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

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

**Agenda item:** 8.2.1

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

**Title:** Email discussion summary for [98-bis-e][128]NR\_RF\_FR1\_enh\_Part\_1

**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 [128] includes following topics:

1. Topic #1: UL MIMO configuration for SUL band configurations as in 8.2.2.1
2. Topic #2: intra-band contiguous UL CA for FR1 power class 2 which is for agenda 8.2.2.4
3. Topic #3: intra-band NC UL CA for FR1 power class 2 which is for agenda 8.2.2.5
4. Topic #4: Intra-band UL contiguous CA for UL MIMO which is for agenda 8.2.2.6

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

* 1st round:
* Align the MPR values of PC2 intra-band UL contiguous CA for 1PA architecture
* Discuss on different views of MPR for 2\*23dBm PA architecture, to get some initial consensus
* Decide on the RF architecture options for intra-band UL NC CA
* Agree on some other RF requirements, and signalling issue for intra-band UL NC CA
* Agree on the RF requirement items for UL CA+UL MIMO
* 2nd round: TBA
* Try to have some initial agreements for MPR of contiguous UL CA
* Reach agreement on RF architecture for intra-band UL NC CA
* Agree on the baseline on evaluating the MPR/AMPR for intra-band UL NC CA
* Try to agree on draft CR for PC3 intra-band UL CA+UL MIMO
* Get consensus on the SUL and UL switching time left issue

# Topic #1: UL MIMO configuration for SUL band configurations

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2104637 | ZTE | Draft CR:Reason for change: The switching time between SUL and NUL cannot be 0us if enabling UL-MIMO for SULSummary of change: Change Note 1 in Table 5.3C-1/2/3/4 |

## 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:*

**Issue 1-1: Whether 0µs switching time is feasible between SUL and NUL when SUL is MIMO enabled?**

* Proposals
	+ Not feasible
* Recommended WF
	+ TBA

**Issue 1-2: Note 1 of Table 5.2C-1, 5.2C-2, 5.2C-3 and 5.2C-4 in TS 38.101-1**

* Proposals
	+ Change Note1 as in R4-2104637
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1

**Issue 1-1: Whether 0µs switching time is feasible between SUL and NUL when SUL is MIMO enabled?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Not feasible. |
| CMCC | Issue 1-1: feasibleIssue 1-2: No. There is no need to change the note1.This CR had been proposed and discussed in last RAN4 meeting. The changed note seems only apply to 2Tx switching between SUL and NUL. However, in our understanding, if 0us switching time is not feasible between SUL and NUL when SUL is MIMO, it should also be not feasible between SUL and NUL when SUL is not MIMO.In our understanding, 0us should be default UE behavior if no switching period is reported by UE. If UE needs a switching period, it will report the UE capability and the note is not applicable anymore. |
| ZTE | Not feasible under the current 2 Tx RF chains reference receiver architecture. |
| Huawei, HiSilicon | Feasible. UE may support more than 2Tx RF chains. |
| vivo | Tend to prefer not to consider more than 2Tx RF chains architecture. |
| Apple | May or may not be feasible. It depends on UE implementation. |

Sub topic 1-2

**Issue 1-2: Note 1 of Table 5.2C-1, 5.2C-2, 5.2C-3 and 5.2C-4 in TS 38.101-1**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Agree with the change. |
| CMCC | Do not agree with the changes. |
| ZTE | Since the current requirements were defined with the assumption of 2 Tx RF chains, the change is necessary. If 3 or more Tx RF chains are assumed in the future, then this can be limited to these UEs with only 2 Tx RF chains. |
| Huawei, HiSilicon | No need to make changes of note 1. The switching time depends on UE implementation. There is no limitation that UE can only have certain implementation architectures. Meanwhile, the switching time capability can be reported for UE which cannot realize 0 us switching. |
| Apple | We do not have strong view on the note changes. If 0us switching is not feasible for SUL with MIMO, the switching time requirement needs to be captured somewhere in the specifications. |

### 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** |
| 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** | *No agreement reached during 1st round, and there is no WF could reach during online session.* |

### 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.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| R4-2104637 | *noted* |

## Discussion on 2nd round (if applicable)

# Topic #2: 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** |
| R4-2104655 | Nokia | 1PA architecture is assumed, MPR simulation results are provided on following configurations:* 20MHz+20MHz 15kHz SCS and 50MHz+50MHz 15kHz SCS (class B), and
* 60MHz+100MHz 30kHz SCS and 100MHz+100MHz 30kHz SCS (class C).

No IBE or EVM was evaluated. |
| R4-2104994 | LGE | **Proposal 1: Based on the MPR results, we propose following MPR Table for PC2 NR intra-band contiguous CA UE with contiguous RB allocation.**

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
|  | inner | outer | inner | outer |
| DFT-s-OFDM | Pi/2 BPSK | 1.0 | 3.5 | 2.5 | 7 |
| QPSK | 1.0 | 3.5 | 2.5 | 7 |
| 16QAM | 1.5 | 3.5 | 2.5 | 7 |
| 64QAM | 3.0 | 4.0 | 5 | 7 |
| 256QAM | 5.5 | 6.0 | 7 | 7.5 |
| CP-OFDM | QPSK | 2.0 | 4.0 🡪4.5 | 3.5 | 8 |
| 16QAM | 2.5 | 4.0 🡪4.5 | 3.5 | 8 |
| 64QAM | 3.5 | 4.0 🡪4.5 | 5 | 8 |
| 256QAM | 6.5 | 6.5 | 7 | 8 |

**Proposal 2. We propose MPR Table for PC2 NR intra-band contiguous CA UE with non-contiguous RB allocation.**

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
| inner | Outer11 | Outer22 | inner | Outer11 | Outer22 |
| DFT-s-OFDM | Pi/2 BPSK | 2 🡪3 | 5.5 🡪 6.5 | 11.5 🡪 13.0 | 2.5🡪3 | 6🡪 6.5 | 13 |
| QPSK | 2🡪3 | 5.5 🡪 6.5 | 2.5🡪3 | 6🡪 6.5 |
| 16QAM | 2.5🡪3 | 5.5 🡪 6.5 | 3 | 6🡪 6.5 |
| 64QAM | 4.5 | 6 🡪 6.5 | 5 | 6🡪 6.5 |
| 256QAM | 6 | 6.5 | 6.5 | 6.5 |
| CP-OFDM | QPSK | 2.5 🡪3 | 6.5 🡪 7.0 | 12 🡪14.0 | 3.5 | 7 | 14 |
| 16QAM | 3 | 7 | 3.5 | 7 |
| 64QAM | 5 | 7 | 5 | 7 |
| 256QAM | 7.5 | 7.5 | 7.5 | 7.5 |
| NOTE 1: Outer 1 MPR for Pi/2 BPSK and QPSK is reduced by 2dB for aggregated allocation bandwidth > 10MHz NOTE 2: Outer 2 MPR is reduced by 4.5dB for aggregated allocation bandwidth > 10MHz |

 |
| R4-2106304 | Skyworks | **Proposal 1 on MPR requirements:*** **The 2x100MHz PC2 PA+ 2LO architecture uses the same MPR than the baseline 200MHz single PC2 PA + 1LO case, is limited to bandwidth class D and should not drive higher MPR/A-MPR values.**
* **The 2x200MHz PC3 PA+1LO case has a dedicated MPR table covering both TxDiv and UL MIMO operation and should be treated under the intra-band UL contiguous CA for UL MIMO objective.**

**Proposal 2 on contiguous allocations PC2 class B and C UL CA MPR:*** **The following MPR table is adopted for PC2 contiguous allocation MPR (changes from PC3 highlighted in yellow)**

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
| inner | outer | inner | outer |
| DFT-s-OFDM | Pi/2 BPSK | 2.5 | 3.5 | 2.5 | 7 |
| QPSK | 2.5 | 3.5 | 2.5 | 7 |
| 16QAM | 2.5 | 3.5 | 2.5 | 7 |
| 64QAM | 3.0 | 4.0 | 5 | 7 |
| 256QAM | 5.5 | 6.0 | 7 | 7.5 |
| CP-OFDM | QPSK | 3 | 5 | 3.5 | 8 |
| 16QAM | 3 | 5 | 3.5 | 8 |
| 64QAM | 3.5 | 5 | 5 | 8 |
| 256QAM | 6.5 | 6.5 | 7 | 8 |

**Proposal 3 on contiguous allocations NS04 PC2 class C A-MPR:*** **NS04 A-MPR = MPR for outer class C PC2**
* **NS04 A-MPR = MPR+0.5dB for inner class C PC2 when Rbstart ≤ 0.33\*Bwchannel\_CA/0.18MHz**
* **NS04 A-MPR = MPR for inner class C PC2 when Rbstart > 0.33\*Bwchannel\_CA/0.18MHz**

**Proposal 4 on non-contiguous allocations MPR:*** **PC3 QPSK MPR is adopted for PC2 (1Tx) with additional back-off as in Table 6.2A.2.1-3 below (yellow highlight)**

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

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
| inner | Outer11 | Outer22 | inner | Outer11 | Outer22 |
| DFT-s-OFDM | Pi/2 BPSK | 3 | 6.5 | 13 | 3 | 6.5 | 13 |
| QPSK | 3 | 6.5 | 3 | 6.5 |
| 16QAM | 3 | 6.5 | 3 | 6.5 |
| 64QAM | 4.5 | 6.5 | 5 | 6.5 |
| 256QAM | 6 | 6.5 | 6.5 | 6.5 |
| CP-OFDM | QPSK | 3 | 7 | 14 | 3.5 | 7 | 14 |
| 16QAM | 3 | 7 | 3.5 | 7 |
| 64QAM | 5 | 7 | 5 | 7 |
| 256QAM | 7.5 | 7.5 | 7.5 | 7.5 |
| NOTE 1: Outer 1 MPR for Pi/2 BPSK and QPSK is reduced by 2dB for aggregated allocation bandwidth > 10MHz NOTE 2: Outer 2 MPR is reduced by 4.5dB for aggregated allocation bandwidth > 10MHz |

**Proposal 5 on non-contiguous allocations NS04 A-MPR:*** **For channels and allocations where IM3 is within the -13dBm/MHz NS04 region, the PC2 MPR is sufficient**
* **PC2 (1Tx) NS04 A-MPR for outer 1 and outer 2 with IM3 in -25dBm/MHz region is 15.5 for B<2.16**
* **All SEM limited allocations will see the back-off increase for PC2 vs PC3 but ACLR limited region will stay the same thus the following AMPR curve are proposed: AMPRIM3 to meet -25dBm/MHz**

**MA = 15.5; 0 ≤ B < 2.16** **14; 2.16 ≤ B < 3.24****13; 3.24 ≤ B < 5.04****11.5; 5.04 ≤ B < 10.08** **10; 10.08 ≤ B < 16.56** **8; 16.56 ≤ B < 21.96****6; 21.96 ≤ B****Proposal 6 on removal of inner for non-contiguous allocation and addition of edge contiguous allocation for Class B MPR:*** **The 2x26dBm 2LO architecture should not drive the bandwidth class B MPR nor the baseline MPR for bandwidth class B.**
* **Inner allocation should not be removed from BW Class B non-contiguous allocation**
* **Edge allocation addition to BW class B contiguous allocation should be further justified and if introduced restricted to the relevant cases.**
 |
| R4-2107260 | Huawei, HiSilicon | ***Proposal 1: Define MPR for PC2 contiguous CA as in table 1 for contiguous RB allocation.***

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
|  | inner | outer | inner | outer |
| DFT-s-OFDM | Pi/2 BPSK |  |  |  |  |
|  | QPSK | 2.5 | 5.5 | 3 | 7 |
|  | 16QAM | 3 | 5.5 | 3 | 7 |
|  | 64QAM | 3.0 | 5.5 | 5 | 7 |
|  | 256QAM | 5.5 | 6.0 | 7 | 7.5 |
| CP-OFDM | QPSK | 3.0 | 6.5 | 4 | 8 |
|  | 16QAM | 3.5 | 6.5 | 4 | 8 |
|  | 64QAM | 3.5 | 6.5 | 5 | 8 |
|  | 256QAM | TBD | TBD | TBD | TBD |

***Proposal 2: Define MPR for PC2 contiguous CA as in table 2 for non-contiguous RB allocation.***

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) |
|  | inner | Outer11 | Outer22 | inner | Outer11 | Outer22 |
| DFT-s-OFDM | Pi/2 BPSK | 3 | 7 | 13 | 3.5 | 8 | 15 |
|  | QPSK | 3 | 7 |  | 3.5 | 8 |  |
|  | 16QAM | 3 | 7 |  | 3.5 | 8 |  |
|  | 64QAM | 4.5 | 7 |  | 5 | 8 |  |
|  | 256QAM | 6 | 7 |  | 6.5 | 8 |  |
| CP-OFDM | QPSK | 4 | 7.5 | 14 | 3.5 | 8.5 | 15 |
|  | 16QAM | 4 | 7.5 |  | 3.5 | 8.5 |  |
|  | 64QAM | 5 | 7.5 |  | 5 | 8.5 |  |
|  | 256QAM | 7.5 | 7.5 |  | 7.5 | 8.5 |  |
| NOTE 1: Outer 1 MPR for Pi/2 BPSK and QPSK is reduced by 2dB for aggregated allocation bandwidth > 10MHz NOTE 2: Outer 2 MPR is reduced by 4.5dB for aggregated allocation bandwidth > 10MHz |

***Proposal 3: introduce edge RB case for contiguous allocation. MPR for edge RB is FFS.*** |
| R4-2107370 | Qualcomm | **Proposal 1: Use contiguous ULCA MPR for contiguous allocations for PC2 as shown in Table 2.2.1-1 based on 1PA reference architecture.**

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) (IE declare2A absent) |
| inner | outer | edge | inner | outer |
| DFT-s-OFDM | Pi/2 BPSK | 1.0 | 3.5  | [5.5] | 2.0 | 4.0 |
| QPSK | 1.0 | 3.5 | [5.5] | 2.0 | 4.0 |
| 16QAM | 1.5 | 3.5 | [5.5] | 3.0 | 4.5 |
| 64QAM | 3.0 | 4.0 | [5.5] | 4.0 | 4.5 |
| 256QAM | 5.5 | 6.0 | [FFS] | [FFS] |
| CP-OFDM | QPSK | 2.0 | 4.0 | [5.5] | 3.0 | 5.5 |
| 16QAM | 2.5 | 4.0 | [5.5] | 3.5 | 5.5 |
| 64QAM | 3.5 | 4.0 | [5.5] | 5.5 | 5.5 |
| 256QAM | 6.5 | 6.5 | [FFS] | [FFS] |

**Proposal 2: Use contiguous ULCA MPR for non-contiguous allocations for PC2 as shown in Table 2.2.2-1 regardless of PA architecture.**

|  |  |  |
| --- | --- | --- |
| Modulation | MPR for bandwidth class B(dB) | MPR for bandwidth class C(dB) (IE declare2A absent or not absent) |
|  | inner/ Outer11 | Outer22 | inner | Outer11 | Outer22 |
| DFT-s-OFDM | Pi/2 BPSK |  | 5.5 | 11.5 |  5.5 |  8.5 | 13 |
| QPSK |  | 5.5 |  5.5 |
| 16QAM |  | 5.5 |  5.5 |
| 64QAM |  | 6 |  5.5 |
| 256QAM |  | 6.5 |  6.5 |
| CP-OFDM | QPSK |  | 6.5 | 12 |  5.5 |  8.5 | 14 |
| 16QAM |  | 7 |  5.5 |
| 64QAM |  | 7 |  5.5 |
| 256QAM |  | 7.5 |  7.5 |
| NOTE 1: Outer 1 MPR for Pi/2 BPSK and QPSK is reduced by 2dB for aggregated allocation bandwidth > 10MHz NOTE 2: Outer 2 MPR is reduced by 4.5dB for aggregated allocation bandwidth > 10MHz. 256QAM MPR reduction is [FFS]. |

 |

## 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 for contiguous RB allocation

*Sub-topic description:*

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

**Issue 2-1-1: inner and outer MPR for Bandwidth class B**

*Moderator note：All proposed values are not less than the MPR defined for PC3*

* Proposals：Green coloured number seems aligned among companies

|  |  |  |
| --- | --- | --- |
| BW class B | Inner | Outer |
| Modulation | PC3 in R16 | Skws | QC | HW | LGE | Nokia(In figure) | PC3 in R16 | Skws | QC(no edge) | HW | LGE | Nokia(In figure) |
| DFT | QPSK | 1 | 2.5 | 1 | 2.5 | 1 |  | 3.5 | 3.5 | 3.5 | 5.5 | 3.5 |  |
| 16QAM | 1.5 | 2.5 | 1.5 | 3 | 1.5 |  | 3.5 | 3.5 | 3.5 | 5.5 | 3.5 |  |
| 64QAM | 3 | 3 | 3 | 3 | 3 |  | 4 | 4 | 4 | 5.5 | 4 |  |
| 256QAM | 5.5 | 5.5 | 5.5 | 5.5 | 5.5 |  | 6 | 6 | 6 | 6 | 6 |  |
| CP | QPSK | 2 | 3 | 2 | 3 | 2 |  | 4 | 5 | 4 | 6.5 | 4.5 |  |
| 16QAM | 2.5 | 3 | 2.5 | 3.5 | 2.5 |  | 4 | 5 | 4 | 6.5 | 4.5 |  |
| 64QAM | 3.5 | 3.5 | 3.5 | 3.5 | 3.5 |  | 4 | 5 | 4 | 6.5 | 4.5 |  |
| 256QAM | 6.5 | 6.5 | 6.5 | TBD | 6.5 |  | 6 | 6.5 | 6.5 | TBD | 6.5 |  |

* Recommended WF
	+ TBA

**Issue 2-1-2: inner and outer MPR for Bandwidth class C**

*Moderator note：one set of proposed values is less than current PC3 MPR.*

* Proposals：

|  |  |  |
| --- | --- | --- |
| BW class C | Inner | Outer |
| Modulation | PC3 in R16 | Skws | QC | HW | LGE | Nokia(In figure) | PC3 in R16 | Skws | QC | HW | LGE | Nokia(In figure) |
| DFT | QPSK | 2.5 | 2.5 | 2 | 3 | 2.5 |  | 7 | 7 | 4 | 7 | 7 |  |
| 16QAM | 2.5 | 2.5 | 3 | 3 | 2.5 |  | 7 | 7 | 4.5 | 7 | 7 |  |
| 64QAM | 5 | 5 | 4 | 5 | 5 |  | 7 | 7 | 4.5 | 7 | 7 |  |
| 256QAM | 7 | 7 | TBD | 7 | 7 |  | 7.5 | 7.5 | FFS | 7.5 | 7.5 |  |
| CP | QPSK | 3.5 | 3.5 | 3 | 4 | 3.5 |  | 8 | 8 | 5.5 | 8 | 8 |  |
| 16QAM | 3.5 | 3.5 | 3.5 | 4 | 3.5 |  | 8 | 8 | 5.5 | 8 | 8 |  |
| 64QAM | 5 | 5 | 5.5 | 5 | 5 |  | 8 | 8 | 5.5 | 8 | 8 |  |
| 256QAM | 7 | 7 | TBD | TBD | 7 |  | 8 | 8 | TBD | TBD | 8 |  |

* Recommended WF
	+ TBA

**Issue 2-1-3: Edge RB**

* Proposals：
	+ Option 1: Define edge RB for Bandwidth class B
	+ Option 2: Define edge RB for Bandwidth class B and class C
	+ Option 2: no need to define edge RB, it can be combined with outer allocation
	+ Option 3: need further justified and if introduced restricted to the relevant cases
* Recommended WF
	+ TBA

### Sub-topic 2-2: MPR for non-contiguous RB allocation

*Sub-topic description*

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

**Issue 2-2-1: MPR for Bandwidth class B**

*Moderator note：All proposed values are not less than the MPR defined for PC3*

* Proposals

|  |  |  |
| --- | --- | --- |
| BW class B | **Inner** | **Outer1** |
| Modulation | PC3 | Skws | QC | HW | LGE | Nokia | PC3 | Skws | QC | HW | LGE | Nokia |
| DFT | QPSK | 2 | 3 | 5.5 | 3 | 3 |  | 5.5 | 6.5 | 5.5 | 7 | 6.5 |  |
| 16QAM | 2.5 | 3 | 5.5 | 3 | 3 |  | 5.5 | 6.5 | 5.5 | 7 | 6.5 |  |
| 64QAM | 4.5 | 4.5 | 6 | 4.5 | 4.5 |  | 6 | 6.5 | 6 | 7 | 6.5 |  |
| 256QAM | 6 | 6 | 6.5 | 6 | 6 |  | 6.5 | 6.5 | 6.5 | 7 | 6.5 |  |
| CP | QPSK | 2.5 | 3 | 6.5 | 4 | 3 |  | 6.5 | 7 | 6.5 | 7.5 | 7 |  |
| 16QAM | 3 | 3 | 7 | 4 | 3 |  | 7 | 7 | 7 | 7.5 | 7 |  |
| 64QAM | 5 | 5 | 7 | 5 | 5 |  | 7 | 7 | 7 | 7.5 | 7 |  |
| 256QAM | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |  | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |  |
| BW class B | **Outer2** |
| Modulation | PC3 | Skws | QC | HW | LGE | Nokia |
| DFT | QPSK | 11.5 | 13 | 11.5 | 13 | 13 |  |
| 16QAM |  |
| 64QAM |  |
| 256QAM |  |
| CP | QPSK | 12 | 14 | 12 | 14 | 14 |  |
| 16QAM |  |
| 64QAM |  |
| 256QAM |  |

* Recommended WF
	+ TBA

**Issue 2-2-2: MPR for Bandwidth class C**

* Proposals

|  |  |  |
| --- | --- | --- |
| BW class C | Inner | Outer1 |
| Modulation | PC3 | Skws | QC | HW | LGE | Nokia | PC3 | Skws | QC | HW | LGE | Nokia |
| DFT | QPSK | 2.5 | 3 | 5.5 | 3.5 | 3 |  | 6 | 6.5 | 8.5 | 8 | 6.5 |  |
| 16QAM | 3 | 3 | 5.5 | 3.5 | 3 |  | 6 | 6.5 | 8 | 6.5 |  |
| 64QAM | 5 | 5 | 5.5 | 5 | 5 |  | 6 | 6.5 | 8 | 6.5 |  |
| 256QAM | 6.5 | 6 | 6.5 | 6.5 | 6.5 |  | 6.5 | 6.5 | 8 | 6.5 |  |
| CP | QPSK | 3.5 | 3.5 | 5.5 | 3.5 | 3.5 |  | 7 | 7 | 8.5 | 8.5 | 7 |  |
| 16QAM | 3.5 | 3.5 | 5.5 | 3.5 | 3.5 |  | 7 | 7 | 7 |  |
| 64QAM | 5 | 5 | 5.5 | 5 | 5 |  | 7 | 7 | 7 |  |
| 256QAM | 7.5 | 7.5 | 7.5 | 7.5 | 7.5 |  | 7.5 | 7.5 | 7.5 |  |
| BW class B | Outer2 |
| Modulation | PC3 | Skws | QC | HW | LGE | Nokia |
| DFT | QPSK | 13 | 13 | 13 | 15 | 13 |  |
| 16QAM |  |
| 64QAM |  |
| 256QAM |  |
| CP | QPSK | 14 | 14 | 14 | 15 | 14 |  |
| 16QAM |  |
| 64QAM |  |
| 256QAM |  |

* Recommended WF
	+ TBA

**Issue 2-2-3: Combine inner and outer 1 for Bandwidth class B?**

* Proposals
	+ Option 1: Yes
	+ Option 2: No
* Recommended WF
	+ TBA, companies please provide the reason for choosing the option.

### Sub-topic 2-3: MPR for 2\*23dBm 200MHz PA

**Issue 2-3-1: MPR for 2\*23dBm 200MHz PA and 1LO**

* Proposals
	+ Option 1: Define the MPR under intra-band UL contiguous CA for UL MIMO objective, and a dedicated MPR table is defined
	+ Option 2: BW class C MPR is independent of PA architecture.
* Recommended WF
	+ TBA

**Issue 2-3-2: MPR for 2\* 100MHz PA and 2LO**

* Proposals
	+ Option 1: The 2x100MHz PC2 PA+ 2LO architecture uses the same MPR than the baseline 200MHz single PC2 PA + 1LO case, is limited to bandwidth class D and should not drive higher MPR/A-MPR values.
* Recommended WF
	+ TBA

### Sub-topic 2-4: AMPR for NS\_04

**Issue 2-4-1: Contiguous allocation**

* Proposals
	+ From R4- R4-2106304:
* **NS04 A-MPR = MPR for outer class C PC2**
* **NS04 A-MPR = MPR+0.5dB for inner class C PC2 when Rbstart ≤ 0.33\*Bwchannel\_CA/0.18MHz**
* **NS04 A-MPR = MPR for inner class C PC2 when Rbstart > 0.33\*Bwchannel\_CA/0.18MHz**
* Recommended WF
	+ TBA

**Issue 2-4-2: Non-Contiguous allocation**

* Proposals
	+ From R4- R4-2106304:
* **For channels and allocations where IM3 is within the -13dBm/MHz NS04 region, the PC2 MPR is sufficient**
* **PC2 (1Tx) NS04 A-MPR for outer 1 and outer 2 with IM3 in -25dBm/MHz region is 15.5 for B<2.16**
* **All SEM limited allocations will see the back-off increase for PC2 vs PC3 but ACLR limited region will stay the same thus the following AMPR curve are proposed: AMPRIM3 to meet -25dBm/MHz**

**MA = 15.5; 0 ≤ B < 2.16**

 **14; 2.16 ≤ B < 3.24**

**13; 3.24 ≤ B < 5.04**

**11.5; 5.04 ≤ B < 10.08**

 **10; 10.08 ≤ B < 16.56**

 **8; 16.56 ≤ B < 21.96**

**6; 21.96 ≤ B**

* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub-topic 2-1

**Issue 2-1-1: inner and outer MPR for Bandwidth class B**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | LGE can acceptable for the revised MPR table with green color by Moderator  |
| Ericsson | A general comment: unlike for LTE and contiguous UL CA in FR2, the MPRc per serving cell c for contiguous and non-contiguous UL CA in FR1 (PC3) *still* apply when the UE is configured with CA whereas the total power can be reduced by up to MPR ≥ MPRc for the supported power class. In practice this means that the power levels of all serving cells can be reduced due to the power prioritization rules in 38.213. Example: if the UE reaches PCMAX as determined by the allowed MPR for CA, then the Pcell power can be reduced below this level even if the MPRc < MPR for the Pcell, and all Scell power levels can be further reduced or Scell(s) dropped. From 38.101-1 (note the second paragraph)6.2A.4.1.1 Configured transmitted power for Intra-band contiguous CAFor uplink carrier aggregation the UE is allowed to set its configured maximum output power PCMAX,*c* for serving cell *c* and its total configured maximum output power PCMAX.The configured maximum output power PCMAX,*c* on serving cell *c* shall be set as specified in clause 6.2.4, MPR*c* and A-MPR*c* are determined by clause 6.2.2. There is one power management term for the UE, denoted P-MPR, and P-MPR*c* = P-MPR. The total configured maximum output power PCMAX shall be set within the following bounds:Moreover, if all Scells are dropped (PCMAX exceeded), does the MPR as determined by the UL grants and “equal PSD” for all active serving cells or the MPRc apply for the Pcell? In the latter case the allowed power reduction would be smaller (it is recognized that the UE is still configured for CA).The same applies for the non-contiguous case.  |
| ZTE | Firstly, with many numerical inputs to the meeting, we do see a good chance to reach a compromised values, as we did usually before.In addition to the aligned values marked in green, and the values in yellow seem agreeable since all concrete inputs are identical. |
| Huawei, HiSilicon | For Bandwidth class B QPSK inner allocation, 1dB is not enough from our simulation result. For the case D\_50M+50M\_144RB126\_125RB0. We observed that some MPR results are based on 2PA architecture, which is with lower MPR. We prefer to use 2.5dB for DFT and 3dB for CP here. For Bandwidth class B QPSK outer allocation, we can accept to average the value companies propose here. Which is:

|  |  |
| --- | --- |
| BW class B | Outer |
| Modulation | PC3 in R16 | **Skws** | **QC(no edge)** | **HW** | **LGE** | Average |
| DFT | QPSK | 3.5 | 3.5 | 3.5 | 5.5 | 3.5 | 4 |
| 16QAM | 3.5 | 3.5 | 3.5 | 5.5 | 3.5 | 4 |
| 64QAM | 4 | 4 | 4 | 5.5 | 4 | 4.5 |
| 256QAM | 6 | 6 | 6 | 6 | 6 | 6 |
| CP | QPSK | 4 | 5 | 4 | 6.5 | 4.5 | 5 |
| 16QAM | 4 | 5 | 4 | 6.5 | 4.5 | 5 |
| 64QAM | 4 | 5 | 4 | 6.5 | 4.5 | 5 |
| 256QAM | 6 | 6.5 | 6.5 | TBD | 6.5 | 6.5 |

 |
| Qualcomm (copied by SKW due to fork) | QC numbers are based on measured data for 20+20 and 50+50 configurations. This is no change from our previous contribution in RAN4-98e (R4-2101160). I do not see justification for BW Class B inner MPR increase from PC3 to PC2 based on PA calibration point and EVM target. I would like to know from companies how we arrive at this increase. LTE never had this increase up to 40MHz aggregated BW. Are we seeing an issue up to 100MHz? |
| Skyworks | For both inner and outer, there is very good agreement for DFT and fairly good for CP from all companies. In our opinion a 2 to 2.5dB higher MPR is not acceptable is it almost whippes out the benefit of PC2 vs PC3. We would like to understand better the misalignment and would like to bound the difference between PC3 and PC2 such that PC2 provides real benefits. |

**Issue 2-1-2: inner and outer MPR for Bandwidth class C**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | The worst MPR value can be define the MPR requirement among interested companies’ results |
| ZTE | We observe that deviation of values for inner MPR (bandwidth class C) is quite narrow, probably an average of the values could be a good starting point for a compromise.  |
| Huawei, HiSilicon | MPR provided by QC seems not from 1PA architecture, value is even lower than PC3 MPR.For DFT class C inner allocation, we prefer 3dB, for other values, we could accept average values excluding results provided by QC. Which is:

|  |  |  |
| --- | --- | --- |
| BW class C | Inner | Outer |
| Modulation | PC3 in R16 | Skws | QC | HW | LGE | Our compromise | PC3 in R16 | Skws | QC | HW | LGE | Our compromise |
| DFT | QPSK | 2.5 | 2.5 | 2 | 3 | 2.5 | 3 | 7 | 7 | 4 | 7 | 7 | 7 |
| 16QAM | 2.5 | 2.5 | 3 | 3 | 2.5 | 3 | 7 | 7 | 4.5 | 7 | 7 | 7 |
| 64QAM | 5 | 5 | 4 | 5 | 5 | 5 | 7 | 7 | 4.5 | 7 | 7 | 7 |
| 256QAM | 7 | 7 | TBD | 7 | 7 | 7 | 7.5 | 7.5 | FFS | 7.5 | 7.5 | 7.5 |
| CP | QPSK | 3.5 | 3.5 | 3 | 4 | 3.5 | 4 | 8 | 8 | 5.5 | 8 | 8 | 8 |
| 16QAM | 3.5 | 3.5 | 3.5 | 4 | 3.5 | 4 | 8 | 8 | 5.5 | 8 | 8 | 8 |
| 64QAM | 5 | 5 | 5.5 | 5 | 5 | 5 | 8 | 8 | 5.5 | 8 | 8 | 8 |
| 256QAM | 7 | 7 | TBD | TBD | 7 | 7 | 8 | 8 | TBD | TBD | 8 | 8 |

 |
| Qualcomm (copied by SKW due to fork) | QC numbers are based on measured data for 100+60 and 100+100 configurations. This is less MPR than PC3 table because this is only a proposal that is based when PA does not declare 2PA and if 2 sets of requirements are used. QCs proposal in RAN4-98-e was for whether the UE declares 1PA or 2PA. The only issue we see is that for 256QAM, for 1PA, the MPR needs to be further studied.If we only have 1 set of requirements then we propose the max (MPR for BW class C 1PA, MPR for BW class C 2PA), and the 256QAM MPR values would need to be further studied for BW class C for PC2. |
| Skyworks | The MPR should be based on the baseline 1PA approach and implementations using two PC2 PAs with intrinsic higher linearity should comply to the 1PA derived values.Proposed compromise by Huawei takes their input for the lower order modulation inner, but since this drives the benefit of PC2 vs PC3 we would suggest to consider 2.5dB and 3.5dB for DFT and CP respectively as the value for QPSK and 16QAM. |

**Issue 2-1-3: Edge RB**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 2 or option 3. |
| ZTE | A typo: duplicate Option 2 shown. Slightly preferred to Option 2 to define edge RB for both bandwidth classes. |
| Huawei, HiSilicon | We prefer to define edge RB for both class B and class C, but the MPR for edge RB is FFS. Considering ourter RB for class C is already 7dB, we may only define edge RB for class B finally.Edge RB MPR may have relation to BB implementation, e.g. CIM3, we propose the MPR value is FFS. |
| Qualcomm (copied by SKW due to fork) | Option1. To clarify, PC2 edge MPR is only required for BW class B due to actual CA guard band. This MPR is not due to PA non-linearity, but only dominated by WOLA in the baseband.We welcome companies to calculate the CA guard band and double check:

|  |  |  |  |
| --- | --- | --- | --- |
| CA\_BW/CBW | SingleCC |  | CA\_min |
| 15 |  | 0.3825 |  | 0.2975 |
| 20 |  | 0.4525 |  | 0.2675 |
| 25 |  | 0.5225 |  | 0.2675 |
| 30 |  | 0.5925 |  | 0.3375 |
| 35 |  | 0.5725 |  | 0.4075 |
| 40 |  | 0.5525 |  | 0.4075 |
| 45 |  | 0.6225 |  | 0.5475 |
| 50 |  | 0.6925 |  | 0.4075 |

 |
| Skyworks | Even with the lower guard band the CA outer MPR is larger than for single CC. For contiguous allocation we do not understand the concept of edge allocation other than when only one CC is allocated. If this is the only issue we should cover it differently. |
| Nokia | At least option 1. Option 2 is also Ok if we can see the same phenomenon though it is less likely. |

Sub-topic 2-2

**Issue 2-2-1: MPR for Bandwidth class B**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | LGE can acceptable for the revised MPR table with green color by Moderator. Other MPR value can be consider with worst MPR values among interested companies’ results |
| ZTE | In addition to identical values marked in green, a narrow range of values for outer1/2 is observed. As commented above, an average of these values might be a good starting point for a compromise. |
| Huawei, HiSilicon | We can accept the average value among companies. For inner case provided by QC, if we don’t combine inner+outer1 for class B, would it be possible that inner allocation with lower MPR? |
| Skyworks | We cannot accept that inner gets >3dB worse than PC3, so Qualcomm values seem out of proportion as being equal to outer 1. This is not justified and removes the whole benefit of PC2. For outer1 and outer 2 an increase can be justified. |

**Issue 2-2-2: MPR for Bandwidth class C**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | LGE can acceptable for the revised MPR table with green color by Moderator. Other MPR value can be consider with worst MPR values among interested companies’ results |
| ZTE | For outer2, an average of values might be a good starting point for a compromise. |
| Huawei, HiSilicon | We can accept the average value among companies. |
| Qualcomm (copied by SKW due to fork) | QC is concerned about MPR reduction for allocation size at 256QAM for PC2. This needs further study for May meeting. |
| Skyworks | We cannot accept that inner gets 2.5dB worse than PC3, so Qualcomm values seem out of proportion as being equal to outer 1. This is not justified and removes the whole benefit of PC2. For outer1 and outer 2 an increase can be justified although if the increase is based on 2x26dBm PA we do not accept that MPR is driven by this. |

**Issue 2-2-3: Combine inner and outer 1 for Bandwidth class B?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 2 to keep the existing PC3 MPR table format. |
| ZTE | Option 2 to keep the current table.  |
| Huawei, HiSilicon | We prefer option 2. |
| Qualcomm (copied by SKW due to fork) | QC prefers to combine the inner and outer 1 MPR for PC2 BW class B due to low voltage bias PA and transceiver distortion products that could accumulate to the IM5 product in the -13dBm/M region in PC2. However, we could come to a compromise if the numbers add up. |
| Skyworks | We cannot accept that inner is combined with outer and as a result PC2 does not deliver any higher power than PC3. |
| Nokia  | Option 2. Where does the idea come from? The values look different… |

Sub-topic 2-3

**Issue 2-3-1: MPR for 2\*23dBm 200MHz PA and 1LO**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 2. Need more discussion to decide more detail RF architecture |
| OPPO | Option 1, Define the MPR under intra-band UL contiguous CA for UL MIMO objective, and a dedicated MPR table is defined. |
| Ericsson | The MPR should be the same for 1TX PC2 and PC2 supported by 2 x 23 dBm. The latter should not drive increased MPR. We note that in general, PC2 already has a relaxed lower tolerance (+2/-3 dB instead of +2/-2 dB for PC3). |
| Huawei, HiSilicon | 1\*26dBm PA and 2\*23dBm PA configuration is not the same, considering the implementation. We think PC3 CA MPR and emission requirement defined on the both connectors could be the start of this topic. |
| Qualcomm (copied by SKW due to fork) | Option 1: Prefer to define MPR independent of PA architecture. We could choose the maximum of MPR\_1PA, MPR\_2PA, but for PC2, 256 QAM MPR can be finalized in the May meeting. Please note that our contribution in this meeting highlighted lower MPR numbers for 1PA architecture for BW class C except 256QAM maybe an issue. |
| Skyworks | Similar to the discussion for TxDiv for single CC that is still not finalized, a separate MPR is better and combined with the ULCA+ULMIMO thread. The MPR should be based on the baseline architecture and the permitted (relaxed approach of two PC2 PA) should reach the same performance as 1PA. |

**Issue 2-3-2: MPR for 2\* 100MHz PA and 2LO**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | The title is incorrect, should be 2\*100MHz PC2 PA and 2LO? The Option 1 is ok to use same MPR for 2x100MHz PC2 PA+ 2LO as baseline. |
| Huawei, HiSilicon | To OPPO, revise the title.OK to use the same MPR as the reference. |
| Qualcomm (copied by SKW due to fork) | Do you mean limit to BW class C?? |
| Skyworks | The MPR should be based on the baseline architecture and the permitted (relaxed approach of two PC2 PA) should reach the same performance as 1PA. furthermore this is only justified for BW class C as the BW limitation is not relevant for BW class B. |

Sub-topic 2-4

**Issue 2-4-1: Contiguous allocation**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Need more A-MPR results from companies |
| Qualcomm (copied by SKW due to fork) | Please consider the proposal from R4-2101160 from RAN4-98-e.So, for contiguous allocations, in PC2, AMPR=MPR when Fedge, low – BWChannel\_CA < 2490.5 MHz. AMPR = MPR for inner allocations for Rbstart > 0.33\*Bwchannel\_CA/0.18MHzAMPR = max (MPR, AMPRcc’) for inner allocations for Rbstart ≤ 0.33\*Bwchannel\_CA/0.18MHzAMPR = max (CA\_NS04 AMPR\_PC3, AMPRcc’’ +1dB) for outer DFT-s-OFDM allocations for BW class BAMPR = max (CA\_NS04 AMPR\_PC3, AMPRcc’’ +0dB) for outer CP-OFDM allocations for BW class BAMPR = MPR for BW for outer allocations for BW class C.AMPRcc’ = PC2\_A4 AMPR in table 6.3.2.2-2 in 38.101-1AMPRcc’’ = PC2\_A3 AMPR in table 6.3.2.2-2 in 38.101-1 |
| Skyworks | We also provided data but are Ok to postpone to allow more companies to contribute |

**Issue 2-4-2: Non-Contiguous allocation**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Need more A-MPR results from companies |
| Qualcomm (copied by SKW due to fork) | ok |
| Skyworks | We also provided data but are Ok to postpone to allow more companies to contribute |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#2-1** | **Issue 2-1-1: inner and outer MPR for Bandwidth class B**Comments provided in the 1st round on the MPR values:* Inner allocation:
	+ Keep it the same as PC3
	+ Take the average value
	+ Take the worst value
* Outer allocation
	+ Take the average value
	+ Take the worst value
	+ If proposed MPR difference is larger than 2dB, the value is not acceptable

Recommend to further align the MPR value in the 2nd round**Issue 2-1-2: inner and outer MPR for Bandwidth class C**Comments provided in the 1st round on the MPR values:* Inner allocation:
	+ Take the average value
	+ Take the worst value
* Outer allocation
	+ Take the average value
	+ Take the worst value
	+ Proposed MPR should be based on 1PA architecture
* MPR for 256QAM need further discussion

Recommend to further align the MPR value in the 2nd round**Issue 2-1-3: Edge RB**Clarify from QC:To clarify, PC2 edge MPR is only required for BW class B due to actual CA guard band. This MPR is not due to PA non-linearity, but only dominated by WOLA in the baseband.We welcome companies to calculate the CA guard band and double check:Recommend to check CA guard band issue on MPR. |
| **Sub-topic#2-2** | **Issue 2-2-1: MPR for Bandwidth class B*** Inner allocation:
	+ >3dB is not acceptable
	+ Take the worst value
	+ Take the average value excluding QC value
* Outer1 allocation
	+ Take the average value
	+ Take the worst value
* Outer2 allocation
	+ Take the average value
	+ Take the worst value

Recommend to further align the MPR value in the 2nd round**Issue 2-2-2: MPR for Bandwidth class C**Comments provided in the 1st round on the MPR values:* Inner allocation:
	+ >5.5dB is not acceptable
	+ Take the worst value
* Outer1 allocation
	+ Take the average value
	+ Take the worst value
* Outer2 allocation
	+ Take the average value
	+ Take the worst value
* MPR for 256QAM need further discussion

Recommend to further align the MPR value in the 2nd round**Issue 2-2-3: Combine inner and outer 1 for Bandwidth class B?**5 companies do not agree to combine inner and outer11 company can accept separate inner and outer1 MPR by adding inner MPR valueFurther check the issue: low voltage bias PA and transceiver distortion products that could accumulate to the IM5 product in the -13dBm/M region in PC2 |
| **Sub-topic#2-3** | **Issue 2-3-1: MPR for 2\*23dBm 200MHz PA and 1LO**No clear consensus here, recommend to collect more input on MPR value.**Issue 2-3-2: MPR for 2\* 100MHz PA and 2LO****Tentative agreement:**Architecture 2\* 100MHz 26dBm PA and 2LO only applies for bandwidth class C, it uses the same MPR than the baseline 200MHz single PC2 PA + 1LO case |
| **Sub-topic#2-4** | **AMPR for NS\_04**Further discuss and collect more AMPR value input in the next meeting  |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| 1 | WF on MPR/AMPR requirements for PC2 intra-band UL contiguous CA | Skyworks |
|  |  |  |

### 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”.*

|  |  |  |
| --- | --- | --- |
| T-doc number | Title | Comments |
| R4-210xxxx | WF on MPR/AMPR requirements for PC2 intra-band UL contiguous CA | Qualcomm: QC’s inner values must be considered. Transceiver distortion products do come into play and cannot be ignored. QC will not accept the average excluding its values. |
| We also realize that the outer 1 BW class B value cannot be averaged with the inner values of other companies. In our contribution we do have measured 1PA in section 4 of R4-2107370 showing 4dB back-off for DFTs and CP inner waveforms for fixed bias PA, which are lower than the adaptive bias PA values given in the proposal. Note the 4dB are measured values with no margin. |
| LGE: the proposed MPR values for edge RB allocation of PC2 intra-band contiguous CA for Class B and C are acceptable to us.The MPR for non-contiguous RB allocation of intra-band contiguous CA for Class C is acceptable. But we prefer 14.0 dB MPR value for the outer 2 case of class B in slide 5 not 13.5dB. Since QC revised results and other companies results are 14dB. |
| Nokia: We are OK with the original WF and disagree with the changes from QC and LGE. Before concluding the MPR, it is better to ask QC to check their data just in case. For slide 5, inner and outer 256QAM MPR values are quite aligned across companies. But, QC’s inner MPR values other than 256QAM have quite different from other companies. On top of that, QC’s inner MPR values are completely the same as those for outer1 case. There may be an error or at least it is better to know why QC’s MPR values have different tendency compared to the others.For slide 6, inner 256QAM MPR values are aligned across companies. But, QC’s inner MPR values other than 256QAM have quite different from other companies.  |
| Ericsson: some more general comments (also to the NC case):-- should the MPR for the total signal apply for the Pcell if this is the only cell remaining after power prioritization according to 38.213? The MPR governing PCMAX is often much larger than the MPR\_c-- are the cases where MPR >> MPR\_c viable? For class C the MPR is 7 dB also for QPSK whereas MPR\_c = 1 dB for single CC and outer allocations. Should all UE architectures be considered viable if the resulting MPR is very large?-- for NC, MPR > 13 dB in some cases. Adding the 6 dB PCMAX tolerance, the PASS/FAIL is below 23 – 13 – 6 = 4 dBm total UE power not including TT… (?)Consider the following example based on the latest versions of specifications (RAN1 and RAN4).Example: Class B with contiguous allocation: assume two fully allocated CCs of equal CHBW, DFTS QPSK and that the UE uses full MPR, neglect terms like DTIB:* MPR = 4 dB, PCMAX = 26 dBm – 4 dB = 22 dBm (max total UE power)
* For the Pcell and Scell: PCMAX,c = 26 dBm – 1 dB = 25 dBm (MOP per serving cell)

In conformance testing with UP commands on all cells* The Pcell will reach up to 22 dBm as limited by PCMAX, no power left for the Scell that is reduced in power or dropped

In the field* Same behaviour unless the CC UL power can be adjusted by power control such that there is 19 dBm on each CCs (7 dB below the power class per carrier) to achieve equal PSD across carriers.

Reconfiguring the UE for single CC allows PCMAX,c = 26 dBm – 2.5 dB = 23.5 dB with 64QAM and 24 dBm with 16QAM (sic), which would achieve similar or better performance.Hence, should the single-CC MPR\_c apply for the Pcell when Scells are dropped? Or a similar MPR value? The same behaviour is expected for other cases for which the MPR for CA is (much) larger than that for a single CC. The same behaviour expected for PC3. |
|  |  | Qualcomm: We can only accept WF at this time with inner MPR values with [4] dB in square brackets <= [2] MHz allocation size.Based on the information we have for this meeting; we think this is fair. To Nokia, we have explained clearly the PA bias and the effect of transceiver distortion products preceding the PA can affect theyield margins and hence the need. Remember, this is a tighter specification than LTE-CA because LTE-CA does not differentiate inner and outer 1. |
|  |  | Skyworks: I think the last version of the WF captures all the agreeable aspects: I will clean up the WF before sending the final version |

# Topic #3: 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** |
| R4-2104437 | Nokia | **Proposal: In case RAN4 develops PC2 intra band non-contiguous CA requirements, challenges to develop MPR requirements and re-consideration of exception for general spurious emission/SEM should be considered.** |
| R4-2104819 | Skyworks | **Proposal on architecture:*** **Baseline architecture #1 (2x26dBm x2LO) is used to derive MPR/A-MPR values without accounting for the issues of other architectures and can be started immediately.**
* **Architecture #3 (2x23dBm 1LO + TxDiv/UL MIMO) requires additional MPR, further study to handle exceptions and is better pursued in the new WI addressing UL MIMO and TxDiv issues as done for the contiguous UL CA + UL MIMO case. It anyhow deserves a separate MPR/A-MPR specification than baseline.**
* **Architecture #2 (1x26dBm 1LO) has similar issues than #3 with slightly lower back-off required and can be covered together with #3 for the MPR table.**
* **Architecture #4 (26dBm+23dBm 2LO) has significant drawbacks in terms of switching time and MPR for questionable benefits.it is proposed not to pursue this option.**
 |
| R4-2106366 | ZTE | Proposal 1: Use the single CC parameter for the capability of MaxUplinkDutyCycle for PC2 intra-band contiguous CA. Proposal 2: Pcmax: re-use Pcmax from PC3 intra-band NC UL CA:- Changes to 38.101-1, if any, are FFSProposal 3:For PC2 intra-band UL non-contiguous CA with 2PA architecture, the emission requirement is defined as the sum from both UE transmit antenna connectors. |
| R4-2106542 | Xiaomi | Proposal 1: for high power UE TDD intra-band contiguous and non-contiguous CA cases, it is proposed no dedicated signaling is introduced and the reporting value maxUplinkDutyCycle-PC2-FR1 signaling for single carrier can be reused.Proposal 2: if proposal 1 is agreeable, the LS as attached in the annex is needed to inform RAN2 above agreements. |
| R4-2107261 | Huawei, HiSilicon | Observation 1: #2 and #3 architecture can support UL NC CA, and #3 can support UL MIMO for NC CA in nature. Band limitation of <3.3GHz can be removed.Proposal 1: for #2 and #3 architecture, reuse the in-gap exception requirement defined for PC3 intra-band UL NC CA.Observation 2: #4 architecture can support intra-band UL NC CA, it may need Tx swap time when transmission scheduling are switching among 3 cases in fig 1. The switching time can be 0us or 35us or 140us.Proposal 2: All the 4 architectures should be kept in the WI study, RAN4 should evaluate MPR requirements based on all architectures, and check whether 1 set of MPR can be used for all architectures. |
| R4-2107282 | Qualcomm | Proposal 1: Do not consider 2x23 dBm case for NC UL CA PC2Proposal 2: 1x26 dBm case for NC UL CA is not considered in MPR evaluation until carrier leakage handling is clarified. |
| R4-2105088 | Ericsson | <this contribution relates to new solution for preventing scell dropping>**Observation 1: the power prioritization rules in 38.213 imply that the power control for UL CA is similar to that of EN-DC for which the MCG is prioritized subject to a total EN-DC power, the PCMAX for EN-DC. For UL CA, the total Scell power would be capped at 23 dBm and the Scell(s) reduced or dropped for a concurrent Pcell transmissions at 23 dBm that is of equal or higher priority. This affects the actual power reductions (back-off) used on the UL serving cells and an MPR specification based on “equal PSD”.****Observation 2: preventing Scell power reductions and “equal PSD” in conformance tests can be achieved by specifying limits relative to the configured power for the serving cells. This would account for the *actual* power back-off (up to MPR and same for all serving cells) that is applied by the UE. The UE-specific limits are configured by RRC and could be activated and deactivated by a MAC-CE.** |

## 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: Architecture options handling

*Sub-topic description:*

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

**Issue 3-1-1: 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: Reuse in-gap exception under some conditions(e.g. Sync) as defined for PC3
	+ Option 2: use MPR to meet in-gap emission requirement
	+ Option 3: other
* Recommended WF
	+ TBA

**Issue 3-1-2: For 1x23dBm + 1x26dBm PA + 2LO with 100MHz BW, how to handle the swap time between PAs?**

* Proposals
	+ Option 1: define new swap time specifically for this architecture
	+ Option 2: swap time is 0us
	+ Option 3: 0us or 35us or 140us
* Recommended WF
	+ TBA

**Issue 3-1-3: architecture option(s) for intra-band UL NC CA: architecture No. is as in the table**

|  |  |
| --- | --- |
| 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 |

* Proposals
	+ Option 1: All 4 architectures need to be studied on RF requirements
	+ Option 2: #1 and #4 are considered
	+ Option 3: #1,#2 and #3
	+ Option 4: Other
* Recommended WF
	+ TBA

### Sub-topic 3-2: MPR

**Issue 3-2-1: MPR comparison among architecture options**

<Recommend discussion on the analysis provided in R4-2104819>

* Proposals
* Compared with MPR based on architecture #1, Architecture #3 (2x23dBm 1LO + TxDiv/UL MIMO) requires additional MPR
* Architecture #2 (1x26dBm 1LO) has similar issues than #3 with slightly lower back-off required
* Compared with MPR based on architecture #1, Architecture #4 requires for higher MPR
* Recommended WF
	+ TBA

**Issue 3-2-2: baseline architecture to derive MPR/AMPR**

* Proposals
	+ Option 1:
* Baseline architecture #1 (2x26dBm x2LO) is used to derive MPR/A-MPR values
* Architecture #3 (2x23dBm 1LO + TxDiv/UL MIMO) is better pursued in the new objective addressing UL MIMO and TxDiv issues as done for the contiguous UL CA + UL MIMO case.
	+ Option 2: All architectures need to be considered on MPR/AMPR, and check whether 1 set of MPR can be used for all architectures.
	+ Option 3: Other
* Recommended WF
	+ TBA

### Sub-topic 3-3: MaxUplinkDutyCycle Signalling

**Issue 3-3-1: MaxUplinkDutyCycle Signalling for intra-band UL NC CA**

* Proposals
	+ No dedicated signaling is introduced, the reporting value of maxUplinkDutyCycle-PC2-FR1 signaling for single carrier can be reused.
* Recommended WF
	+ TBA

**Issue 3-3-2: LS**

* Proposals
	+ Option 1: send the LS with contents in R4-2106542 annex
	+ Option 2: send the LS after some revision of R4-2106542 annex
	+ Option 3: other
* Recommended WF
	+ TBA

### Sub-topic 3-4: RF requirements other than MPR

**Issue 3-4-1: Pcmax**

* Proposals
	+ re-use Pcmax from PC3 intra-band NC UL CA:

- Changes to 38.101-1, if any, are FFS

* Recommended WF
	+ TBA

**Issue 3-4-2: emission requirement**

* Proposals
	+ For PC2 intra-band UL non-contiguous CA with 2PA architecture, the emission requirement is defined as the sum from both UE transmit antenna connectors.
* Recommended WF
	+ TBA

###  Sub-topic 3-5: other

**Issue 3-5-1: Are discussions of R4-2105088 in the current scope of Rel-17 FR1 RF enh WID?**

* Proposals
	+ Option 1: Yes
	+ Option 2: No
* Recommended WF
	+ TBA

**Issue 3-5-2: If ‘no’ of issue 3-5-1, do we need to add “preventing scell power dropping in conformance test” into the WID?**

* Proposals
	+ Option 1: Yes
	+ Option 2: No
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 3-1

**Issue 3-1-1: 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** |
| LGE | Prefer option 1 to reuse same approach in PC3 |
| OPPO | Either option 1 (*Reuse in-gap exception under some conditions (e.g. Sync) as defined for PC3*) and option 2 (*use MPR to meet in-gap emission requirement*) are ok, and more prefer Option 1. |
| ZTE | Either Option1 and Option 2. More prefer option 1. |
| Huawei, HiSilicon | We support option 1. |
| Skyworks | As we have shown in our paper the urrent exceptions are not sufficient for some cases due to SEM mask. Extreme MPR is required. Option 1 is anyhow under the dependency of being acceptable for other operators in the gap. The cases in our paper needs to be properly analyzed. |
| Qualcomm | Currently, when 2PA is not declared there are missing MPR requirements in PC3 NC-ULCA. The 2PA MPR may not be the same as 1PA MPR to meet emission requirements outside the gap. Also, to Skyworks point, there is no MPR for the condition when there are no synchronized CCs in the gap. PC3 NC-ULCA requirements must be completed before PC2 NC-ULCA requirements. A discussion paper will be brought to the next meeting on this topic. |
| Nokia | Combination of option 1 and 2. Since we really don’t know if general spurious, SEM can be ignored in terms of regulations. It is safer to have two requirements for which exceptions are allowed and not allowed. |
| Vivo | Option 1 |
| Apple | Need clarification on what the exception means. Does it mean no in-gap emission requirement or with relaxed in-gap emission requirement? Also does the exception only apply for frequency separation equalling or less than 200 MHz? |

**Issue 3-1-2: For 1x23dBm + 1x26dBm PA + 2LO with 100MHz BW, how to handle the swap time between PAs?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 3 for switching time 0us/35us/140us |
| OPPO | Option 1. This case only related to PA switch, comparing to the Tx switching feature less time is expected. |
| Qualcomm | Option 2 |
| Huawei, HiSilicon | Option 1 and option 3 are both OK for us. We may need further discussion on specific swap time.To OPPO, for PA swap, this could be a RF chain and PA switching procedure, or just retune the PLL to the other frequency, this is why we propose swap time as current UL tx switching. But we are open to discuss on whether shorter time can be reached.  |
| Skyworks | We would like to understand the loss in benefit of using PC2 vs PC3 for the different switching times before we can agree to one or multiple values. |
| Nokia | Option 2. And do we really need this now? before concluding PA architecture discussion. |
| vivo | Option 1 or Option 3. |
| Apple | Is there really a need to dynamically swap PAs? |

**Issue 3-1-3: architecture option(s) for intra-band UL NC CA: architecture No. is as in the table**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 1 to keep all 4 candidate RF architecture for MPR/A-MPR requirements |
| OPPO | Option 3, i.e. #1,#2 and #3 architecture can be considered. |
| Qualcomm | Option 2 |
| ZTE | Option 1.  |
| Huawei, HiSilicon | We prefer option 1. |
| Skyworks | If all 4 architecture are evaluated, we want to make sure that they all provide a benefit vs PC3 including the overheads in switching time and increased MPR. In any case if more architecture are studied, it is not agreeable that MPR is based on architectures that have limitations in BW and co-existence with in gap channels. If added as option they should have their own MPR table. |
| Nokia | Before concluding this, it is better to understand how specification should look according to the options. We don’t know how these options are selected among various combinations of UE architectures.  |
| vivo | Option 1 |
| Apple | We are open to include all 4 architectures for MPR/A-MPR requirements evaluations. But we prefer to have only one set of requirements defined in the specifications. All implementations based on UE’s own choice shall meet the said set of the requirements. |

Sub topic 3-2

**Issue 3-2-1: MPR comparison among architecture options**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | LGE acceptable Moderator proposal for this issue |
| OPPO | Ok with proposal. |
| ZTE | Ok with proposal. |
| Skyworks | Architecture 1 MPR should be the baseline for MPR and other architecture delta understood and if worse than current PC3 capability, should not be pursued. We are fine with all architecture being evaluated (we will provide further analysis/measurement for all) but in the end only the cases that delivers the PC2 benefits should drive the MPR requirement. |
| vivo | Ok with proposal. |

**Issue 3-2-2: baseline architecture to derive MPR/AMPR**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Prefer option 2 to consider all RF architectures |
| OPPO | Option 2 is preferred (All architectures need to be considered on MPR/AMPR, and check whether 1 set of MPR can be used for all architectures). If go with Option 1 (Baseline architecture #1 (2x26dBm x2LO) is used to derive MPR/A-MPR) then this means UE architectures need to be differentiated by signalling, this hasn’t been discussed whether it is desired or not. |
| Ericsson | Option 2 or Option 3. The network should be able to derive expected MPR based the CA configuration, the supported power and the BCS conveyed in the BC capability, not the UE architecture or LO configuration. |
| ZTE | Option 2. The requirements should be applied to all possible implementation, so it is needed to check whether or not one set of MPR is enough. |
| Huawei, HiSilicon | We prefer option 2. According to the analysis on issue 3-2-1, architecture #3/4 has higher MPR than architecture #1/#2, more analysis may be needed.  |
| Skyworks | Option 1: to have a clear delta vs PC3 at equivalent architecture approach. Then depending on delta other architectures can be accommodated if they still offer benefits vs PC3. This may result in multiple MPR requirements or additional MPR vs basline….FFS |
| Apple | Baseline usually would mean one choice and could simplify the matter.  |

Sub topic 3-3

**Issue 3-3-1: MaxUplinkDutyCycle Signalling for intra-band UL NC CA**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Acceptable moderator proposal |
| OPPO | Ok with reuse single carrier signalling. This has already been agreed? |
| Ericsson | Reuse single-carrier signalling. |
| Xiaomi | We support the proposal since it is our proposal |
| ZTE | Ok with the proposal. To OPPO, this was discussed in last meeting and was tentative agreed, however, moderator proposed some options. In the end, no consensus. |
| vivo | Ok with the proposal |
| Apple | Ok with the proposal to reuse single carrier signalling. |

**Issue 3-3-2: LS**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 1 |
| Ericsson | Option 3: we don’t need to tell RAN2 that they should do nothing, unless we would like to extend the applicability of an existing field to include CA configurations. The existing field applies per band. |
| Xiaomi | Option 1To Ericsson, the reason for the LS is that, from current TS 38.306, the *maxUplinkDutyCycle-PC2-FR1* is defined only for single carrier, which cannot be applied for intra-band CA cases. we need a LS to inform RAN 2 to get the common understanding between RAN4 and RAN2.  |
| ZTE | Option 1. The description in RAN2 IE may need some revised to cover the HPUE intra-band CA. RAN2 needs to know the consensus from RAN4 for further action. |
| Huawei, HiSilicon | We agree with Ericsson, this UE capability is per band indicated already. |

Sub topic 3-4

**Issue 3-4-1: Pcmax**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Acceptable moderator proposal |
| OPPO | Ok with proposal, i.e. re-use Pcmax from PC3 intra-band NC UL CA: - Changes to 38.101-1, if any, are FFS |
| Qualcomm | Pcmax for PC3 contiguous and non-contiguous is wrong so it can not be reused. It refers to single CC MPR and and per cell pcmax. Pcmax is UE limit and if RAN4 believes this is right, then intra-band CA MPR should be removed from the specification since it is not used.  |
| Xiaomi | Ok with proposal |
| ZTE | Acceptable moderator proposalTo QC, yes, the MPR/A-MPR needs to be updated, and the discussion for MPR/A-MPR are underway. Currently, the changes to TS38.101-1 is FFS. |
| Huawei, HiSilicon | Pcmax for PC3 contiguous and non-contiguous is under discussion in Rel-16 maintenance. We have some problem on PHR reporting issue when Pcmax is included in the PHR.For CA MPR, it is already used in Pcmax,CA section, remove is not correct. |
| Vivo | OK with the proposal, further update would be needed as explained according to discussion on PC3. |
| Apple | OK with the proposal |

**Issue 3-4-2: emission requirement**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LGE | Acceptable moderator proposal |
| OPPO | Ok with proposal, i.e. For PC2 intra-band UL non-contiguous CA with 2PA architecture, the emission requirement is defined as the sum from both UE transmit antenna connectors. |
| Qualcomm | Ok with proposal |
| Xiaomi | Ok with proposal |
| ZTE | Acceptable moderator proposal |
| Skyworks  | Ok with proposal |
| Apple | Okay with the proposal. What is the ACLR requirement for each individual sub-block? 30 dB or 31 dB? |

Sub topic 3-5

**Issue 3-5-1: Are discussions of R4-2105088 in the current scope of Rel-17 FR1 RF enh WID?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2 (no). The Scell dropping related testing issue was discussed in FR2 and the outcome is an LS (R4-2103124) goes to RAN5 to clarify that equal PSD is the condition to derive MPR/AMPR and no changes to FR2 RAN4 spec. Similar issue also happens in FR1, and probably no changes are needed either? |
| Ericsson | Option 1. Yes, the discussions do not only concern a method for preventing SCell dropping. According to the WF “equal PSD” is assumed for the specification of the MPR for the total signal. However, if the UE is power limited (PCMAX exceeded) the UE will prioritize transmissions amongst the serving cells (Pcell or any other serving-cell transmission with higher priority), which means that the UE PSD would be unequal. Regarding compliance with unwanted emissions, the “equal PSD” case is not the worst case given a total UE output power but should nevertheless cover all cases. This is obviously relevant for the MPR evaluation for UL CA and hence in the scope of the WID. Another consequence of 38.213: if Scells are dropped, does the (higher) MPR for the CA configuration still apply for the remining Pcell? See the comment on sub-topic 2-1-1.The UE will follow the behaviour specified in 38.213, this may have an impact on MPR determination regardless of any proposed methods for preventing Scell dropping. |
| Qualcomm | Not in the scope of the WID |
| Huawei,HiSilicon | We think it is not in the scope currently. |
| Nokia | Better to be discussed in the single placement. |
| vivo | Option 2. |
| Apple | Our understanding is that it is not in the scope of Rel-17 FR1\_RF\_enh WID. |

**Issue 3-5-2: If ‘no’ of issue 3-5-1, do we need to add “preventing scell power dropping in conformance test” into the WID?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Option 2 (no). No change was made for FR2, and similarly no change probably needs to FR1. |
| Ericsson | This is a RAN discussion but the same issues in conformance tests for FR1 – and in the field (even more importantly) – as for the corresponding FR2 case. Note that the cell-specific P-Max cannot be used in this case for limiting e.g. the PCell power, not even for conformance testing. |
| Qualcomm | Previously, Ericson comment was that P-max is sufficient to correct the problem. Why WID for this is needed? Preference is no/Option2.  |
| Huawei, HiSilicon | For conformance test, we already commented in Rel-15 topics in the last meeting, Pmax setting can solve the problem.For non-conformance testing issue, we are not sure whether it is appropriate to add into FR1 WID, would like to hear more views. |
| Vivo | Option 2 |
| Apple | Not necessary if RAN5 can manage to test the UL CA requirements. |

### CRs/TPs comments collection

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

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#3-1****Sub-topic#3-2** | Agreement in online session:* Companies to provide more MPR values to decide on the net power gain of PC2 in comparison with PC3
* If some architecture is beneficial in supporting UL MIMO, the same or different set of requirements can be considered
* To further check if in-gap exceptions (for both PC3 and PC2) required by some architectures are allowed by regulations
 |
| **Sub-topic#3-3** | **Issue 3-3-1: MaxUplinkDutyCycle Signalling for intra-band UL NC CA**Tentative agreement:Reuse single-carrier signalling.**Issue 3-3-2: LS**No agreement to send out the LS. |
| **Sub-topic#3-4** | **Issue 3-4-1: Pcmax**No agreement to reuse the PC3 Pcmax.**Issue 3-4-2: emission requirement**Tentative agreement:For PC2 intra-band UL non-contiguous CA with 2PA architecture, the emission requirement is defined as the sum from both UE transmit antenna connectors. |
| **Sub-topic#3-5** | **Issue 3-5-1: Are discussions of R4-2105088 in the current scope of Rel-17 FR1 RF enh WID?****Issue 3-5-2: If ‘no’ of issue 3-5-1, do we need to add “preventing scell power dropping in conformance test” into the WID?**It is not easy to have agreement on this issue, recommend to discuss in the next meeting. |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| 1 | WF on RF architecture options handling for PC2 intra-band UL NC CA | Huawei, HiSilicon |
|  |  |  |

### 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”.*

|  |  |  |
| --- | --- | --- |
| T-doc number | Title | Comments |
|  | WF on RF architecture options handling for PC2 intra-band UL NC CA | LGE: there was no in-gap exception requirements for architecture #2 and #3. We would like to add the additional in-gap requirements for arch. #2 and #3 in WF as same principle. Nokia: We should make clear that MPR evaluations consider at least the case in-gap requirements applies. Because 3GPP is not in the position to change ITU-R decision. Skyworks: WF is OK as is but this input for next meeting:.the impact of meeting SEM in the gap or how much interference is present if exception is made should be part of the assessment for the 2CC per PA cases. Similarly the different swap times impact on throughput need to be estimated to understand the benefit of such PC2 cases vs PC3. It may be that only some small enough swap time is acceptable.  |
|  |  |  |

# Topic #4: 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** |
| R4-2104956 | vivo | **Proposal 1:** Extend most of the requirements of UL-MIMO + Intra-band C CA based on current configuration and basic requirements.**Proposal 2**: For MPR and Transmit modulation quality requirements, special attention and some study is needed for UL-MIMO + Intra-band C CA.**Proposal 3**: The detailed case-by-case requirements analysis in Table 1be used as a basis for the requirments definition.Table 1. Tx Characteristics Background and analysis for UL-MIMO + Intra-band UL C CA

|  |  |  |  |
| --- | --- | --- | --- |
| **Tx characteristics** | **UL-MIMO**  | **Intra-band UL C CA** | **UL-MIMO +** **Intra-band UL C CA** |
| UE maximum output power | 6.2D.1Per-UE (Sum of each Tx) | 6.2A.1.1Per-UE (Sum of each CC) | Per-UE(Sum of all Tx and CC) |
| UE maximum output power reduction | 6.2D.2Per-UE[Requirements under discussion] | 6.2A.2.1Per-UE | [FFS, Per-UE but requirements need study] |
| UE addition maximum output power reduction | 6.2D.3Per-UE | 6.2A.3.1.1Per-UE | Per-UE |
| Configured transmitted power | 6.2D.4Per-UE, defined for one CC | 6.2A.4.1.1Per-UE | Per-UE |
| Minimum output power  | 6.3D.1Per-UE | 6.3A.1.1Per-carrier | Per-carrier, sum of 2Tx |
| Transmit OFF power | 6.3D.2Per connector | 6.3A.2.1Per-carrier | Per-carrier per connector |
| Transmit ON/OFF time mask | 6.3D.3Per connector | 6.3A.3.1Per-carrier | Per-carrier per connector |
| Power control  | 6.3D.4Per-UE | 6.3A.4.1Per-carrier | Per-carrier, sum of 2Tx |
| Frequency error | 6.4D.1Per connector | 6.4A.1.1Per-carrier | Per-carrier per connector |
| Transmit modulation quality (EVM, Carrier leakage, IBE and EVM spectrum flatness) | 6.4D.2[Per antenna connector. Under discussion] | 6.4A.2.1Both active and RB allocation in one carrier | [FFS] |
| Time alignment error  | 6.4D.3Difference between 2Tx | N/A | [N/A] |
| Requirements for coherent | 6.4D.4Difference between 2Tx | N/A | [N/A] |
| Occupied bandwidth  | 6.5D.1Per-UE | 6.5A.1.1aPer-UE | Per-UE |
| Out of band emission | 6.5D.2Per-UE | 6.5A.2.2.1Per-UE  | Per-UE |
| Spurious emission  | 6.5D.3Per-UE | 6.5A.3Per-UE | Per-UE |
| Transmit intermodulation | 6.5D.4Per connector | 6.5A.4.2.1Per-UE | Per connector, 2carreirs active |

 |
| R4-2106562 | OPPO | ***Observation 1: For UL CA+UL MIMO, the potential UE architecture is two Pas with each PA supporting the aggregated CBW.******Proposal 1: Take the two Pas architecture with each PA supporting the aggregated CBW as baseline to define requirements.******Observation 2: When UE indicates it supports UL CA+UL MIMO feature, the supported aggregated CBW shall also be clear to NW.******Proposal 2: Consider reporting the supported aggregated CBW within UL CA+UL MIMO feature to NW.******Observation 3: Requirements for UL MIMO only considered 100MHz, requirements for UL CA only considered single layer transmission, both may not be applicable directly to UL CA+UL MIMO.*** |
| R4-2107274 | Huawei, HiSilicon | **Proposal 1: For intra-band contiguous UL CA with MIMO, RF requirements with following configuration is defined:*** **2 layer configuration with codebook TPMI index 0.**
* **1 layer 2 port configuration with full power transmission: mode 0/1/2**
* **Tx diversity**

**Proposal 2: For power class3, intra-band UL contiguous CA in MIMO** **RF requirements are defined as in [1]. ->** draft CR R4-2107278**Proposal 3: RAN4 Evaluate PC2 intra-band UL contiguous CA in MIMO from the start of PC3 MPR requirement.**  |
| R4-2107278 | Huawei, HiSilicon | Provide draft CR for power class 3 intra-band UL contiguous CA for UL MIMO |

## 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: RF requirements framework

*Sub-topic description:*

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

**Issue 4-1-1: Configurations for CA+UL MIMO requirements**

* Proposals
	+ RF requirements with following configuration is defined:
* 2 layer configuration with codebook TPMI index 0.
* 1 layer 2 port configuration with full power transmission: mode 0/1/2
* Tx diversity
* Recommended WF
	+ TBA

**Issue 4-1-2: RF requirement items to be defined for CA+UL MIMO requirements**

* Proposals

|  |  |
| --- | --- |
| **Tx characteristics** | **UL-MIMO +** **Intra-band UL C CA** |
| UE maximum output power | Per-UE(Sum of all Tx and CC) |
| UE maximum output power reduction | [FFS, Per-UE but requirements need study] |
| UE addition maximum output power reduction | Per-UE |
| Configured transmitted power | Per-UE |
| Minimum output power  | Per-carrier, sum of 2Tx |
| Transmit OFF power | Per-carrier per connector |
| Transmit ON/OFF time mask | Per-carrier per connector |
| Power control  | Per-carrier, sum of 2Tx |
| Frequency error | Per-carrier per connector |
| Transmit modulation quality (EVM, Carrier leakage, IBE and EVM spectrum flatness) | [FFS] |
| Occupied bandwidth  | Per-UE |
| Out of band emission | Per-UE |
| Spurious emission  | Per-UE |
| Transmit intermodulation | Per connector, 2carreirs active |

* Recommended WF
	+ TBA

**Issue 4-1-3: Baseline RF architecture**

* Proposals
	+ Two Pas architecture with each PA supporting the aggregated CBW
* Recommended WF
	+ TBA

### Sub-topic 4-2: MPR

**Issue 4-2: MPR**

* Proposals
	+ PC3 intra-band UL contiguous CA in MIMO reuse the MPR defined for PC3 contiguous CA
	+ For PC2 intra-band UL contiguous CA in MIMO, Evaluate value of delta MPR needed from the start of PC3 MPR requirement.
* Recommended WF
	+ TBA

### Sub-topic 4-3 signalling

*Sub-topic description*

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

**Issue 4-3: Signalling**

* Proposals
* Report the supported aggregated CBW within UL CA+UL MIMO feature to NW(R4-2106562)
* Recommended WF
	+ TBA

### Sub-topic 4-4 Draft CR

*Sub-topic description*

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

**Issue 4-4: Draft CR for PC3 intra-band UL contiguous CA for UL MIMO**

* Proposals
* Option 1: Endorse draft CR R4-2107278
* Option 2: Endorse the draft CR after revision
* Option 3: other
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 4-1

**Issue 4-1-1: Configurations for CA+UL MIMO requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with proposal, i.e. UL MIMO, TxD and 1layer two port configurations needs to be considered since the main point is for CA+2Tx even in the WID it is CA+UL MIMO. |
| Ericsson | Wait until the discussions on TX diversity for the non-CA case are concluded.  |
| Qualcomm | Agree with Ericsson on txd.  |
| ZTE | Same view as Ericsson and Qualcomm. |
| Huawei, HiSilicon | Draft CR for Tx diversity on non-CA is already endorsed. The only issue is MPR requirements. It means Tx diversity feature is already agreed by RAN4. So non-CA Tx diversity TEI issue is not the blocking issue on defining CA case.We support the proposal.  |
| Skyworks | TxDiv and link to UL MIMO for single CC needs to be resolve before we can progress here |
| vivo | Basically, ok with the proposal. However, some further simplification and reduction of configurations can also be considered. |
| Apple | This is for CA+UL MIMO, why do we have to consider 1 layer two port configurations and Tx diversity? |

**Issue 4-1-2: RF requirement items to be defined for CA+UL MIMO requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | FFS, Requirements for UL MIMO only considered 100MHz, requirements for UL CA only considered single layer transmission, both may not be applicable directly to UL CA+UL MIMO. |
| ZTE | Should revisit these requirements. Currently requirements for UL-MIMO and UL CA are defined separately. |
| Huawei, HiSilicon | We support the proposed table for PC3.For PC2 CA\_UL MIMO, more discussion is needed. |
| vivo | It is proposed to use this as baseline. If something special is found, revision can also be considered case by case.  |
| Apple | We need more time to look into the necessary RF requirement items. |

**Issue 4-1-3: Baseline RF architecture**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with proposal, i.e. Two PAs architecture with each PA supporting the aggregated CBW |
| ZTE | Fine with the proposal. |
| Huawei, HiSilicon | TxD may not apply with this architecture. We cannot accept the proposal. |
| Apple | Okay with the proposal |

Sub topic 4-2

**Issue 4-2: MPR**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Requirements for PC3 UL CA only considered single layer Tx, the IMD might happen in UL CA+UL MIMO which leads to more MPR, therefore, MPR defined for PC3 contiguous CA can be used as starting point but not reuse directly. |
| Qualcomm | Would MPR for CA+UL MIMO be different from CA or UL MIMO? We would prefer to wait until UL MIMO MPR discussion is solved.  |
| ZTE | For MPR, better to wait and until the conclusion from UL-MIMO MPR discussions, similar view as Qualcomm. |
| Huawei, HiSilicon | For PC3 UL MIMO, there is already MPR requirement defined in current spec.The left issue is only UL MIMO PC2 MPR requirement.So it is reasonable to have: PC3 intra-band UL contiguous CA in MIMO reuse the MPR defined for PC3 contiguous CAFor PC2 UL MIMO+CA case, we only propose to evaluate the delta MPR needed from CA PC3 MPR requirement. Evaluation is always allowed. |
| Skyworks | TxDiv and link to UL MIMO for single CC needs to be resolve before we can progress here |
| vivo | Also prefer to have a more clear picture of UL-MIMO MPR. |
| Apple | The proposal for PC3 looks similar to what was used for single carrier UL MIMO. However, we still need more time to digest the proposal. |

Sub topic 4-3

**Issue 4-3: Signalling**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Currently the UL CA bandwidth class is reported via *ca-BandwidthClassUL-NR*, however, it doesn’t consider the UL MIMO impact. For UE with two PAs, it can support for example 200MHz UL CA without UL MIMO or it can support 100MHz with UL MIMO. However, with current one UL CA bandwidth capability reported, NW cannot know the restriction of UL MIMO configuration. If NW simultaneously configure UE with CA+MIMO, then this UE needs to use two PAs to support the aggregated 200MHz CBW but MIMO is not possible. The aggregated CBW under UL CA+UL MIMO feature shall be clear to NW. |
| ZTE | The UE capability of combining UL-MIMO and UL CA should be defined and reported to NW. |
| Huawei, HiSilicon | Currently, CA+MIMO UE capability is already included in RAN2 spec, UE can indicate CA capability per BC per Band, then UL MIMO capability is reported per CC.  |

Sub topic 4-4

**Issue 4-4: Draft CR for PC3 intra-band UL contiguous CA for UL MIMO**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Same comment as issue 4-2. Requirements for PC3 UL CA only considered single layer Tx, the IMD might happen in UL CA+UL MIMO which leads to more MPR, therefore, MPR defined for PC3 contiguous CA can be used as starting point but not reuse directly. |
| Qualcomm | Would be good to remove hanging paragraphs and correct the mixed use of suffix D and G. Maybe bettwe wait little more since we have multiple open items and CR going on in parallel so that leads easily to the situation and same issues is discussed in multiple places |
| ZTE | Better to wait before MPR and other RF requirements are concluded. |
| Huawei, HiSilicon | We can first see the conclusion we can get in the open issues. |
| Skyworks | Need more progress in the discussion before we can agree |
| Apple | It is understood that most of the contents are inherited from the existing specifications. But we still need more time to review the contents in details. |

### 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#4-1** | **Issue 4-1-1: Configurations for CA+UL MIMO requirements**Further check following issues with the group:There is no unsolved issue for PC3 UL MIMO, so we could progress on PC3 intra-band CA for UL MIMO RF requirements?Do we agree 2 layer UL MIMO configuration need to be defined for the PC3 intra-band CA for UL MIMO RF requirements?Do we agree 1 layer 2 port UL MIMO configuration need to be defined for the PC3 intra-band CA for UL MIMO RF requirements?**Issue 4-1-2: RF requirement items to be defined for CA+UL MIMO requirements**Recommend to further discuss in 2nd round**Issue 4-1-3: Baseline RF architecture**Double check, can we have the agreement:Two Pas architecture with each PA supporting the aggregated CBW |
| **Sub-topic#4-2** | **Issue 4-2: MPR** No agreement on MPR value in the 1st round.Recommend to consider PC3 intra-band UL CA for UL MIMO MPR first, with following options:* PC3 intra-band UL contiguous CA in MIMO reuse the MPR defined for PC3 contiguous CA
* MPR defined for PC3 contiguous CA can be used as starting point, check whether there is delta MPR
 |
| **Sub-topic#4-3** | **Issue 4-3: Signalling** Further discuss in the 2nd round:Whether current RAN2 signalling could convey the information? |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| 1 | WF on intra-band UL contiguous CA for UL MIMO | vivo |
|  |  |  |

### 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**  |
| R4-2107278 | *Return to* |

## 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”.*

|  |  |  |
| --- | --- | --- |
| T-doc number | Title | Comments |
|  | WF on intra-band UL contiguous CA for UL MIMO | Nokia: we should wait for how the TxD requirements being discussed look.Skyworks: Overall for TxD and Ul MIMO we need to come to a clear reference for the PA sizing in terms of calibration waveform and related requirement. Hopefully we can exchange or view in next meeting |
| R4-2107278 | Draft CR for PC3 intra-band UL contiguous CA for UL MIMO | OPPO: Suggest to postpone to next meeting for further check. |

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
| WF on MPR/AMPR requirements for PC2 intra-band UL contiguous CA | Skyworks |  |
| WF on RF architecture options handling for PC2 intra-band UL NC CA | Huawei, HiSilicon |  |
| WF on intra-band UL contiguous CA for UL MIMO | vivo |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2104637 |  | ZTE | Noted |  |
| R4-2104655 |  | Nokia | Noted |  |
| R4-2104994 |  | LGE | Noted |  |
| R4-2106304 |  | Skyworks | Noted |  |
| R4-2107260 |  | Huawei, HiSilicon | Noted |  |
| R4-2107370 |  | Qualcomm | Noted |  |
| R4-2104437 |  | Nokia | Noted |  |
| R4-2104819 |  | Skyworks | Noted |  |
| R4-2106366 |  | ZTE | Noted |  |
| R4-2106542 |  | Xiaomi | Noted |  |
| R4-2107261 |  | Huawei, HiSilicon | Noted |  |
| R4-2107282 |  | Qualcomm | Noted |  |
| R4-2105088 |  | Ericsson | Noted |  |
| R4-2104956 |  | vivo | Noted |  |
| R4-2106562 |  | OPPO | Noted |  |
| R4-2107274 |  | Huawei, HiSilicon | Noted |  |
| R4-2107278 |  | Huawei, HiSilicon | *Return to* |  |
|  |  |  |  |  |

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