consider the solution to ‘scell dropping’ issue.*** |
| R4-2114551 | Qualcomm | **Observation 1: Adding a new limiting parameter to PCMax does not prevent UE from dropping cells with lower maximum power**  **Observation 2: To solve the problem of UE dropping scell and giving more control for the network, new parameter that indicates UE the preferred priority of cells is needed.**  **Proposal 1: Define new parameter to indicate priority between configured UL cells for the UE.**  **Proposal 2: Before agreeing to CR’s in RAN4 that alter UE behaviour regarding cell prioritization or scaling,** **RAN1 should be presented with the question if the chosen approach will create a conflict with RAN1 requirements** |
| R4-2113890  *Move from AI 6.1.10.2* | OPPO | ***Observation 1: The original issue was about the RAN5 testing problem to achieve equal PSD between CA in FR2 Pcmax requirement.***  ***Observation 2: RAN4 sent LS to RAN5 clarify the requirement and also the testing approaches, which confirms the power scaling UE behavior of 38.213.***  ***Observation 3: There is no conclusion on whether the low priority CC power scaling/dropping is a field problem and several issues need to be clarified for better understanding.***  ***Proposal 1: It is proposed to clarify the following aspects for better understanding the issue in the field.***  ***1) Whether power scaling/prioritization defined in 38.213 has problem, if it is then problem should be discussed in RAN1***  ***2) Why NW scheduling cannot prevent the low priority CC connection drop, e.g. by increase the low priority CC power and decrease the high priority CC power in close loop power control***  ***3) How NW decide to activate/deactivate Pmax in high priority CC and cause no problem in the linkage when UE is in the cell edge***  ***Observation 4: There is no fixed CC priority in CA, and the priority is determined by channels (PRACH, PUCCH, PUSCH, SRS), and NW indication with phy-PriorityIndex signaling.***  ***Proposal 2: It is proposed to put max power limit on the high priority CC instead of always on the PCC if this approach is to be further pursued in RAN4.***  ***Observation 5: If the prioritization/scaling is considered to be problematic, then RAN1 shall reconsider what they have defined.***  ***Proposal 3: It is proposed to further discuss the prioritization/scaling behavior in RAN1 if it is considered to be problematic. And RAN4 can inform RAN1 about the considerations on the potential field issue.*** |
| R4-2112816  *CAT F CR for TS 38.101-2* *(Rel-16)*  *Move from AI 6.1.9* | Ericsson | Draft CR for FR2:  Introduction of power limits for serving cells of UL CA |
| R4-2112816  *CAT A CR*  *Move from AI 6.1.9* | Ericsson |  |
| R4-2112813  *Move from AI 6.1.9* | Ericsson | LS on power limits for serving cells of UL CA:  Propose to send an LS to RAN2 to ask for specification appropriate Ies and MAC-CE as per the Draft LS attached below and ask RAN1 to confirm that there is no impact on the RAN1 specifications. |
| R4-2112811  *CAT F CR for TS 38.101-1 (Rel-16)*  *Move from AI 6.1.9* | Ericsson | Draft CR for FR1:  Introduction of power limits for serving cells of UL CA |
| R4-2112812  *CAT A CR*  *(Not submitted)*  *Move from AI 6.1.9* | Ericsson |  |

## 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 4-1: Pre-discussions

*Sub-topic description:*

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

**Issue 4-1-1: Can Scell dropping can be solved by implementation solutions?**

* Proposals
  + 1: BS can increase the low priority CC power and decrease the high priority CC power in close loop power control
  + 2: The base station would adjust the TPC based on the UL signal SNR condition and UE’s PHR.
* Recommended WF
  + TBA

**Issue 4-1-1:**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Yes, in our view. And both point 1 and 2 are doable. |
| Huawei, HiSilicon | For point 1, close loop power control is slow. And the gNB can not get UE MPR in advance, it means gNB does not know Pcmax,CA is lower than Pcmax,c1+Pcmax,c2 in advance. gNB only know this after seeing scell dropped.  For point 2, BS just adjust the TPC based on SNR condition and demod threashold on each CC, that leads to CC with lower priority dropped, because the SNR condition for CC with high priority is scheduled with highest coding rate it can reach. |
| CHTTL | Though it is doable to adjust the power as mentioned, we are not sure this can completely avoid Scell dropping issues in the field, would like to hear other companies’ view. Also the solutions proposed by Ericsson can enable a fast adjustion between the concurrent and non-concurrent transmission which can not be done by the TPC based method if our understanding is correct. |
| Qualcomm | Proposals 1 and two here seem to the be the same, TPC is closed loop control(?). But in our view, gNB can control power on each channel and knows which physical channel is in which cell. |
| Verizon | We support Ericsson proposal for Rel-17! The proposed solution provides a way to balance the UE power in a cell from remaining power for other cells, avoids SCell dropping and also has no change of RAN1 specifications. Though we are still open other proposals for the future systems, this proposal can be straightforward and testable for this release. |
| Nokia | Regarding 1, power control for each CC is independent each other. Regarding 2, it depends on implementation. |
| Ericsson | In the field the prioritization is highly dynamic for the determination of the required power transmissions for each serving cell (independent power control) depends on e.g. PL estimates for each cell and the allocations that vary on a slot basis, e.g. for PUSCH    so the remaining power for other cells is also highly variable and the threshold PCMAX can also change. A robust solution is needed, none of the two proposals (part of the same loop) achieve this. Moreover, the power control accuracy is significant adding further uncertainty at the gNB, only the UE is aware of its actual configured power setting and balance between its transmissions on the UL carriers. This is why the solution should be implemented in the UE but configured and controlled by the gNB. |

**Issue 4-1-2: RAN1 or RAN4 driven?**

* Proposals
  + Option 1: If SCell dropping in UL CA would be confirmed as a real field issue, RAN1 should be involved in any specification alteration on the intent to mitigate this issue.
  + Option 2: RAN4 driven, but ask RAN1 to confirm that there is no impact on the RAN1 specifications.
* Recommended WF
  + TBA

**Issue 4-1-2:**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1. Since this SCC dropping is caused by RAN1 power control mechanism and if RAN4 consider this is a real field issue then RAN1 should be the main group to solve it. |
| Huawei, HiSilicon | Option 2. |
| CHTTL | Option 2, support to solve in RAN4 |
| Qualcomm | Both options are good, but ran1 should be informed about the motivation of the change and before ran4 makes any changes to ensure no conflict is created. |
| Nokia | Option 1: Apart from which WGs is responsible for, if this is an issue, we need to ask RAN1 for resolations. |
| Ericsson | Option 2. We are prepared to postpone the Rel-16 CRs for one more meeting cycle anticipating answers from RAN1 (and RAN2 regarding introduction of the power limits in the RRC specification and the MAC-CE element). |
| LGE | Option 2 |

**Issue 4-1-3: Release issue**

* Proposals
  + Option 1: the solution targets for Rel-16
  + Option 2: the solution is newly studied in Rel-17.
* Recommended WF
  + TBA

**Issue 4-1-3:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| SoftBank | Option 1 is referable but we are fine with Option 2. |
| OPPO | Option 2 if preferred, if this is a real NW issue, and actually this should be decided by RAN1 once RAN1 is involved and spec changes. |
| Huawei, HiSilicon | Option 2. If new RAN4 driven solution is introduced, it at least also has impact on RAN2 spec. so better not to touch RAN2 Rel-16 spec. |
| CHTTL | same view as oftbank. |
| Qualcomm | New IE’s should be rel-17. Rel-16 is done and too late to influence implementation anymore. |
| Nokia | It depends on the solution to be selected. |
| Ericsson | Option 1 preferred due to the nature of the problem and that UL CA was specified in Rel-15, but could accept Rel-17 if impossible (early indication may be possible like for e.g. TxD). |
| LGE | Option 2 |

**Issue 4-1-4: New objective in Rel-17**

* Proposals
  + Adding new objective “solution to scell dropping for CA” into Rel-17 FR1 RF enhancement WI. FR2 CA is also studied within the scope, but with lower priority.
* Recommended WF
  + TBA

**Issue 4-1-4:**

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Not preferred at present. Rel-17 has passed more than half and there still many issues keep open and seems not easy to conclude. Keep adding new items will keep making RAN4 overloaded. This should be avoided. And once RAN4 confirm this issue is real field issue and can be discussed further in RAN how to handle it. |
| Huawei, HiSilicon | With operator confirming on this issue has impact to their network, we think it needs new objective in Rel-17 WI. |
| Qualcomm | Difficult to relate to the FR1 being prioritized since FR2 is where the problem was identified and according to discussion during the UL CA WID in FR1 in RAN4#98, FR1 does not have this problem since p-max exists for FR1. In fact proponent of this proposal commented:  Secondly, FR1 CA could be configured into any status: equal PSD, equal power…etc. by Pmax IE per Cell. From R4-2009656, it seems the problem is triggered by FR2 since no FR2 Pmax introduced.  The paper (R4-2114468) does not explain what has changed since RAN4#98 what would make RSN4 prioritize FR1.  In our view, the objective if such is needed, should be in FR2 enhancement WI. |
| Nokia | We think we don’t need to take time for this. But we don’t see the reason to handle FR1 and FR2 in different ways. |
| Ericsson | We propose to consider Rel-16 maintenace, CRs were provided already at RAN#99-e for both FR1 and FR2 and are now resubmitted. If not possible then within a suitable work item but with the same priority for FR1 and FR2.  The problem is also at hand for FR1. The P-Max is cell-specific and cannot be used in the field for it would affect all UEs in the cell irrespective if these are configured with CA. In conformance tests P-Max could be used (then only one UE). |

### Sub-topic 4-2: RAN4 solutions

**Issue 4-2-1: RAN4 driven solutions proposed**

* Proposals
  + Option 1: solution as in R4-2112826: RRC configuration +MAC activation onΔPCMAX,f,c , and introduce this config into Pcmax definition for SC and CA
  + Option 2: solution as in R4-2114551: new parameter that indicates UE the preferred priority of cells
  + Option 3: other
* Recommended WF
  + TBA

**Issue 4-2-1:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| SoftBank | We do not have strong opinion which options are more referable, but considering the background of this issue, it is helpful if some kinds of solution are made in Rel-17. |
| OPPO | Option 3.  If RAN4 would like to define some max power for CA, then at least the priority of PCC and SCC need to be considered. According to 38.213, the high priority CC is not fixed in CA where the priority is a comparison of channels (PRACH, PUCCH, PUSCH, SRS), and the priority can also be indicated by NW with p*hy-PriorityIndex* signaling. So there is no fixed priority in CA, and put max power limit always on the PCC is not always proper. The priority conditions need to be further considered at least, for example activate the power limit only on the higher priority CC by comparison of channels and NW priority indication. |
| Huawei, HiSilicon | If we decide to study this issue in Rel-17, we need to agree on adding new objective in RAN meeting before discussing on the specific solution. |
| CHTTL | Slightly prefer option 1, but we are also open for other solutions. For option 2, we are wondering there might have remaining power that can be used when applying the delta P\_Scell to another carrier directly? |
| Qualcomm | Our view as proponent of option 2 is that option 1 leaves still unclarity for UE since it sets the power limit but it is unclear will UE still transmit the scell over the pcell.  Maybe better way is to come up with a description separately for each solution or one that describes both and ask ran1 if it is feasible to do this spec change. |
| Nokia | Option 3: better to share the issue with RAN1 and ask them for resolution if this is identified an issue to be solved. |
| Ericsson | We propose that Option 1 is adopted as proponents, RAN1 specifications are unaffected. Dropping or scaling of lower priority transmissions as governed by 38.213 is proprietary, some implementation might never scale, just drop the Scell if lower priority. Now, the Option 1 allows setting power limits on all cells (not only on the Pcell) hence making sure that the Scell is not dropped. Example: if the total PCMAX = 23 dBm with two UL cells, then relative limits of PCMAX = -3 dB can be configured on both thus making sure than none of them are dropped or even scaled. Note that the limits would only apply for concurrent transmissions. If the Pcell is scheduled in a slot without overlapping Scell transmissions, then the power limits do not apply and the Pcell can be transmitted at 23 dBm (neglecting all other factors). The priority rules are unaffected for the UE allocates the power on each cell up to the respective configured maximum power, where the latter is specified by RAN4.  We note that Option 2 would affect the RAN1 priority rules and introduce dependent power control.  We are fine to ask RAN1 on both options in an LS. We are open to any solution that solves the problem in the field for conformance tests (e.g. “equal PSD” as in the example above using Option 1). |

**Issue 4-2-2: Pumax introduction and additional test case**

* Proposals
  + RAN4 should avoid to add additional test case when consider the solution to ‘scell dropping’ issue.
* Recommended WF
  + TBA

**Issue 4-2-2:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with proposal. |
| Huawei, HiSilicon | Considering the current CA combination test burden, we object to introduce any new Pumax that leads to new tests in RAN5. |
| Qualcomm | If there is new requirement, it should be tested. It is premature to agree what needs to be tested when we are discussion possibility for WID objective. |
| Vivo | Support proposal. |
| Ericsson | The requirements and limits must be tested. In particular, the Option 1 above allows both for absolute and relative power limits on the PCMAX,c of each serving cell. Relative power limits are key for both FR1 and FR2: for FR1 the gNB is not aware of the actual power backoff used by the UE and for FR2 the plane of reference of the PCMAX,c is implementation specific so absolute limits cannot be used for FR2. |

**Issue 4-2-3: What is the frequency range that the solution should work for?**

* Proposals
  + Option1: Both FR1 and FR2
  + Option 2: FR1 with higher priority
  + Option 3: other
* Recommended WF
  + TBA

**Issue 4-2-3:**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| SoftBank | Support Option 1. This issue does not depend on the frequency range, so fixing it with both FR1 and FR2 is important. |
| OPPO | Option 1if this is justified as filed issue. |
| Huawei, HiSilicon | We prefer option 2. Current FR2 has not Pmax definition in Pcmax equation. Until now, the solution proposed requires UE to follow the power configuration set to UE. We can expect that FR1 is easier for agreement. While for FR2, we are open to discuss this with 2nd priority. |
| CHTTL | we support Softbank’s comment. |
| Qualcomm | FR2 is the one that is said to have a problem in testing according to original anritsu paper and Ericsson paper in this meeting says they observe this in field. The proponent of FR1 is saying “this could happen” so before deciding issue 4-2-3, it would be good to understand if this is theoretical “could happen” issue or observed problem in the field of in testing for FR1. |
| Nokia | Option 1 |
| vivo | Option 1. |
| Ericsson | Option 1. Ericsson has provided draft CRs for both FR1 and FR2 for possible endorsement at this meeting. We are fine to postpone these for another meeting cycle to allow more time for consideration and wait for a possible reply from RAN1 in case an LS is sent. |

## Companies views’ collection for 1st round

### Open issues

**Collect in 4.2**

### 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** |
| R4-2112811 | Huawei, HiSilicon: If we decide to study this issue in Rel-17, we need to agree on adding new objective in RAN meeting before discussing on the specific solution.  If new RAN4 driven solution is introduced, it at least also has impact on RAN2 spec. so better not to touch RAN2 Rel-16 spec. |
| Qualcomm: premature to agree this. |
|  |
| R4-2112816 | Huawei, HiSilicon: If we decide to study this issue in Rel-17, we need to agree on adding new objective in RAN meeting before discussing on the specific solution.  If new RAN4 driven solution is introduced, it at least also has impact on RAN2 spec. so better not to touch RAN2 Rel-16 spec. |
| Qualcomm: premature to agree this. |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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”.*

# Topic #5: UL MIMO Bands

*This part includes contributions in Agenda 8.41.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2114523 | Huawei, HiSilicon | ***Observation 1: A-MPR requirement should be considered for NR bands supporting UL MIMO for power classes other than PC3, which is studied band by band***  ***Observation 2: Band specific A-MPR requirements for UL MIMO are considered additionally in clause 6.2.3 with A-MPR applicable to non-MIMO mode***  ***Observation 3: In the specification, it has example that same A-MPR requirements are applicable to both UL MIMO and TxD***  ***Proposal: It is proposed that the A-MPR requirements studied in the basket WI for UL MIMO bands are also applicable for transparent TxD in the same band with same power class.*** |

## 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 5-1: AMPR for UL MIMO bands

*Sub-topic description:*

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

*Copy the proposal on each RF requirement item from R4-2104956 and also referenced by R4-2109680*

**Issue 5-1-1: Applicability of AMPR requirement for UL MIMO bands**

* Proposals
  + AMPR defined for UL MIMO Bands can applicable for transparent TxD in the same band with same power class
* Recommended WF
  + TBA

**Issue 5-1-1: Applicability of AMPR requirement for UL MIMO bands**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with proposal. |
| Huawei, HiSilicon | Ok with proposal. |
| Skyworks | If PC3 case (with 2 PC3 Pas) refers to 1Tx PC3 MPR no A-MPR study needed. For PC2 though the UL MIMO basket is PC3 so far, so this would need an update of WI objectives. In our view the critical cases will be where small A-MPR values exist. |
| Nokia | We understand the intention of the proposal, but we think this should be discussed in TxD WI because it seems more companies are involved in TxD WI. |
| LGE | Ok with proposal. |

## Companies views’ collection for 1st round

### Open issues

**Collect in 5.2**

### 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** |
| R4-2114523 | Nokia: Regarding proposal 1, does “the basket WI for UL MIMO bands” mean “NR\_bands\_UL\_MIMO\_PC3\_R17”? So, PC3 is the only target? |
| Company B |
|  |
| YYY | Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

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** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

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