**3GPP TSG-RAN WG4 Meeting # 101b-eR4-220xxxx**

**Electronic Meeting, January 17-25, 2022**

**Source:** Skyworks Solutions, Inc.

**Title:** WF on PC2 intra-band NC UL CA for FR1

**Agenda Item:** 6.3.2.3 HPUE for TDD intra-band non-contiguous UL CA [NR\_RF\_FR1\_enh-Core]

**Document for:** Approval

# Discussion

In this meeting a number of contributions looked at how to map the different PC3 and PC2 non-contiguous intra-band UL CA MPR for different architectures and operation [4-8]

## Summary for 1st round [118] thread

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|  | **Status summary** |
| **Sub-topic#3**  **intra-band NC CA** | ***Issue 3-1-1: Capabilities utilized to distinguish the available MPR requirements for PC3 and PC2 NC CA with different implementation architectures***  *Tentative agreements:*  *Take option 1 for the 2nd round discussion.*  *Candidate options:*   * + *Option 1:* ***dualPA-Architecture***   + *Option 2:* ***uplinkTxDC-TwoCarrierReport-r16***   + *Option 3: Other*   *Nine companies provided feedback during the 1st discussion. Six of them explicitly support option 1. Two of them seems also ok with option 1. And one company prefer to discuss it together with Issue 2-1-2. Also noted that the proponent company for the capability of dualPA-Architecture clarified that the original intention for dualPA-Architecture is aligned with the implementation for 1Tx per CC which is different from the purpose for TxD.*  *Recommendations for 2nd round:*  *Based on option 1, further check the CR in 2nd round.* |
| ***Issue 3-1-2: 1CC fall-back MPR for NC UL CA***  *Tentative agreements:*  *N/A*  *Candidate options:*   * + *PC3:* * *When RBs are allocated only in one CC the following MPR applies for PC3:*   + *For PC3, there is no 2Tx cases, Table 6.2.2-1 applies.*   *Most companies agree with the proposal for PC3 UE. One company thinks that MPR applies depending on configuration i.e. as long as UE is configured for CA, the MPR from CA tables apply.*   * + *PC2:* * ***Option 1****: When RBs are allocated only in one CC the following MPR applies for PC2:*   + *When uplinkTxDC-TwoCarrierReport-r16 is reported Table 6.2.2-2 applies.*   + *When uplinkTxDC-TwoCarrierReport-r16 is not reported:*     - *If TxD is signalled, 2Tx PC2 table in R4-2119971 applies*     - *If TxD is not signalled, 1Tx PC2 in Table 6.2.2-2 applies.* * ***Option 2****:When RBs are allocated only in one CC the following MPR applies for PC2:*   + *When dualPA-Architecture is absent, Table 6.2.2-2 applies.*   + *When dualPA-Architecture is reported:*     - *If TxD is signalled, 2Tx PC2 table in R4-2119971 applies*     - *If TxD is not signalled, 1Tx PC2 in Table 6.2.2-2 applies.* * ***Option 3****:When RBs are allocated only in one CC the following MPR applies for PC2:*   + *When dualPA-Architecture is absent, table in R4-2119971 applies*   + *When dualPA-Architecture is reported:*     - *If TxD is signalled, 2Tx PC2 table in R4-2119971 applies*     - *If TxD is not signalled, 1Tx PC2 in Table 6.2.2-2 applies.* * ***Option 4:***    + *If dualPA-Architecture means Two Los and if that is present, 6.2.2-2 applies.*     - *If the above definition of dualPA-Architecture is not agreeable, uplinkTxDC-TwoCarrierReport-r16 can be considered but this capability alone does not directly mean that the UE has two Los. If the UE has two DC locations, it’s possible to report both but if it has only one, it reports only one if requested by network.*   + *If not, and TxD is signanaled, PC2 2Tx MPR applies to PC2 UL CA whose highest PC is PC2 while PC2 1Tx MPR applies to PC2 UL CA(during fallback) whose highest PC is PC1.5.*   + *If not and TxD is NOT signalled, 1Tx PC2 is applied to an UL CA*   *Recommendations for 2nd round:*  *To be further discussed based on the WF.* |
| ***Issue 3-1-3: Can rel-16 TS 38.101-1 specification be transparent to dualPA capability?***  *Tentative agreements:*  *N/A*  *Candidate options:*   * + *Option 1: Yes, see proposal in* [*R4-2200336*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200336.zip).   + *Option 2: No.*   *Companies other than the proponent company seems have different views on the Rel-16 spec be transparent to dualPA capability. And one company this the Rel-16 issue should not be considered in the Rel-17 WI.*  *Recommendations for 2nd round:*  *No further discussion in 2nd round. The issue could be further considered in next meeting under Rel-16 maintenance agenda if needed.* |
| ***Issue 3-2-1: Spec reorganization for UL intra-band NC CA***  *Tentative agreements:*  *Option 1 is agreeable in principle.*  *Candidate options:*   * *Option 1:*   + *Add clause 6.2A.2.2.0 to address the hanging paragraph issue*   + *Existing NC MPR requirements to meet -30dBm/MHz and -13dBm/MHz are put under new sub-clauses for PC3 with indicating of dualPA-Architecture supported.*   + *New MPR requirements comply with -30dBm/Mhz and -13dBm/MHz requirements are captured in sub-clauses for:*   + *PC2 UE with indicating dualPA-Architecture supported*   + *PC3 UE without indicating dualPA-Architecture supported*   + *PC2 UE without indicating dualPA-Architecture supported* * *Option 2:*   + *Other, FFS*   *Recommendations for 2nd round:*  *Based on option 1, further check the CR in 2nd round.* |

## WF Scope

Based on moderator recommendation this way forward needs to address 1CC fall-back MPR for NC UL CA and map the different MPR based on available signaling. Since Issue 3-1-1 and Issue 3-2-1 are based on using *dualPA-Architecture*, this way forward will focus on re-using the same signaling. Agreements in this way forward will be captured in the revision of R4-2201943 Big CR for PC2 intra-band non-contiguous UL CA in the appropriate sub clauses.

## Way forward on issue 3-1-2: 1CC fall-back MPR for NC UL CA

### PC3 NC ULCA

As there are no 2Tx architectures for PC3 NC UL CA, when there is RB allocation only in one CC, the 1Tx PC3 MPR applies. However for when 2 CC have RB allocated, one aspects has to be covered:

* Different 2Tx MPR based on use of one LO or two LO that can be distinguished by LO *dualPA-Architecture* indicated for 2LO architecture.
  + 1LO architecture is restricted to bandwidth separation class ≤ 200MHz AND Gap Bandwidth ≤ aggregated BW
  + 2LO architecture is applicable to any bandwidth separation class and any gap.

**Agreement:**

**WF on 2CC and 1CC fallback PC3 MPR mapping for a UE configured for intra-band non-contiguous UL CA:**

* **When *dualPA-Architecture* is reported (2LO case) and is applicable to any bandwidth separation class and any gap bandwidth**
  + **When RBs are allocated in both CC MPR in section 6.2A.2.2 of R17 38.101-1 applies**
  + **When RBs are allocated only in one CC, the MPR in Table 6.2.2-1 of R17 38.101-1 applies**
* **When *dualPA-Architecture* is absent (1LO case) and is applicable only to bandwidth separation class ≤ 200MHz AND Gap Bandwidth ≤ aggregated BW**
  + **When RBs are allocated in both CC MPR in section 6.2A.2.2 of R17 38.101-1 applies**
  + **When RBs are allocated only in one CC, the MPR in Section 1.4 of WF R4-2119955** **applies**

Huawei: we would like to make sure the other issues are agreeable. We are OK with proposals.

OPPO: OK with WF. Now we use dual PA to indicate two LO. In RAN2 306 spec, it just mentions this capability supports only two LO not mentioning DC location. We should inform that this capabilities can also indicate DC locations.

Ericsson: For lowest MCS to highest MCS, because there is tolerance available, the failure in the conformance test is 5dB lower. From network perspective, is there any UE behaviour to be changed? If you have power backoff of 8dB the total power exceed 18dBm and you need 15dBm on each CC.

Skyworks: Two LO architecture only works on the restricted channel configuration up to 200MHz bandwidth separation class. When looking at the difference, the difference is A-MPR for larger location is much larger than dual PA architeure. There is very different capability for those two architectures.

Ericsson: If Half dB difference, there is no need to indicate at all. If there is difference that network cannot configure UE, that is crucial information. 200MHz bandwidth class separation is crucial.

ZTE: For WF text, the requirement that UE met relies on the real RB allocation. What is impact on test design? Secondly, about dual PA case, for the second sub-bullet, 1Tx requirements are applicable which will limit the implementation. This flexibility should be allowed.

Qualcomm: To Ericsson, I do not think dual PA is relevant and it should be bandwidth class separation which is relevant. There is no need for dual PA .. we need separation.

Skyworks: it is not true that depending on bandwidth class separation. LO number information is also needed. 2LO has not such limitation. There is not 0.5dBm difference.

Ericsson: to Qualcomm, the bandwidth class can be used for that purpose. However, to indicate bandwidth class is consistent with UE implementation. That is the function of architecture.

Huawei: agree with Skyworks. The WF is for test applicability. We can use applicability.

LGE: the simple way is to define only two LO case in Rel-17. The other can be discussed in Rel-18.

Qualcomm: CR should be updated. There is no mention about the gap bandwidth.

Ericsson: to Skyworks, LO PA architecture has any impact on network CA configuration. That part should be made clear. In conformance, we should consider tolerance.

Skyworks: without restriction, 1LO needs infinite MPR.

**Comment collection, please do modify WF text, WF will be consolidated based on comment captured in the table below**

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| **Company** | **Comments** |
| OPPO | Generally ok. Some wording refinement might be needed.  1. The second bullet may cause misunderstanding, since when RBs are allocated on in one CC, there is no 2LO case (1st sub-bullet)…  Maybe it is better start with UE architecture then RB allocation like:   * **When *dualPA-Architecture* is reported (2LO case)**   + **When RBs are allocated in both CC MPR in section 6.2A.2.2 of R17 38.101-1 applies**   + **When RBs are allocated only in one CC, the MPR in Table 6.2.2-1 of R17 38.101-1 applies and is applicable to any bandwidth separation class and any gap bandwidth** * **When *dualPA-Architecture* is absent (1LO case)**   + **When RBs are allocated in both CC MPR in section 6.2A.2.2 of R17 38.101-1 applies**   + **When RBs are allocated only in one CC, the MPR in Section 1.4 of WF R4-2119955** **applies and is applicable only to bandwidth separation class ≤ 200MHz AND Gap Bandwidth ≤ aggregated BW**   2. If we mapping ***dualPA-Architecture*** as 2LO, then the description in 38.306 may need clarify. For example, saying “indicates the support of dual PA and corresponding two DC location”    3. For further clarification, in the beginning of this issue, it says “*As there are no 2Tx architectures for PC3 NC UL CA*…”, but in 38.101-1 it has below description, maybe yellow highlighted is typo? |
| Nokia | Thank you for the hard work! Though I may misunderstand the proposals, it seems that the side conditions such that gap etc., applies to the case only when RBs are allocated in one CC regardless of the original proposal and OPPO’s alternative. I mean if we go with OPPO’s alternative, better to mention the PA architecture with associated side conditions first as you did in the next WF for PC2 NC UL CA.  Regarding *dualPA-Architecture*, as we commented in our paper, if we use this as indicating the number of LOs, we just would like to ask companies if there are consistency across specifications on how to use it…If consistency holds, it’s ok. |
| Skyworks | To OPPO, I updated to your recommended order and it is more consistent with PC2. For clarifying *dualPA-Architecture* means 2 LO frequencies in38.306 we support this and to our knowledge is consistent with the n41 intra-band ENDC case which used DualPA first. This is also consistent with the case where contiguous UL CA is supported with 1PA per CC (ie LO). Note that the only 1LO PC3 evaluated is a single 23dBm PA. |
| Qualcomm | Agree with Nokia, we should think where to inject that dualPA in the spec. Maybe a topic for next meeting if we agree this approach in this meeting. We should also think what to do to rel-16 spec.  Otherwise, the Oppo approach is ok. |
| Huawei | We are ok with updated proposal by OPPO. Regarding the meaning of *dualPA-Architecture* , based on the clarification by the IE proponent company and further explanation of the usage for n41 intra-band ENDC, we think there is no misunderstanding of using the IE, but some further clarification is also fine for us. |

### PC2 NC ULCA

Since Issue 3-1-1 and Issue 3-2-1 are based on using *dualPA-Architecture*, this way forward will focus on re-using the same signaling.

There are two aspects that needs to be covered:

* Different 2Tx MPR based on use of one LO or two LO that can be distinguished by LO *dualPA-Architecture* indicated for 2LO architecture.
  + 1LO architecture is restricted to bandwidth separation class ≤ 200MHz AND Gap Bandwidth ≤ aggregated BW
  + 2LO architecture is applicable to any bandwidth separation class and any gap.
* Use of *TxD* or not which dictates the MPR for 1CC
  + Architectures using TxD does not have a full power PA and thus uses the 1CC 2Tx PC2 MPR when there is allocation only in one CC
  + Architectures not using TxD that have a full power PA and thus uses the 1CC 1Tx PC2 MPR when there is allocation only in one CC

Agreement:

**WF on 2CC and 1CC fallback PC2 MPR mapping for a UE configured for intra-band non-contiguous UL CA:**

* **When *dualPA-Architecture* is reported (2LO case, at least one full power PA exists, *TxD* does not apply) and it is applicable to any bandwidth separation class and any gap bandwidth :**
  + - **when RBs are allocated in both CC, PC2 MPR in section 3.3 of way forward R4-2114948 applies**
    - **when RBs are allocated only in one CC, Table 6.2.2-2 of R17 38.101-1 applies**
* **When *dualPA-Architecture* is absent (1LO case) and it is applicable only to bandwidth separation class ≤ 200MHz AND Gap Bandwidth ≤ aggregated BW:** 
  + - **If *TxD* is signalled**
    - **when RBs are allocated in both CC, the MPR in Section 1.3 of WF R4-2119955** **applies**
    - **when RBs are allocated only in one CC, 2Tx 1CC PC2 Table in R4-2119971 draftCR applies**
    - **If *TxD* is not signalled, 1Tx PC2 in Table 6.2.2-2 applies.**
    - **when RBs are allocated in both CC, the MPR in Section 1.3 of WF R4-2119955** **applies**
    - **when RBs are allocated only in one CC, Table [6.2.2-2] of R17 38.101-1 applies**

**OPPO: for the first bullet,**

**Comment collection, please do modify WF text, WF will be consolidated based on comment captured in the table below**

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| **Company** | **Comments** |
| OPPO | For 2LO case, it is limited to one full power PA, how about 23+23 or 26+26 case? |
| Nokia | We guess the first main bullet needs to say that TxD is not signalled while dualPA-archiecture is signalled. |
| Skyworks | For NC UL CA with 2LO (1PA per CC) you need at least one PA to reach PC2 since when there is 1RB on one side and full on the other side the full RB side needs to reach full power so at least one PA needs to be 26dBm this is why only 23+26 and 26+26 were evaluated and share the same MPR. In that sense TxD is not applicable to the two LO case but it does not harm to add. |
| Qualcomm | What does this mean:   * + - **If *TxD* is not signalled, 1Tx PC2 in Table 6.2.2-2 applies.**     - **when RBs are allocated in both CC, the MPR in Section 1.3 of WF R4-2119955** **applies**     - **when RBs are allocated only in one CC, Table 6.2.2-2 of R17 38.101-1 applies**   It seems to have two definitions. Maybe intention was   * + - **If *TxD* is not signalled:**     - **when RBs are allocated in both CC, the MPR in Section 1.3 of WF R4-2119955** **applies**     - **when RBs are allocated only in one CC, [Table 6.2.2-2] of R17 38.101-1 applies**   However, the 1 LO and the allocation in one CC (last bullet here), are we sure we have looked at this case? There is a IM product that is not accounted in 1CC MPR. Can we put this in the [ ] as shown? We will either bring MPR proposals in next meeting or then we can remove the []. |
| Huawei | We are ok with the modified proposal, put the requirement of Table 6.2.2-2 in bracket is also fine for us. |

# References

1. R4-2114948 WF on PC2 intra-band UL NC CA and contiguous CA with 2Tx architecture, Skyworks Solutions Inc. , RAN4#100e
2. R4-2119955 WF on intra-band NC UL CA for FR1, Skyworks Solutions Inc., RAN4#101e
3. R4-2119971 Draft CR on MPR of Tx Diversity (TxD) PC2 for two PC3 PA architecture, LG Electronics, RAN4#101e
4. R4-2200334 Requirements for different architectures and their capabilities, Qualcomm Incorporated, RAN4#101be
5. R4-2200336 2CC LO location reportting and dualPA capability in rel-16, Qualcomm Incorporated, RAN4#101be
6. R4-2200493 Signalling on PC2 intra-band NC UL CA for FR1, Nokia, Nokia Shanghai Bell, RAN4#101be
7. R4-2200498 Requirement and signaling aspect of non-contiguous ULCA , Skyworks Solutions Inc. , RAN4#101be
8. R4-2201944 Consideration on signalling to differentiate MPR for different architectures, Huawei, HiSilicon, RAN4#101be
9. R4-2201674 Draft CR TS 38.101-1 R17: Addition of PC2 non-contiguous ULCA MPR requirements, Skyworks Solutions Inc. , RAN4#101be
10. R4-2201943 Big CR for PC2 intra-band non-contiguous UL CA, Huawei, HiSilicon, Qualcomm, RAN4#101be