3GPP TSG-RAN WG4 Meeting # 109 R4-23xxxxx

Chicago, US, November 13 – 17, 2023

**Agenda item:** 5.3.4

**Source:** Moderator (vivo)

**Title:** Topic summary for [109][125] FR1\_enh2\_part2

**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.*

# Topic #1: 4Tx Requirements

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2318033**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318033.zip) | Nokia, Nokia Shanghai Bell | On interpretation of requirements for 4Tx coherent UL MIMO  A screenshot of a computer screen  Description automatically generated  **Proposal:** if our interpretation of the requirements of [1] is correct, adopt the following text.  For coherent UL MIMO, Table 6.4D.4-1 lists the maximum allowable difference between the measured relative power and phase errors between any two ports **out of the** scheduled **ports** for UL transmission at their respective antenna connectors in any slot within the specified time window from the last transmitted SRS on the same antenna connectors, for the purpose of uplink transmission (codebook or non-codebook usage) and those measured at that last SRS. |
| [**R4-2320901**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2320901.zip) | Qualcomm, InterDigital | Requirements for coherent UL MIMO  For coherent UL MIMO, Table 6.4D.4-1 lists the maximum allowable difference between the measured relative power and phase errors between any two coherent ports out of the scheduled ports for UL transmission at their respective antenna connectors in any slot within the specified time window from the last transmitted SRS on the same antenna connectors, |
| [**R4-2318778**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318778.zip) | Qualcomm Technologies Int | Pcmax tolerance for 4 Tx  **Observation 1:** By adopting the proposed 4 Tx PCmax tolerance curve the 4 Tx device may transmit lower power than the 2 Tx device which is undesirable from a product standpoint.  **Observation 2**: Larger power variation across the individual PAs adversely impacts the UL MIMO throughput performance of the device.  **Observation 3**: Pcmax tolerance scaling based on the number of transmit PAs is inadvisable for a large number of transmitters.  **Observation 4:** For certain UL MIMO use cases all power ranges can be used equally. Therefore, when creating the Pcmax tolerance curve for 4 Tx the entire 2 Tx Pcmax tolerance curve should be shifted by the relaxation value so that this relaxation is applied to all power ranges.  **Proposal 1:** Use the following Pcmax table for 4 Tx   |  |  |  | | --- | --- | --- | | PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) | | 23.5 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 | | 22.5≤ PCMAX,*c* < 23.5 | 5.0 | 2.0 | | 21.5≤ PCMAX,*c* < 22.5 | 5.0 | 3.0 | | 20.5≤ PCMAX,*c* < 21.5 | 6.0 | 4.0 | | 16.5 ≤ PCMAX,*c* < 20.5 | 5.0 | | | 11.5 ≤ PCMAX,*c* < 16.5 | 6.0 | | | -40 ≤ PCMAX,*c* < 11.5 | 7.0 | | |
| [**R4-2318946**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318946.zip) | vivo | Remaining issues of 4Tx requirements  New TxD capability Impact  **Proposal 1:** Extend the general description of Tx diversity requirements to cover more capabilities, e.g. as following:  e) The requirements for Tx diversity in this release are applied for UE which indicates IE [*txDiversity-r16*], [*txDiversity2T-r18*] or [*txDiversity4T-r18*]. 2Tx requirements for TxD should be applied to UE indicating [*txDiversity-r16*] or [*txDiversity2T-r18*], and 4Tx requirements should be applied to UE indicating [*txDiversity4T-r18*].  **Proposal 2:** Discuss a general term like “Tx Diversity capabilities” instead of listing all the capabilities for most of the cases.  **Proposal 3:** Discuss case by case (e.g. according to Table 1) which part should use which use general capability wording or specific capability for 2Tx or 4Tx TxD.  **Proposal 4:** Treat all the TxD capabilities related revision in this WI to avoid duplicate analysis and possible overlapping.  PCMAX,c tolerance for 4Tx  **Proposal 5:** Adopt 1 or 2dB tightening compared for the highest range as in Table 2 or 3 for Pcmax Tolerance.  **Table 2. Scheme 1 (1dB tightening)**   |  |  |  | | --- | --- | --- | | PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) | | 25 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 | | 24 ≤ PCMAX,*c* < 25 | 5.0 | 3.0 | | 23 ≤ PCMAX,*c* < 24 | 5.0 | 4.0 |   **Table 3. Scheme 2 (2dB tightening)**   |  |  |  | | --- | --- | --- | | PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) | | 24 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 | | 23 ≤ PCMAX,*c* < 24 | 5.0 | 4.0 | |
| **REV\_**[**R4-2319171**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319171.zip)  Note: Late file on the reflector | Spreadtrum Communications | Discussion on remaining issues on 4TX requirements  **Proposal 1:** Take the value of PCMAX,c tolerance for 4TX in Table 4 into consideration.  **Table 4: PCMAX,c tolerance for 4TX**   |  |  |  | | --- | --- | --- | | PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) | | PCMAX,*c*=29 | 3.0 | 2.0 | | 26 ≤ PCMAX,*c* ＜29 | 3.5 | 2.0 | | 25≤ PCMAX,*c* < 26 | 5.0 | 2.0 | | 24 ≤ PCMAX,*c* < 25 | 5.0 | 3.0 | | 23 ≤ PCMAX,*c* < 24 | 6.0 | 4.0 | | 19 ≤ PCMAX,*c* < 23 | 5.0 | | | 14 ≤ PCMAX,*c* < 19 | 6.0 | | | -40 ≤ PCMAX,*c* < 14 | 7.0 | | |
| [**R4-2319730**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319730.zip) | Huawei, HiSilicon | On remaining UE RF requirements for 4Tx    **Figure 1:** Lower bound tolerance of total configured power with equal power for 4 Tx  **Table 1:** PCMAX,c tolerance for 4 Tx UL-MIMO for 4 Tx   |  |  |  | | --- | --- | --- | | PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) | | 25 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 | | 24 ≤ PCMAX,*c* < 25 | 5.0 | 2.0 | | 23 ≤ PCMAX,*c* < 24 | 5.0 | 3.0 | | 22 ≤ PCMAX,*c* < 23 | 5.0 | 4.0 | | 19 ≤ PCMAX,*c* < 22 | 5.0 | | | 14 ≤ PCMAX,*c* < 19 | 6.0 | | | -40 ≤ PCMAX,*c* < 14 | 7.0 | |   ***Proposal 1:*** *It is proposed to adopt the proposed Pcmax,c tolerance for 4Tx as in Table 1 .*  ***Proposal 2:*** *It is proposed to list the TxD capabilities in clause 4.2 for the Applicability of minimum requirements, and not use the term with specific capability for the requirements part in the spec.* |
| [**R4-2319441**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319441.zip) | Ericsson | On new UE capability for TxD  **Proposal 1:** there is no need to introduce a new per band per BC UE capability for TxD support, the per-band capability can be indicated by existing BandNR for 3Tx band combinations. Inform RAN2 accordingly.  **Proposal 2:** further clarify the intention of the TxD indication and the need for a specific TxD indication for 4Tx. |
| [**R4-2319405**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319405.zip) | Samsung | LS on 2Tx-TxD capability and 4Tx-TxD capability  ***Observation 1:*** *In principle, FS 4Tx-TxD can be utilised for single band (None-CA) case from signalling perspective (as the size of “BandCombinationList” can be 1), by reporting this BC (including only one band) and create the FS for this BC.*  ***Observation 2****: If RAN4 targets both single band (None-CA) and CA, it should be clearly delivered to RAN2 and left RAN2 to determin introduce a single FS capability or two separate capabilities.*  ***Observation 3****: If 4T-TxD for CA is far away, introduce a per band capability might be more reasonable.*  ***Proposal 1:*** *It is proposed to re-discuss the target of 4Tx-TxD within Rel-18.*  *- Target only single band (None CA) →Samsung’s preference*  *- Target both single band (None CA) and CA*  ***Proposal 2:*** *In terms of 2Tx-TxD, RAN4 discuss the interaction between the existing capability (txDiversity-r16) and this new FS capability.*   * Approach 1: new capability is included in a certain band/BC, it will override per band capability for this band/BC. Otherwise, the UE applies per band capability. The presence of new capability signaling requires the support of txDiversity-r16. In case of absence of the signaling follows txDiversity-r16 in the corresponding band. *(Samsung’s understanding: this precludes the case: TxD is for single band A, and 1Tx for A within CA\_A-B, so we do not think Approach 1 is reasonable though it is the common RAN2 way)* * Approach 2: existing capability is applied to non-CA only. New capability should be applied for CA band combination. It means the absence of new capability signaling means no support of tx diversity in the band/band combination. * Approach 3: existing capability is applied to non-CA only. New capability should be applied for CA band combination. It means the absence of new capability signaling means no support of tx diversity in the band/band combination. The presence of new capability signaling requires the support of *txDiversity-r16* *→Samsung’s understanding/preference*   ***Proposal 3:*** *The presence of 4Tx-TxD signaling does not require the support of 2Tx-TxD signalling.* |
| [**R4-2318034**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318034.zip) | Nokia, Nokia Shanghai Bell | Relation between legacy TxD and new TxD capabilities  **Observation 1**: RAN4 asked RAN2 to define *twoTxDiversity-r18* per feature set, which allows a UE to differentiate which band combinations it supports 2Tx Diversity for a particular band.  **Observation 2**: RAN4 asked RAN2 to define *fourTxDiversity-r18* per feature set, which allows a UE to differentiate which band combinations it supports 4Tx Diversity for a particular band.  **Observation 3**: The *fourTxDiversity-r18* capability must cover a scenario that that a UE supports 4TxD for a band which is not contained in any band combinations supported by the UE or the UE doesn’t support any band combinations.  **Observation 4**: From signaling design perspective, it is possible to signal a BandCombination with single band entry. Hereafter this is called single-band band combination. Then, a UE can indicate 4TxD support for a band in that single-band combination. This way, however, would not be diffused way and a network may not be able to correctly understand it.  **Observation 5**: It is not always clear how or whether the legacy per-band capability *txDiversity-r16* applies when the supported band is one of the bands in a band combination.  **Observation 6**: Applying the fallback principle to the per-FS capabilities *twoTxDiversity-r18* and *fourTxDiversity-r18* would resolve certain ambiguities of *txDiversity-r16*.  **Observation 7**: For a given feature set where *fourTxDiversity-r18* is indicated, it seems redundant to signal *twoTxDiversity-r18* for the same FS, as UE support for 2TxD may be inferred by support for 4TxD. Hence, Case 7 and 8 shouldn’t exist.  **Proposal 1**: A UE indicating *fourTxDiversity-r18* for a given FS need not indicate *twoTxDiversity-r18* for the same FS; and a network shall understand that a UE supports *twoTxDiversity-r18* in a FS where *fourTxDiversity-r18* is indicated.  **Observation 8**: Given its ambiguity, the usage of the legacy per-band *txDiversity-r16* capability in combination with per-FS capabilities *twoTxDiversity-r18* and *fourTxDiversity-r18* does not seem useful assuming the single-band BC inherits the per-FS TxD capabilities from higher-order BCs. Otherwise, a clear definition is needed, e.g., BCs doesn’t inherit per-band txDiversity-r16 capability. Accordingly, per-band fourTxDiversity-r18 capability is needed.  **Proposal 2**: RAN4 should discuss the following:  If a single-band BC (one band entry in BandCombination in TS38.331) is assumed to inherit the per-FS TxD capability from higher-order BCs through the fallback principle:  - Whether a Rel-18 UE shall signal *txDiversity-r16* for a band where it also supports *twoTxDiversity-r18* or *fourTxDiversity-r18*.  - Whether a Rel-18 network shall ignore *txDiversity-r16* for a band where a UE also supports *twoTxDiversity-r18* or *fourTxDiversity-r18*.  Else if a single-band BC does not inherit the per-FS TxD capability from higher-order BCs through the fallback principle:  - Whether a network shall only interpret *txDiversity-r16* for the single-band operation.  - Whether a new per-band capability is needed to indicate that the UE supports 4TxD for single-band.  **Proposal 3**: Send an LS to RAN2 if any agreements are made for this matter. |
| [**R4-2318813**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2318813.zip) | LG Electronics | draft CR on 4Tx MPR to remove square bracket  Proposal：Remove [] from 4Tx MPR in Table 6.2D.2-5. |
| [**R4-2319731**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_109/Docs/R4-2319731.zip) | Huawei, HiSilicon | draft big CR for TS 38.101-1 4Tx requirements |
|  |  |  |

## Open issues summary

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

### Sub-topic 1-1 Coherence UL MIMO

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-1-1: UL-MIMO coherence wording proposal for 4Tx**

* Proposals
  + Option 1: (Nokia)
    - For coherent UL MIMO, Table 6.4D.4-1 lists the maximum allowable difference between the measured relative power and phase errors between any two ports **out of the** scheduled **ports** for UL transmission at their respective antenna connectors in any slot within the specified time window from the last transmitted SRS on the same antenna connectors, for the purpose of uplink transmission (codebook or non-codebook usage) and those measured at that last SRS.
    - Note: Intention is to only specify the cases between any two ports, rather than multiple ports at the same time.
  + Option 2: (Qualcomm, InterDigital)
    - For coherent UL MIMO, Table 6.4D.4-1 lists the maximum allowable difference between the measured relative power and phase errors between any two coherent ports out of the scheduled ports for UL transmission at their respective antenna connectors in any slot within the specified time window from the last transmitted SRS on the same antenna connectors,
    - Note: Based on option 1, additionally consider partially coherent condition by having one more restriction.
  + Option 3: Others
* Recommended WF
  + TBD

### Sub-topic 1-2 Pcmax Tolerance

*Sub-topic description*

*Open issues and candidate options before meeting:*

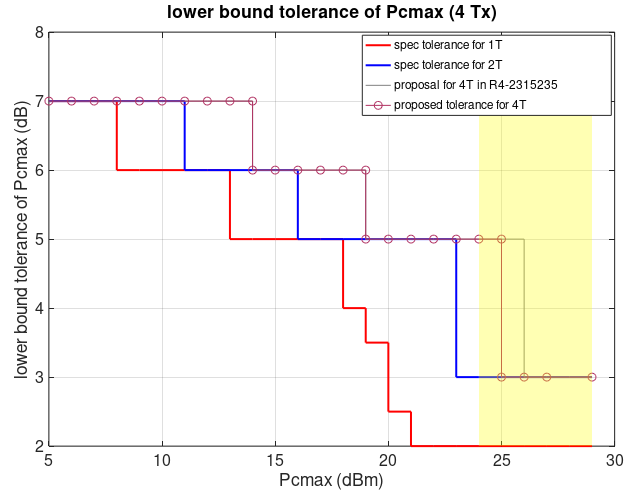
**Issue 1-2-1: PCMAX,c tolerance for 4Tx**

*WF in RAN4#108bis*

* + *In RAN4#108bis, adopting the following table which is based on shifting 2Tx curve by 3dB with certain power ranges in [] as baseline:*
  + *In RAN4#109, the ranges with [] will be revisited for possible reduction of shift values.*

|  |  |  |
| --- | --- | --- |
| *PCMAX,c (dBm)* | *Tolerance TLOW(PCMAX\_L,c) (dB)* | *Tolerance THIGH(PCMAX\_H,c) (dB)* |
| *[26] ≤ PCMAX,c ≤ 29* | *3.0* | *2.0* |
| *[25] ≤ PCMAX,c < [26]* | *5.0* | *2.0* |
| *[24] ≤ PCMAX,c < [25]* | *5.0* | *3.0* |
| *23 ≤ PCMAX,c < 24* | *6.0* | *4.0* |
| *19 ≤ PCMAX,c < 23* | *5.0* | |
| *14 ≤ PCMAX,c < 19* | *6.0* | |
| *-40 ≤ PCMAX,c < 14* | *7.0* | |

* Proposals
  + Proposal 1: Based on 3dB relaxation of the power ranges compared to 2Tx, and 1dB tightening for the higher range.



|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| 25 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 |
| 24 ≤ PCMAX,*c* < 25 | 5.0 | 2.0 |
| 23 ≤ PCMAX,*c* < 24 | 5.0 | 3.0 |
| 22 ≤ PCMAX,*c* < 23 | 5.0 | 4.0 |
| 19 ≤ PCMAX,*c* < 22 | 5.0 | |
| 14 ≤ PCMAX,*c* < 19 | 6.0 | |
| -40 ≤ PCMAX,*c* < 14 | 7.0 | |

* + Proposal 2: 0.5dB relaxation of the power ranges compared to 2Tx.

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| 23.5 ≤ PCMAX,*c* ≤ 29 | 3.0 | 2.0 |
| 22.5≤ PCMAX,*c* < 23.5 | 5.0 | 2.0 |
| 21.5≤ PCMAX,*c* < 22.5 | 5.0 | 3.0 |
| 20.5≤ PCMAX,*c* < 21.5 | 6.0 | 4.0 |
| 16.5 ≤ PCMAX,*c* < 20.5 | 5.0 | |
| 11.5 ≤ PCMAX,*c* < 16.5 | 6.0 | |
| -40 ≤ PCMAX,*c* < 11.5 | 7.0 | |

* + Proposal 3: Based on 3dB relaxation of the power ranges compared to 2Tx, and 0.5dB more relaxation for ceratin tolerance value. (Late)

|  |  |  |
| --- | --- | --- |
| PCMAX,*c*(dBm) | Tolerance TLOW(PCMAX\_L,*c*) (dB) | Tolerance THIGH(PCMAX\_H,*c*) (dB) |
| PCMAX,*c*=29 | 3.0 | 2.0 |
| 26 ≤ PCMAX,*c* ＜29 | 3.5 | 2.0 |
| 25≤ PCMAX,*c* < 26 | 5.0 | 2.0 |
| 24 ≤ PCMAX,*c* < 25 | 5.0 | 3.0 |
| 23 ≤ PCMAX,*c* < 24 | 6.0 | 4.0 |
| 19 ≤ PCMAX,*c* < 23 | 5.0 | |
| 14 ≤ PCMAX,*c* < 19 | 6.0 | |
| -40 ≤ PCMAX,*c* < 14 | 7.0 | |

* Recommended WF
  + TBD

### Sub-topic 1-1 TxD capability Related

*Sub-topic description*

*Open issues and candidate options before meeting:*

**Issue 1-3-1: The applicability relationship of Legacy and newly introduced 2Tx capability**

* Proposals
  + Option 1: New Rel-18 2Tx TxD capability would be applied to both single band (non-CA) and for CA cases.
    - This means legacy per-band capability would be override / omitted from Rel-18, as long as new Rel-18 2Tx TxD capability exist.
    - This option can be further differentiated by whether legacy per-band capability is required or not. i.e.
      * 1a. legacy per-band capability is still required
      * 1b. legacy per-band capability is not required anymore.
  + Option 2: Legacy per-band capability is applied to non-CA only, and new Rel-18 2Tx TxD capability for CA band combination only.
    - This means the legacy and new capability would be used for non-CA and CA respectively.
    - This option can be further differentiated by whether legacy per-band capability is required or not. i.e.
      * 2a. legacy per-band capability is still required
      * 2b. legacy per-band capability is not required anymore.
  + Option 3: Others
* Recommended WF
  + TBA

**Issue 1-3-2: The inter-dependency of newly introduced Rel-18 2Tx-TxD capability and 4Tx-TxD capability**

* Proposals
  + Option 1: The presence of 4Tx-TxD signalling does not require the support of 2Tx-TxD signalling.
  + Option 2: A UE indicating fourTxDiversity-r18 for a given FS need not indicate twoTxDiversity-r18 for the same FS; and a network shall understand that a UE supports twoTxDiversity-r18 in a FS where fourTxDiversity-r18 is indicated.
  + Option 3: Others
* Recommended WF
  + TBA

**Issue 1-3-3: Whether Rel-18 4Tx TxD capability should be limited to CA cases only.**

* Proposals
  + Option 1: No.
  + Option 2: Yes. This may means another 4Tx TxD capability for non-CA case is needed.
  + Option 3: Others
* Recommended WF
  + TBA

**Issue 1-3-4: Structure of the requirements.**

* Proposals
  + Proposal 1: Extend the general description of Tx diversity requirements to cover more capabilities.
  + Proposal 2: Discuss a general term instead of listing all the capabilities for most of the cases.
  + Proposal 3: Discuss case by case which part should use which use general capability wording or specific capability for 2Tx or 4Tx TxD.
* Recommended WF
  + TBA

**Issue 1-3-5: Discuss whether another LS is needed to RAN2.**

* Proposals
  + Option 1: Yes
  + Option 2: No.
  + Option 3: Others
* Recommended WF
  + TBA