**3GPP TSG-RAN WG4 Meeting #97-e R4-2016974**

**Electronic Meeting, Nov .2nd – 13th 2020**

**Agenda item:** 12.2.1

**Source:** Huawei, HiSilicon

**Title:** Email discussion summary for RAN4#97\_#133\_NR\_RF\_FR1\_enh\_Part\_1

**Document for:** Information

# Introduction

This part includes contributions in agenda 12.2.1, 12.2.1.1 and 12.2.1.4.

Classify the contents into 3 topics:

1. Topic #1: Work Plan
2. Topic #2: UL MIMO configuration for SUL band configurations as in 12.2.1.1
3. Topic #3: intra-band contiguous UL CA for FR1 power class 2 which is for agenda 12.2.1.4

Candidate target of email discussion are as below:

* 1st round:
  + Make agreement on work plan
  + Reach consensus on enabling UL MIMO configuration for SUL
  + Reach consensus on intra-band contiguous UL CA PC2
* 2nd round:
  + Approve on the CR/LS for enabling UL MIMO configuration for SUL
  + Approve on the WF for intra-band contiguous UL CA HPUE

# Topic #1: Work plan for Rel-17 FR1 UE RF enhancement

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2016540 | Huawei, HiSilicon | This paper provides Work Plan on Rel-17 FR1 UE RF enhancement according to the time budget agreed in RAN#89 meeting. |

## Open issues summary

### Sub-topic 1-1 Work plan for Rel-17 FR1 UE RF enhancement

**Issue 1-1: Work plan**

* **Proposals: Agree on the work plan in R4-2016540**
* **Recommended WF**
  + TBA

## Companies views’ collection for 1st round

### Open issues

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| **Sub-topic** | **Comments: (Company: …)** |
| 1-1 | ZTE: If aiming to complete all works related to enable UL-MIMO support for SUL in RAN4#100e, it would be good to clarify in the work plan:   1. Only one formal CR is targeted in RAN4#100e, to enable UL-MIMO support for SUL, similar way like introducing UL Tx switching in Rel-16. 2. Before this formal CR, draft CRs are targeted   And if looking at the current work plan, there is no specific work for both RAN4#99e and RAN4#100e: “Finalize any issue which is not completed for this topic”. It would be good also to have even paces.  ” |
| Skyworks: for PC2 UL CA B/C the PC3 inner/outer(1,2) definitions for contiguous and non-contiguous cases should be part of the MPR/AMPR assumptions in this meeting. If there are corner cases that justifies it it may be reviewed for PC2 but the barrier should be high for this. We have provided evidence that there are not reason to change the definition since it is related to IMDs position that are not depending on power class. Small edge allocation does not exist for contiguous and are outer 2 anyhow. |
| Huawei: to ZTE, How could only 1 CR across 3GPP WGs?  For SUL enable for UL MIMO , the target is #98bis-e.  For no specific work for both RAN4#99e and RAN4#100e, we think “Finalize any issue which is not completed for this topic” is quite a big workload which ensure the spec is 100% correct.  To Skyworks, agree with you, hope we can have some MPR simulation assumption agreement in this meeting. I can add inner/outer allocation into the work plan. |
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### 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.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2016540 | revised |
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## Summary for 1st round

### Open issues

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

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| Sub-topic#1 | *Recommendations for 2nd round:* |
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*Recommendations on WF/LS assignment*

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

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
| **R4-2016908** | work plan for Rel-17 FR1 UE RF enhancement |  |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **Title** | **T-doc Status update recommendation** |
| **R4-2016908** | work plan for Rel-17 FR1 UE RF enhancement | Approved |

# Topic #2: UL MIMO configuration for SUL band configurations

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014735 | CMCC | Summary of change:   1. Section 5.2D: Introduce band n80 in the table of NR operating bands for UL-MIMO in Table 5.2D-1. 2. Section 6.2D: Introduce band n80 in UL MIMO configuration in Table 6.2D.1-1 3. Section 5.2C: Remove Note 3 for SUL band combination in Table 5.2C-1 and Table 5.2C-2 (For UE supporting SUL band combination, UL MIMO is not configured on SUL carrier) |
| LS R4-2014736 | CMCC | LS to RAN2:  Remove restrictions of RAN2 specifications (38.331 and 38.306) on configuring UL MIMO for SUL bands. |
| R4-2015181 | ZTE | Observation 1: SAR issue may become more severe if enabling UL-MIMO support for SUL, in particular at a higher power class.  Proposal 1: RAN4 introduce the missing power class definition for an SUL band combination before the UL-MIMO and 2Tx switching support is enabled for SUL. |
| R4-2015284 | Huawei | Proposal 1: Void note 3 in both table 5.2C-1 and 5.2C-2 in TS 38.101-1 to enable UL MIMO configuration on SUL carriers.  Proposal 2: Send an LS to RAN2 tasking corresponding removal of the restrictions against configuring UL MIMO on SUL carriers and UE indicating correct UL MIMO capabilities for SUL bands.  Proposal 3: Add n80 into table 5.2D-1 UL MIMO band list in TS 38.101-1.  Proposal 4: Establish a new basket WI for introduction of bands supporting UL MIMO according to operators’ requests in Rel-17. |

## Open issues summary

### Sub-topic 2-1: enable UL MIMO configuration on SUL carriers in TS 38.101

**Issue 2-1-1: Revision on TS 38.101 to enable MIMO configuration for SUL**

* Proposals
  + revise the spec as proposed in R4-2015284:
    - Void note 3 in both table 5.2C-1 and 5.2C-2 in TS 38.101-1
    - Add n80 into table 5.2D-1 and 6.2D UL MIMO band list in TS 38.101-1
* Recommended WF
  + **TBA**

**Issue 2-1-2: new basket WI for introduction of bands supporting UL MIMO**

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

**Issue 2-1-3: Whether introducing SUL BC power class is a prerequisite to enabling UL MIMO configuration on SUL bands?**

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

### Sub-topic 2-2: LS to RAN2 on removing restrictions for SUL MIMO

**Issue 2-2-1: Send the LS to RAN2(CC RAN1) as proposed in R4-2014736**

* Proposals
  + **Option 1:** Yes, contents for the LS follows R4-2014736
  + **Option 2:** other
* Recommended WF
  + **TBA**

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Sub-topic** | **Comments: (Company: …)** |
| 2-1 | **Issue 2-1-1:**  ZTE: R4-2015284 does not include change on 6.2D.  CMCC: we proposed the similar changes with R4-2015284. Prefer to discuss the draft CR R4-2014735 directly.  Huawei: we can go with the CMCC CR. |
| **Issue 2-1-2**  ZTE: Not clear how the proposal of creating an UL-MIMO basket WID is associated with UL-MIMO support for SUL.  CMCC: Option 1. Support to create an UL-MIMO basket WID. In this WI, only example band is included, basket WID to capture more UL-MIMO bands is needed in order to meet operators’ deployment requirement  Huawei: We echo with CMCC’s comment. This proposed WI is a placeholder for SUL band with UL-MIMO support. It follows the guidance from MCC. |
| **Issue 2-1-3**  ZTE: Moderator’s question does not reflect our point correctly. Our point is that we have enough time to solve an identified issue (The advised workplan also shows that), which is also beneficial for future works.  OPPO: Option 2 for the question (if question is like this). Total power class and SAR are the potential issues that deserve to study.  CMCC: Option 2. There is already a new WI to specify PC2 UL CA and investigate the SAR solution for both UL CA and SUL band combinations. We prefer to separate the power class discussion and the Tx switching requirements.  Huawei: to ZTE, we think the moderator’s summary accurately reflects the proposal from ZTE paper. We don’t agree with the proposal either since there is no sense to have SUL BC PC specified before enabling SUL UL-MIMO. SUL output power has been thoroughly discussed since Rel-15. Please kindly elaborate the below proposal if it didn’t mean to have prerequisite requirements.  Note that you propose:  *Proposal 1: RAN4 introduce the missing power class definition for an SUL band combination before the UL-MIMO and 2Tx switching support is enabled for SUL*  Ericsson: from the perspective of facilitating SAR, there is no difference between UL CA and SUL even if SUL transmission is not concurrent with NUL. This was also discussed and became apparent in the context of TX switching between two uplink carriers. Unlike for UL CA there is no provision or limitation on the total power for SUL operation, only that the configured power per carrier applies. For all types of SUL operation (not only UL-MIMO), it may be beneficial to make a provision for the total uplink power across the two bands so that SUL can be put on the same footing as the specification of UL CA HPUE.  For Rel-15 our understanding is that the maximum SUL and NUL power was limited to 23 dBm, hence the definition of the configured power. |
| 2-2 | **Issue 2-2-1:**  ZTE: Option 2. The contencts should be discussed and revised.  CMCC: to ZTE, do you have any suggestions to revise the LS?  Huawei: we agree with sending the LS. |

### 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.*

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| **CR/TP number** | **Comments collection** |
| R4-2014735 | Company A |
| Company B |
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## Summary for 1st round

### Open issues

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

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| **Sub-topic** | **Status summary** |
| 2-1 | Issue 2-1-1: To ZTE comments, revision on 6.2D is provided in R4-2014735. Go with CMCC CR R4-2014735. |
| Issue 2-1-2: Check with ZTE whether basket WI can be created. |
| Issue 2-1-3: It seems companies agree on “**introducing SUL BC power class is not a prerequisite to enabling UL MIMO configuration on SUL bands**”.  Further discuss on whether we have enough time and necessary to discuss on SUL BC power class. |
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| 2-2 | Further discuss on the contents of LS R4-2014736. |

*Suggestion on WF/LS assignment*

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

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2014735 | Endorsed |
| LS R4-2014736 | revised |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
| R4-2016909 | LS on removing restriction on configuring UL MIMO for SUL band | approved |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| T-doc number | Title | **T-doc Status update recommendation** |
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# Topic #3: PC2 intra-band contiguous UL CA

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014392 | CATT | Observation 1: Duty cycle based solution and fall back/P-MPR solution were chosen for the closed HPUE topics.  Observation 2: The RAN1 transmission power priority considers both physical channels and cells. It’s difficult to say which cell of Pcell or Scell should be prioritized.  Proposal 1: Duty cycle based SAR solution is used by TDD intra-band contiguous UL CA.  Proposal 2: Total duty cycle capability for the two UL carriers can be reported to the network.  Proposal 3: TDD intra-band contiguous UL CA total duty cycle capability can be defined referring TDD single carrier HPUE duty cycle capability, i.e. 50% is the default total duty cycle capability and the reported IE can be defined as ENUMERATED {n60, n70, n80, n90, n100}.  Observation 3: The solution for the UE behaviour when the scheduling is beyond UE duty cycle capability and/or the capability is absent needs more discussion. |
| R4-2014508 | Skyworks | **Proposal 1 on HPUE architecture for class C contiguous UL CA:**  **• A single TX PC2 PA is the baseline to develop requirement**  **• Additional requirement for two PC3 PAs architecture is FFS once single CC related requirements are finalized.**  **Proposal 2 on ACLR and SEM requirements for PC2 contiguous UL CA:**  **• PC2 ACLR is PC3 ACLR+1 dB at 31 dB**  **• PC2 SEM is the same as for PC3.**  ***Furthermore, back-off measurements are presented for contiguous and non-contiguous allocation MPR and A-MPR.***  **Proposal 3 on contiguous allocations:**  **• Contiguous Inner and Outer allocations definition for PC3 is adopted for PC2 (1Tx)**  **• PC3 QPSK Inner MPR is adopted for PC2 (1Tx)**  **• PC3 QPSK Outer MPR is adopted for PC2 (1Tx) with a potential reduction due to better ACLR**  **• PC2 (1Tx) NS04 A-MPR is FFS but larger than PC3 especially for some inner allocation.**  **Proposal 4 on non-contiguous allocations:**  **• Contiguous Inner, Outer1 and Outer 2 allocations definition for PC3 is adopted for PC2**  **• PC3 QPSK MPR is adopted for PC2 (1Tx) with 1 dB additional back-off**  **• PC2 (1Tx) NS04 A-MPR is FFS but larger than PC3 especially for some inner allocation.** |
| R4-2015038 | ZTE | Observation 1: Rx RF requirements are not impacted.  Proposal 1: No changed for the spectrum emission mask and additional spurious emission requirements, regardless of the RF implementation architectures  Proposal 2: The UE maximum output power is 26dBm+ +/-2dB, regardless of the RF implementation architectures  Proposal 3: Same requirement for PC2 single carrier (i.e. ACLR=31dB) is re-used for PC2 intra-band contiguous UL CA.  Observation 2: P-MPR solution can be used as basedline SAR solution  Proposal 4. For duty cycle based solutions, report duty cycle of PCell.  Proposal 5: A new parameter i.e ΔPPowerClass needs to be introduced on top of the currently PC3 PCMAX\_L equations in case of the duty cycle solution is identified. |
| R4-2015261 | Xiaomi | Proposal 1: required changes for TS 38.101-1 in table 1 shall be considered when HP UE intra-band contiguous CA is introduced.  Observation 1: power class is defined per band other than per CC  Proposal 2: no need to consider different power class configuration of each CC for HP UE intra-band contiguous CA.  Proposal 3: the mechanism for single carrier for PC2 to meet SAR requirments can be reused for high power UE intra-band contiguous CA. |
| R4-2015326 | Vivo | **Observation 1**: The SAR control scheme is one issue that need to be solved for TDD intra-band contiguous UL CA.  **Observation 2**: Intra-band EN-DC (TDD-TDD) scheme can be considered somehow similar to UL CA case in that similar restrictions for two carriers for in-device co-existence.  **Observation 3**: It is already recommended in the WID that “*- Mechanism for HPUE on single carrier can be a start point considering the same UL-DL configuration assumption*”.  **Proposal 1**: Optionally report one UL duty cycle threshold or reuse the capability for single carrier case, make mandatory power class back off if actual transmission exceeded.  **Proposal 2**: Conceptually, one carrier transmission in intra-band contiguous CA configuration can also be regarded as CA transmission if needed in requirements definition.  **Proposal 3**: For default case without the capability reporting, default value solution which is identical to NR single carrier case can be reused.  **Proposal 4**: Do not consider any power class fallback optimization since it was already down scoped. |
| R4-2015354 | OPPO | 2.1 Basic configurations  Observation 1: In Rel-15, same UL/DL configuration and synchronized scenario are adopted for intra-band EN-DC based on the NW deployment reality.  Proposal 1: It is proposed to adopt same UL/DL configuration and synchronized condition for Rel-17 intra-band contiguous UL CA HPUE.  2.2 UE architecture  Observation 2: In Rel-15, dual PA architecture was adopted as reference for the intra-band EN-DC HPUE.  Observation 3: There is possibility that UE might use single PA with 200MHz or two PAs with 100MHz each to support PC2 CA.  Proposal 2: It is proposed to consider two UE reference architectures for intra-band contiguous UL CA HPUE, one is single PA with 200MHz, the other is two PAs with 100MHz each.  2.3 power class  Observation 4: The power class definition between single CC and intra-band contiguous CA are same as the discussion in UL MIMO/TxD and should be clarified from the beginning.  Proposal 3: It is proposed to assume same power class for CA and single CC to simplify the discussion.  2.4 SAR  Observation 5: SAR effects for the two CCs in intra-band contiguous CA are same which makes reusing the solution of SA single band HPUE is possible.  Proposal 4: It is proposed to reuse the solution of SA single band HPUE SAR solution, i.e. based on the reported maxUplinkDutyCycle capability.  2.5 MPR/AMPR  Observation 6: The discussions in Rel-15 B41+n41 intra-band contiguous EN-DC can be used as a reference for two PA architecture scenario. |
| R4-2016537 | Huawei, HiSilicon | ***Proposal 1: use type2 architecture as the default assumption for PC2 intra-band contiguous UL CA, i.e. 2PA architecture, each PA supports up to 200MHz, assumes 23dBm+23dBm, 1LO.***  ***Observation 1: if UE supports PC2 for 2 contiguous CCs on Band A, it should support PC2 for single carrier on Band A.***  ***Proposal 2: Band set for PC2 contiguous CA is the subset of bands for PC2 single carrier.***  ***Proposal 3: Multiple sets of Band combination capability are indicated if PA architecture is different for power class2 and 3 for a certain intra-band combination.***  ***Proposal 4: RAN4 study whether CA UL MIMO RF requirement is specified in TS 38.101-1.*** |

## Open issues summary

### Sub-topic 3-1 architecture baseline and power class signaling

**Issue 3-1-1: RF architecture baseline**

* Proposals
  + Option 1: A single TX PC2 PA is the baseline to develop requirement
  + Option 2: two UE reference architectures for intra-band contiguous UL CA HPUE, one is single PA with 200MHz, the other is two PAs with 100MHz each.
  + Option 3: 2PA architecture, each PA supports up to 200MHz, assumes 23dBm+23dBm, 1LO.
* Recommended WF
  + TBA

**Issue 3-1-2: Relation between PC2 for single carrier and contiguous CA**

* Proposals
  + Option 1: Assume same power class for CA and single CC to simplify the discussion.
  + Option 2: Band set for PC2 contiguous CA is the subset of bands for PC2 single carrier.

**Issue 3-1-3: Power class signalling for intra-band contiguous UL CA**

* Proposals
  + Option 1: No need to consider different power class configuration of each CC for HP UE intra-band contiguous CA.
  + Option 2: Multiple sets of Band combination capability are indicated if PA architecture is different for power class2 and 3 for a certain intra-band combination.

### Sub-topic 3-2 RF requirements

**Issue 3-2-1: MPR/AMPR**

* Proposals
  + Option 1: Rel-15 B41+n41 intra-band contiguous EN-DC can be used as a reference for two PA architecture scenario
  + Option 2:

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| **1PA architecture**   * **on contiguous allocations:**   + **Contiguous Inner and Outer allocations definition for PC3 is adopted for PC2 (1Tx)**   + **PC3 QPSK Inner MPR is adopted for PC2 (1Tx)**   + **PC3 QPSK Outer MPR is adopted for PC2 (1Tx) with a potential reduction due to better ACLR** * **on non-contiguous allocations:**   + **Contiguous Inner, Outer1 and Outer 2 allocations definition for PC3 is adopted for PC2**   + **PC3 QPSK MPR is adopted for PC2 (1Tx) with 1 dB additional back-off** |

* Recommended WF
  + TBA

**Issue 3-2-2: UL-DL configuration**

* Proposals
  + Adopt same UL/DL configuration and synchronized condition for Rel-17 intra-band contiguous UL CA HPUE.
* Recommended WF
  + TBA

**Issue 3-2-3: ACLR**

* Proposals
  + 31dB
* Recommended WF
  + 31dB

**Issue 3-2-4: SEM/Spurious emission/ASE**

* Proposals
  + Same as for PC3
* Recommended WF
  + Same as for PC3

**Issue 3-2-5: Power class definition for PC2**

* Proposals
  + Option 1: 26dBm with +/-2dB torlerance
  + Option 2: other
* Recommended WF
  + TBA

**Issue 3-2-6: Whether CA UL MIMO requirement is needed?**

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

### Sub-topic 3-3 solution for SAR issue

*Sub-topic description*

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

**Issue 3-3-1: Solution for TDD contiguous UL CA**

* Proposals
* Option 1: Duty cycle based SAR solution is used. Total duty cycle capability for the two UL carriers can be reported to the network.
* Option 2: P-MPR solution can be used as basedline SAR solution. For duty cycle based solutions, report duty cycle of PCell.
* Option 3: Other
* Recommended WF
  + TBA

**Issue 3-3-2: If duty cycle based SAR solution, how to define the UE capability？**

* Proposals
  + Option 1: New Total duty cycle capability：50% is the default total duty cycle capability and the reported IE can be defined as ENUMERATED {n60, n70, n80, n90, n100}.
  + Option 2: Reuse the capability for single carrier case
  + Option 3: Other
* Recommended WF
  + TBA

**Issue 3-3-3: Is there need for power class fallback optimization?**

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

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Sub-topic** | **Comments (Company: …)** |
| 3-1 | **Issue 3-1-1**  ZTE: Option 1  Skyworks:  Option 1, 1PA should be the baseline option like for PC3.  For option 2 with 2PA single CC MPR still not agreed so there not even a MPR for allocation in a single CC. with 2PA covering 100MHz each PA has to support PC2 so this should be clear that there is no gain in that case and UL MIMO cannot be covered in UL CA. Option 3 will see reverse IMD issues. And in the case of allocation in one CC will see higher MPR  OPPO: Combination of Option 1/2/3, i.e. define two requirements, one for single PA 200MHz, the other for 2PA with each 200MHz 23dBm. These are the two typical architectures in implementation especially considering supporting 200MHz 26dBm with single PA is still difficult.  Xiaomi: Prefer option 2.  Vivo: Option 1.  Qualcomm:  Option1 is okay but UE should still have option to signal 2PA for any BW limitation, so requirements should be specified to cover both option 1 and option 2. Option 1 is capable of UL-MIMO for PC2 and option 2 is not.  More time is required to understand option 3 to investigate pros and cons.  LGE: option 1 is baseline for PC2 intra-band UL CA UE. For the Option2, it is UE implementation issue.  Huawei: we prefer option 3 currently. Option 2 two PAs with 100MHz each, cannot support UL MIMO, it still need 2LO for one band.  Skyworks: to Huawei, we assume you mean 2 PC2 PAs of 100MHz each with two LO. Like for PC3 this can be accommodated by MPR for 1PA 200MHz PC2  Apple: We prefer option 1. It should be the baseline as it allows for full UL-MIMO support instead of the other option. |
| **Issue 3-1-2**  ZTE: Option 1  Skyworks: Option 1 may only be feasible with 1 PA if a different power class is adopted for TxDiv also it will not work if TxDiv is not based on equal power split. We anyhow agree that for one band single CC and CA should be the same power classHuawei: Option 2. Support single carrier PC2 with 1PA 26dBm and 100MHz, how we make sure such UE support PC2 CA? so option 2.  OPPO: Option 1  Xiaomi: The power class of CA and CC can be different if different PA architecture is used, but we think it is not different when addressing RF requirements or SAR issue. Thus, in order to simplify the discussion, option 1 is acceptable  Vivo：Option 1  Qualcomm: choose option 1,  LGE: support option 1 as “Assume same power class for CA and single CC to simplify the discussion.”  Apple: Option 1 |
| **Issue 3-1-3**  ZTE: Option 1  Skyworks: Option 1 is our choice, in our proposal for 1PA assumption PC2 and PC3 architecture are the same (it potentially also support implementations with partial BW support with 2 PC2 PAs):  OPPO: Option 1  Xiaomi: Option 1.Same as above, no need to consider different power class configuration of each CC for HP UE intra-band contiguous CA, since it can be expected it is not different when addressing RF requirements or SAR requirements  Vivo: Option 1. This is also in-line with our 1PA assumption.  Qualcomm: Option 1  LGE: support option 1 do not need different power class per CC.  Huawei: for option2, it there possibility that UE have different PA architecture for PC3 and PC2?  Apple: Option 1  Ericsson: Option 1. |
| 3-2 | **Issue 3-2-1**  Skyworks: Option2 is our choice, as already discussed within the scope of PC3 UL CA, B41+n41 is based on 2 PC2 PAs with a PC2 ENDC power class and each PA covering 1CC so it is not valid for PC3+PC3 covering full CA BW and PC2 CA power class. Especially RIMD becomes in band interference.  Vivo: Option 2  Qualcomm: Option 2 but not exclude evaluating MPR for 2PA as in ENDC and comparing to see if single requirement can be made for both cases. Same MPR configuration as in PC3. Comeback next meeting with MPR and AMPR proposal for PC2.  LGE: option 2 with 1PA for PC2 intra-band UL CA.  Huawei: whether we need 2 set of MPR assumption for 2PA and 1PA respectively?  Apple: Option 2. The first option is based on dual Tx and not single Tx. |
| **Issue 3-2-2**  ZTE: Agree that the CCs should be synchronized for PC2 TDD intra-band contiguous CA, i.e. same UL/DL configuration between CCs  Skyworks: R17 should have same assumptions than PC3 for UL/DL config. Agree  OPPO: Agree.  Xiaomi: Agree  Vivo: Agree  Qualcomm: Yes, same UL/DL config for both CCs  LGE : Agree with moderator proposal. |
| **Issue 3-2-3**  ZTE: Agree that ACLR =31dB for PC2 intra-band contiguous CA  Skyworks: Agree that ACLR =31dB for PC2 intra-band contiguous CA  OPPO: Agree.  Xiaomi: Agree  Qualcomm: -31dB ACLR  LGE: Agree that ACLR =31dB for PC2 intra-band contiguous CA  Apple: Agree |
| **Issue 3-2-4**  ZTE: Agree with the recommended WF. The SEM/SE and additional SE requirements should be kept as the same as PC3, regardless of the RF architecture.  Skyworks: agree same as PC3  OPPO: Agree.  Xiaomi: Agree  Vivo: Agree  Qualcomm: Same SEM  LGE: Agree with moderator proposal  Apple: Agree |
| **Issue 3-2-5**  ZTE: Option 1: 26dBm with +/-2dB tolerance, regardless of the RF architecture.  Skyworks: note that 26dBm +2/-3 has been requested for 2 PA cases  OPPO: Need to consider the case of 2PA cases whether +2/-2 is applicable.  Xiaomi: Share the same view as OPPO  Qualcomm: +26dbm +2/-3 regardless of architecture  LGE: +26dbm +2/-3 regardless of architecture  Huawei: +26dbm +2/-3 regardless of architecture  Apple: Using +26dbm +2/-3 for all architectures is ok for us |
| **Issue 3-2-6**  ZTE: Option 2: No  Skyworks: No for 1PA assumption and UL MIMO can be supported with 1 additional PA, some proposed 2 PA architecures are not compatible with UL MIMO or will see additional MPR.  OPPO: No in the 1st stage, CA+UL MIMO can be considered as an enhancement after the basic CA requirements are defined since it has big impact on the UE architecture and implementation costs.  Xiaomi: No  Vivo: No. May be considered in the future but not in this WI.  Qualcomm Option 2. Capability exists to indicate MIMO layers  LGE: Option2. No need to support both CA and MIMO  Huawei: without requirement, how we ensure the UE support UL MIMO on CA? |
| 3-3 | **Issue 3-3-1**  ZTE: Option 2. Like other PC2 topic, P-MPR solution can be used as baseline SAR solution. The duty cycle solution is optional and can be used as an “enhanced” solution, and reuse ENDC approach as much as possible.  Skyworks: there should no difference in behavior between one CC or 2CC thus single CC solution can be adopted and same duty cycle declaration can be used (no need per CC)  OPPO: Option 2, but it should be noticed that actually the Rel-15 single band duty cycle capability can be reused considering the same SAR effects for intra-band PCC and SCC.  Xiaomi: The mechanism for single carrier for PC2 to meet SAR requirments can be reused for high power UE intra-band contiguous CA.  Vivo: As commented in our paper and also from different companies, the solution and even the capability for single carrier case can be reused.  Qualcomm: Agree with ZTE that P-MPR should be the baseline solution with duty cycle capability as an optional enhancement. For the duty cycle capability, a single value should suffice in the same way as single CC, same as Skyworks comment.  CATT：Agree with Xiaomi and Vivo. In order to make the discussion and implementation easier, support to use the same dutycycle mechanism as single carrier. To our understanding, Option 1 is the direction. However, we think P-MPR also can be considered if the signaling is absent, which is the latest agreement for FDD+TDD EN-DC HPUE.  LGE: Prefer Option2. RAN4 can satisfy the SAR regulation using P-MPR based solution with reported duty cycle ratios. |
| **Issue 3-3-2**  ZTE: Option 2. In our understanding, the two CC are synchronized operations for PC2 intra-band contiguous CA, reporting only one duty cycle is also enough since the duty cycle for each CC are the same, also can be regarded as total duty cycle. However, we think it is better to differentiate CA and single carrier due to the power class is signalled per BC for band combination while power class is signalled per band for single band PC2. Currently, the PC2 single carrier total duty cycle is applied to single carrier, so we think it is reasonable that the duty cycle for intra-band contiguous CA is also for CC by adopting the similar approach of single carrier duty cycle.  Skyworks: The duty cycle capability declared for single CC should be valid for multiple CC (no difference in SAR)  OPPO: Option 2.  Xiaomi: Option2. Dutycycle for single carrier could be reused  Vivo：Option 2  Qualcomm: Same as single CC  CATT: If the answer of Issue 3-1-2 and Issue 3-1-3 are option 1, then the two options of this issue are the same because option 1 just copied the definition of single carrier.  LGE: Option2. Dutycycle for single carrier could be reused |
| **Issue 3-3-3**  ZTE: Option 1. If the PC2 duty cycle condition is not met, then PC2 should fall back to PC3. Also we think a new parameter i.e ΔPPowerClass needs to be introduced on top of the currently PC3 PCMAX\_L equations in case of the duty cycle solution is identified.  Skyworks: since this UL CA combinations is valid in regions where PC2 may not be allowed, PC3 fallback is needed anyhow and should including duty cycle case.  OPPO: Option 2, no. The discussion has been started from Rel-15, however, no optimized solution can be achieved. Continue this small discussion with so much time is not meaningful, that’s why this topic was dropped from Rel-17 WI.  Xiaomi: Prefer to reuse the existing fall back manner in single carrier case.  Vivo: Option 2. This scope has been clearly moved out during the discussion of Rel-17 WI scope discussion.  Qualcomm: Either P-MPR or fallback to PC3 can be the solution.  LGE: Applying P-MPR mechanism is mean to support fallback to PC3 as considered in single carrier case. No need to optimize fallback mode. |

### 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.*

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| **CR/TP number** | **Comments collection** |
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## Summary for 1st round

### Open issues

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

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| **Sub-topic#3** | **Status summary** |
| 3-1 | Issue 3-1-1:  Option 1: 5 companies  Option 2: 2 company  Option 3: 1 company  Combination of 1/2/3: 1 company  Moderator recommend collect view on whether we agree on Option 1 or combination of options. Following architectures is discussed in 2nd round:   * Option1: PC2 UL CA with one 26dBm PA 200MHz 1LO * Option 2: PC2 UL CA with two 26dBm PA 100MHz 2LO * Option 3: PC2 UL CA with two 23dBm PA 200MHz 1LO |
| Issue 3-1-2  Further discuss whether there is possibility: UE support PC2 for single carrier, but not support PC2 for intra-band UL CA. |
| Issue 3-1-3  Agreement: No need to consider different power class configuration of each CC for HP UE intra-band contiguous CA. |
| 3-2 | We have following agreements:  1. same UL/DL configuration for both CCs  2. ACLR=31dB  3. same SEM/SE requirement as for PC3  Further discuss on MPR assumption  Check whether ZTE can agree with 26dBm +2/-3dB tolerance  Further discuss on UL CA MIMO requirement |
|  |
| 3-3 | Issue 3-3-1:  Potential agreement: satisfy the SAR regulation using P-MPR based solution with reported duty cycle ratios  Issue 3-3-2:  Further discuss on option 1 and option 2  Issue 3-3-3:  Potential agreement: Use the same power class fallback mechanism as for single carrier. |
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*Suggestion on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on MPR simulation assumption for PC2 intra-band contiguous UL CA | Skyworks |
| #2 | WF on RF requirements for PC2 intra-band contiguous UL CA | Huawei |

### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
| R4-2016910 | WF on MPR simulation assumption for PC2 intra-band contiguous UL CA | Qualcomm: We support the WF. |
| R4-2016911 | WF on RF requirements for PC2 intra-band contiguous UL CA | Qualcomm. The emission requirement does not change with the number of antennas.  Skyworks: I think what is meant is that emissions requirement does not change but needs to be verified for the sum of the two connectors. Ideally we would like to reduce the number of architecture options to be evaluated at least in a first run. For this we believe that option 1 and option 2 are the most straight FW and can fully benefit from the PC3 work. |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| T-doc number | Title | **T-doc Status update recommendation** |
| R4-2016910 | WF on MPR simulation assumption for PC2 intra-band contiguous UL CA | Approved |
| R4-2016911 | WF on RF requirements for PC2 intra-band contiguous UL CA | Revised |
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# Topic #4: intra-band NC DL CA

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014493 | Skyworks, SoftBank | **Proposal: n77(3A) NR non-contiguous downlink CA is introduced with release independence from Release 17.**  Furthermore, UE DL MIMO capability alternatives for release 17 are proposed here:  **Proposal on UE capability alternatives for n77(3A) for Release 17:**   * **Alternative 1: 4x4 DL MIMO is mandatory support for n77(3A) DL CA and all related higher order inter-band DL CA combinations:**   + **No signaling and specification update needed**   + **Limited support for lower end phones but also potential limitation on how many additional bands are supported in inter-band DL CA** * **Alternative 2: 4x4 DL MIMO is mandatory support for n77(3A) DL CA but related higher order inter-band DL CA combinations can fall back to 2x2 DL MIMO:**   + **Signaling and specification update needed**   + **Larger support for additional bands in inter-band DL CA** * **Alternative 3: 4x4 DL MIMO is optional support for n77(3A) DL CA and all related higher order inter-band DL CA combinations:**   + **Signaling and specification update needed**   + **Larger support for n77(3A)combination and/or additional bands in related inter-band DL CA**   **Companies are encouraged to provide their preference.** |
| R4-2016331  *moderator Note: related to discussion outcome of R4-2014493, so move to Agenda 12.2.1* | Ericsson, Verizon | add Addition of CA\_n77(3A) and CA\_n77(4A) configurations as defined in WID RP-201571 |

## Open issues summary

### Sub-topic 4-1 n77(3A) and n77(4A) DL CA

**Issue 1-4-1: Release independent definition for n77(3A) and n77(4A) DL CA**

* Proposals
  + n77(3A) NR non-contiguous downlink CA is introduced with release independence from Release 17.
* Recommended WF
  + **TBA**

**Issue 1-4-2: 4\*4 MIMO for n77(3A) and n77(4A) DL CA**

* Proposals
  + Option 1: 4x4 DL MIMO is mandatory support for n77(3A) DL CA and all related higher order inter-band DL CA combinations:
* No signaling and specification update needed
* Limited support for lower end phones but also potential limitation on how many additional bands are supported in inter-band DL CA
  + Option 2: 4x4 DL MIMO is mandatory support for n77(3A) DL CA but related higher order inter-band DL CA combinations can fall back to 2x2 DL MIMO:
* Signaling and specification update needed
* Larger support for additional bands in inter-band DL CA
  + Option 3: 4x4 DL MIMO is optional support for n77(3A) DL CA and all related higher order inter-band DL CA combinations:
* Signaling and specification update needed
* Larger support for n77(3A)combination and/or additional bands in related inter-band DL CA
  + Option 4: Other
* Recommended WF
  + **TBA**

## Companies views’ collection for 1st round

### Open issues

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| **Sub-topic** | **Comments (Company: …)** |
| 4-1 | **Issue 4-1-1**  ZTE: A question for clarification, if the n77(3A) NR non-contiguous downlink CA is introduced with release independence from Release 17, then does it mean the corresponding inter-band CA constituent of n77(3A) is also release independence from Release 17?  Moreover, is n77(4A) release independence from Release 17?  Skyworks: needs more discussion for n77(4A) architecture as it may need four LO unless some restriction on at least 2CC applies which is probably the case if n77 is limited to the US spectrum of C-band, it may even allow 2LO to work. For n77(3A) with 600MHz span, agree with R17 release independence. We may need to distinguish the cases of 3A depending on required number of LO for the release independence: could this be covered with BCS due to different aggregated BW and a note on the total BW aspects.  Qualcomm: We cannot agree on release independence from < release 16. For combinations CA\_n77(4A), more discussion is required regarding the need for any relaxed requirement. Different combination sets would be divided according to channel bandwidth size.  Option 3 is preferable.  LGE: no strong position. Based on operator request, RAN4 can define n77(3A) in Rel-17. |
| **Issue 4-1-2**  SoftBank: Option 1 is prefferable. The motivation of adding this band combination is to achieve higher throughput.  Skyworks: we have a preference for option two especially with n77(4A) as it is a similar trade-off for BW/MIMO layer but we are open to other options. Some signalling may be require anyhow if some BW difference and number of LO may be different.  OPPO: For clarification, does it mean 4x4 MIMO be supported in each CC of non-contiguous CA? If this is the case, the UE architecture especially separate PAs for each CC may cause big burden in implementation. For the time being, Option 3 is preferred.  LGE: 4x4 DL-MIMO can be supported as optional feature. Prefer option3  Huawei: Option 1 without consideration of lower end phones currently.  Apple: Option 3: 4x4 DL-MIMO should be optional |

### 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.*

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| **CR/TP number** | **Comments collection** |
| R4-2016331 |  |
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## Summary for 1st round

### Open issues

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

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| **Sub-topic#3** | **Status summary** |
|  | Issue 4-1-1: the conclusion may depend on outcome of issue 4-1-2 |
|  | Further discuss on the release independent manner for CA\_n77(3A) and CA\_n77(4A) |
|  |
|  | Issue 4-1-2: Further discuss on 4\*4 MIMO for n77(3A) and n77(4A) DL CA |
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*Suggestion on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on 4Rx requirement for CA\_n77(3A) and CA\_77(4A) | SoftBank |
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### CRs/TPs

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

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| **CR/TP number** | **CRs/TPs Status update recommendation** |
| R4-2016331 | Revised |
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## Discussion on 2nd round (if applicable)

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| T-doc number | Title | Comments |
| R4-2016912 | WF on 4Rx requirement for CA\_n77(3A) and CA\_n77(4A) | Qualcomm: CA\_n77(3A) should be optionally supported with release independence from Release 17 whether combination is 4x4 or 2x2.  Skyworks: like any combination n77(3A) is optional, but we agree with release independence from Release 17 and our preference is that 4x4 support is optional for higher order combinations (option 2) but can also live with option 3. |
| R4-2016913 | TP to TR 38.717-01-01 to include CA\_n77(3A) | Skyworks: without input from proponents only n77(3A) in the TR would be agreeable in the TR based on 3 LO assumption.  C-band in the US covers 3700 to 3980MHz and thus with a span of 280MHz it is feasible to support n77(3A) with 3LO but also if at least 2 CCs are confined within 100MHz, n77(4A) can be supported but needs confirmation from proponent. It anyhow seems that the total aggregated BW is larger than the available spectrum in the US. At this point I am not sure that signalling needs to be modified for option 2 and 3 since 2x2 MIMO is allowed for V2X. |
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## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| T-doc number | Title | **T-doc Status update recommendation** |
| R4-2016912 | WF on 4Rx requirement for CA\_n77(3A) and CA\_n77(4A) | Approved |
| R4-2016913 | TP to TR 38.717-01-01 to include CA\_n77(3A) | *Checking* |
|  |  |  |