**3GPP TSG-RAN WG4 Meeting # 97-e R4-200XXXX**

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

**Agenda item:** 7.19.2

**Source:** Moderator (vivo)

**Title:** Email discussion summary for [97e][115] Transmit diversity and power class related to UL MIMO

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion and provide some guidelines for email discussion if necessary.*

The release of transparent TxD was discussed for several meetings. In RAN4#96-e meeting, the transparent TxD was discussed under TEI16 as documented in [R4-2011860] and a WF [R4-2011768] was also agreed. However, the agreements are still limited. There are still divided views and some new options were also discussed. The main points including:

* New EVM definition for transparent TxD
* Declaration of default Tx connector
* UE behavior on keeping the tx diversity under conformance testing
* UE behaviour for power splitting
* Signaling for Transparent TxD
* Applicability of TxD procedure & requirements
* Necessity of CDD related requirement

In addition, there is a long standing RAN5 LS in [R4-1916132] that have not been replied. One draft reply was prepared in [R4-2005217] but was not agreed.

In RAN4#95-e, the Power class & UL-MIMO related topic were discussed and documented in [R4-2008935], a WF [R4-2008408] was noted since no conclusion could be reached. In RAN#88-e, the power class issue was discussed and an conclusion have been made [RP-201392] for Rel-16 power class clarification. In RAN4#96-e meeting, the TxD and Power class issues were separated, and power class related topic was officially suspended for one meeting to prioritize Rel-16 WIs. However, still a few papers were submitted as in [R4-2011860] and an LS [R4-2011903] and draft CR [R4-2011770] to reflect what have been achieved in RAN#88-e.

However, still there are some remaining issues apart from TxD, the main topics include:

* Power-capability indication for SA operation (Rel-15)
* RAN4 clarification of NSA NR power class (Rel-15)
* UL-MIMO Emissions (Rel-15 & Rel-16)

In this meeting, UL-MIMO Emission papers were submitted in Agenda specifically for Rel-15 thus would not be discussed in this thread.

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

* 1st round: TBA
	+ Further discuss and solve the remaining issues;
* 2nd round: TBA
	+ Based on results from 1st round, proceed as much as possible.

# Topic #1: Transparent TxD

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| *R4-20xxxxx* | *Company A* | *Proposal 1:**Observation 1:* |
| [**R4-2014303**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014303.zip) | LG Electronics Polska | Remaining issues on Tx diversity**Observation 1:** There should be no signalling for a UE supporting transparent TxD since it is up to UE’s implementation choices and one of main purposes of having transparent TxD requirement is to let RAN5 know how to distinguish between a legacy UE and a UE supporting TxD during conformance test.**Observation 2:** There must be something that can distinguish between two different architectures (1Tx and 2Tx) and the corresponding MPR values should be applied to them even though there is no signalling required for transparent TxD.**Observation 3:** The option 1 (Use ModifiedMPRbehavior bits to signal additional relaxations) can be one of possible candidates to solve the signalling issue.**Observation 4:** It is not possible to distinguish between a legacy UE and a UE supporting TxD during the current conformance test.**Observation 5:** RAN4 has been attempting to introduce TxD requirements so that RAN5 can easily adopt what they need for developing the corresponding conformance test.**Observation 6:** Using UE vendor declaration can be one of possible options for distinguish between the legacy UE and the UE supporting TxD if there is no signalling.**Proposal 1: RAN4 should use the option 1 (Use modifiedMPRbehavior bits to signal additional relaxations) instead of introducing a new signalling for TxD.****Proposal 2: RAN4 should define TxD requirements in the general section not define dedicated TxD requirement separately.** |
| [**R4-2014583**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014583.zip) | Intel Corporation | Remaining Issues on Transparent TxD **Observation 1**: If $EVM\_{1}\leq EVM\_{2}$, then $EVM\_{Eq.1}\leq EVM\_{1}\leq EVM\_{Eq.2}\leq EVM\_{2}$, where $EVM\_{Eq.1}=\sqrt{(P\_{1}\*EVM\_{1}^{2}+ P\_{2}\*EVM\_{2}^{2})/(P1 + P2)}$ and $EVM\_{Eq.2}= \sqrt{\left(EVM\_{1}^{-2}+EVM\_{2}^{-2}\right)^{-1}}$ with P1, P2 and $EVM\_{1}^{2}$ and $EVM\_{2}^{2}$ defined above.**Proposal 1**: Take $EVM\_{Eq.1}=\sqrt{(P\_{1}\*EVM\_{1}^{2}+ P\_{2}\*EVM\_{2}^{2})/(P1 + P2)}$ as specified EVM for transparent TxD.**Proposal 2**: If TE has only one test port for conducted test, option 3 is followed. If TE has two test ports supporting MIMO operation, option 1b is followed.**Proposal 3:** UE under test should keep tx diversity status unchanged in conformance test (option 1a), if signalling is needed for some UEs to perform transparent TxD (option 1b), such signalling should be optional. Regardless option 1a and 1b, TE should detect and sum for every power step and change in condition from all connectors (Option 2).**Proposal 4:** Define equal power split between Tx connectors.**Proposal 5:** Use ModifiedMPRbehavior bits to signal additional relaxations if MPR/AMPR for transparent TxD is different with general requirements.**Proposal 6**: For better clarity, the transparent specific requirements and test procedure should be differentiated with general case and this differentiation should be based on UE declaration. **Proposal 7**: The requirements of TAE+CDD on transparent TxD should be specified in order to have performance guaranteed.**Proposal 8**: Simulation assumption should be specified for simulation campaign as Table 1: |
| [**R4-2014686**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014686.zip) | Anritsu corporation | Remaining items on transparent Tx diversityIn this contribution we showed our views on the remaining items for transparent Tx diversity issues.***Observation 1: Required EVM performance for each antenna connector transmission in a case of Tx diversity operation will be relaxed with a rate of 1/sqrt (2) at the maximum.******Proposal 1: Decision of the EVM requirement (equation) and clarification of the linear unbiased MMSE definitions shall be treated as a package.******Observation 2: The measurement of EVM at each antenna connector during the TxD mode does NOT need to be carried out simultaneously.*** ***Observation 3: Until now, there are still a possibility that a total number of Tx antenna connectors in a UE is more than 2 depending on the supported bands or FR1 frequency.******Observation 4: Without a declaration of primary Tx connector and possible active antenna connectors, there is no clues for test equipment to judge which antenna connector should be active or not per band for example from 6 connectors in total in a UE.*** ***Proposal 2: Option 2b (new). UE declares which connectors will be active (both the primary TX connector and the other active Tx connector) per band under test.******Observation 5: Since a change of Tx diversity status during a test may require a re-run of measurement, Tx diversity status shall be fixed. Thus option 2 is not acceptable.******Proposal 3: RAN4 decides a policy whether we need to confirm the characteristics of the UE without TxD activated even though the UE declares the capability of TxD.******Observation 6: It is preferred that the test equipment can control the TxD status explicitly by the test mode signalling.******Proposal 4: Agree Option 1b, (1a is the second choice when we do not need to test both UE characteristics with TxD and without TxD).******Observation 7: The necessity of the signalling for transparent TxD depends on how we define requirements and measurement procedures for the UE with TxD feature.******Proposal 5: In a case the signalling is necessary, our preference is Option 2.******Observation 7: As far as the*** ***measurement of each antenna connector is carried out separately and also an order of the applied delay to one Tx carrier is sub-micro-seconds, there is not a testability issue for each carrier.***  |
| [**R4-2014712**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014712.zip) | Qualcomm Incorporated | Tx diversity changes for Rel-16**Proposal 1: RAN4 core requirements for TxD should enable intentionally set power difference between the tx connectors** **Proposal 2: Distinguish requirements for TX Diversity UE’s in some way from single Tx UE’s in RAN4 requirements.**For the CDD issues, we made one observation**Observation: Measuring power and emission per connector and then merging the result will enable S-CDD implementation to meet same requirements than an implementation without S-CDD.**  |
| [**R4-2014713**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014713.zip) | Qualcomm Incorporated | Introduction of Tx diversity into 38101-14.3 Added suffix G for TX D.Isolated impact: Requirements are detailed further. UE’s with no TX diversity follow same general requirements and impact is only to UE with TX diversity which have not been able to pass conformance before the change. Change is contained to these UE’s. |
| [**R4-2014849**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014849.zip) | Samsung | Further discussio on the Support of Transparent Tx Diversity in Rel-16In this paper, we provided our views on the outstanding aspects which should be considered in the work to enable transparent TxD in Rel-16 requirement and corresponding test methods, with following observations and proposals:***Observation 1: The performance of CDD scheme at least depends on factors including: the choice of cyclic delay difference ∆m (correspondingly obtainable TX diversity), the impact of practical channel estimation at gNB, the channel correlation and the delay profile over two TX antennas.*** ***Observation 2: Even the following requirements are specified, CDD-based scheme can still not guarantee better performance than 1TX scheme baseline:*** ***- Minimum allocation bandwidth of contiguous PRB for transparent TxD;******- Upper and lower bound of the sum of TAE+CDD for transparent TxD;******- Minimum number of Rx antenna.*** ***Proposal 1: CDD-related requirement shall not be introduced.*** ***Observation 3: Based on the proposed port EVM and correspondingly analysis in [R4-2011519], the port EVM can reflect the level of TX signal quality for the received signal after linear unbiased MMSE receiver.*** ***Observation 4: As long as the equivalent precoding vector w (in which the phase shifting factor*** $e^{-j\frac{2π}{N}k∆\_{m}} $***shall be included for CDD-based scheme) can be estimated accurately, the proposed test method for port EVM is feasible.*** ***Proposal 2: Per instructed, UE should keep its Tx diversity status unchanged during the conformance tests, in terms of**** ***(1) 2TX diversity mode or 1TX mode;***
* ***(2) If 2TX diversity mode is applicable, equal power splitting can be locked***
* ***(3) If 1TX mode is applicable, one default Tx connector can be claimed by UE vendors.***
 |
| [**R4-2014904**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014904.zip) | Apple Inc. | On Tx diversity**Observation 1**: Currently three options are available to solve the challenges with TxD (modifiedMPRbehavior bits, new capability signalling, new power class). Due to the drawbacks of the first two solutions only a new power class seems to be a promising candidate which also could lead to a release independent solution.**Proposal 1**: Further discuss the introduction of a new power class.**Proposal 2**: Relaxations for TxD should be defined by measurements. Corresponding test requirements should be adjusted so that TxD is properly handled with all the given impairments. Those additional relaxations should not change already agreed PC2 MPR but should be gated behind a certain signalling.  |
| [**R4-2015265**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015265.zip) | Xiaomi | Discussion on Tx diversity open issues**Observation 1: the agreed method that combining two EVM values tested at each antenna connectors by weighting them with the measured power is more consistent with other Tx testing compared to the new test method proposed in [3].****Proposal 1: Option 2 or Option 2a is preferable on declaration for default Tx connector.****Proposal 2: Option 1b is preferable for UE behavior under conformance testing.****Proposal 3: it is proposed to choose option 1a as UE behavior for power splitting.****Proposal 4: it is proposed to choose option 1 for the issue on Signaling for Transparent TxD** |
| [**R4-2015321**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015321.zip) | vivo | Remaining issues in Transparent Tx Diversity**Proposal 1**: Accept either equation for EVM calculation. Keep original one if no consensus can be reached.**Proposal 2**: Only consider test mode definition in case no conclusion could be reached on these issues.**Proposal 3**: *ModifiedMPRbehavior* is still preferred for TxD related signaling. **Proposal 4**: Confirm this point after the signalling of TxD is set.**Proposal 5**: Not to define CDD related requirement.**Proposal 6**: Reply RAN5’s LS. |
| [**R4-2015340**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015340.zip) | OPPO | Discussion on Rel-16 TxD**2.1 Declaration for Default TX Connector and UE Behaviour under Conformance Testing*****Observation 1: UE is not expected to change transmit antennas during conduct tests, and declaration based antenna selection method is applicable.******Proposal 1: It is proposed to assume UE connector under test is unchanged and either UE declaration based method or test mode based method can be used.******Proposal 2: Inform RAN5 about the information above and it is up to RAN5 decide whether UE declaration based method or test mode based method can be used in conformance testing.*****2.2 Power splitting*****Observation 2: No such issue has been brought up in UL MIMO and same principle can be used for TxD.******Observation 3: This issue shall be distinguished as two aspects, one is for requirement definition, and the other is for UE implementation.******Observation 4: Even power is equally split between logical antenna ports, the ILs are most likely different considering the different antenna locations which leads to the conduct power different.******Proposal 3: It is proposed to keep flexibility of UE implementation and allow any power split between connectors but requirements are defined under the assumption that power is equally split.*****2.3 Signaling for Transparent TxD*****Observation 5: It is not clear the intention of introducing TxD signaling and the only possible reason is to make the TxD be aware to TE during testing.******Observation 6: UE declaration method can be used to apply corresponding TxD requirements and no signaling is needed.******Proposal 4: It is proposed to not introducing signaling for TxD and UE declaration can be used for conformance testing.******Proposal 5: It is proposed to focus on TxD requirements definition and further discuss the test specific issues afterwards in maintenance manner.*** |
| [**R4-2015341**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015341.zip) | OPPO | CR on TxD requirements |
| [**R4-2015342**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015342.zip) | OPPO | Reply LS on Tx diversity testing1. Define requirements for FR1 Tx diversity and clarify whether the requirements apply at a UE or at the antenna connector level.

**RAN4 Answer:** Most of the FR1 Tx diversity requirements are defined at a UE level, while some requirements are defined at the antenna connector level like transmit OFF power and ON/OFF time mask. Detailed information can be found in each requirement.1. Confirm that the RAN5 assumption of a maximum of 2 UL antenna connectors for Tx diversity is correct.

**RAN4 Answer:** It is also RAN4 understanding that 2 UL antenna connectors are assumed for Tx diversity during conformance testing.1. Clarify whether the FR1 Tx diversity applies from Rel.-15 or Rel.-16.

**RAN4 Answer:** It has been agreed that FR1 Tx diversity applies from Rel-16 at least. Whether it also applies to Rel-15 is still under discussion. |
| [**R4-2016034**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016034.zip) | Rohde & Schwarz | Discussion on remaining open issues for Tx diversity requirementsIn this contribution we discussed the open issues for Tx diversity and on the number of Tx antenna connectors and make the following proposals. **Proposal 1:** RAN4 agrees on either Option 2 or 2a.**Proposal 2:** RAN4 agrees on Option 1a or 1b. |
| R4-2016285 | Motorola Mobility France S.A.S | On the EVM Definition for Transmit Diversity |
| R4-2016288 | Lenovo, Motorola Mobility | On the EVM Definition for Transmit DiversityIn this contribution, we have extended the analysis in [2] and to the case that the cross-correlation of the transmitter noise is either bounded or unknown. Based on this analysis, we have the following two proposals.**P****roposal 1:** The EVM requirement is applied to the **antenna port**. The antenna port EVM **is defined** as the output of an unbiased linear MMSE receiver for which the EVM is given by$$EVM\_{port}=100∙\sqrt{\left(w^{H}Σ^{-1}w\right)^{-1}}$$where $Σ$is given by$$Σ=\left〈n n^{H}\right〉$$and$$n=\left[\begin{matrix}w\_{1 }n\_{1}^{'}\\w\_{2 }n\_{2}^{'}\end{matrix}\right] .$$Alternatively, the EVM can be calculated as $$EVM\_{port}=100∙ \left(\left[\begin{matrix}1&1\end{matrix}\right]^{H}Σ^{'}^{-1}\left[\begin{matrix}1\\1\end{matrix}\right]\right)^{-\frac{1}{2}}$$where $$Σ^{'}=\left〈n^{'} n^{'H}\right〉 .$$**Proposal 2:** If the test equipment cannot measure the covariance of transmitter noise $n$ at the two antenna connectors, then $EVM\_{port}$ is measured as$$EVM\_{port}=min\left(EVM\_{1},EVM\_{2}\right) .$$ |
| [**R4-2016477**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016477.zip) | Huawei, HiSilicon | On Tx diversity requirements***Proposal 1: It is proposed to focus on the transparent TxD requirements for Rel-16 firstly and considering the release independent manner for supporting transparent TxD in Rel-15.******Proposal 2: It is proposed to focus on the affected requirements and corresponding spec changes list in the table below:******Proposal 3: It is proposed to make decision on the test related issues list in the table below:***

|  |  |
| --- | --- |
| **Items** | **Proposed measurement procedure or UE behavior** |
| Declaration for default Tx connector | TE needs to detect all declared Tx antenna connectors for ACK and NACK and any other expected response from UE. |
| UE behavior under conformance testing | No need to keep TxD status unchanged all the time during the test and test mode is not necessary. |
| Power splitting behavior | Split the power equally between connectors during the test but no need to limit the UE behavior like that in real application. |

 |
| [**R4-2016478**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016478.zip) | Huawei, HiSilicon | CR for TS 38.101-1 Tx diversity requirements |
| [**R4-2016465**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016465.zip) | Skyworks Solutions Inc. | Discussion on Single Carrier MPR versus Architecture**Proposals:*** **2 Tx MPR should be the same MPR requirement for TX Diversity and UL MIMO for the same power class.**
* **2 Tx MPR table should be the same for different 2 TX power classes based on the same 2 TX paths as it is only a difference of Pmax reference.**
* **2 Tx Hybrid forms should not have specific MPR but agreed behavior in single port and UL MIMO modes.**
* **FFS if 1 TX and 2 TX MPR tables should be in the same or separate clauses.**
 |

## 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: Transparent TxD Testing issues

*Sub-topic description:*

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

**Issue 1-1-1: EVM for Transparent TxD**

* Proposals
	+ Option 1: As in agreed WF R4-2008465
		- * $EVM=\sqrt{(P\_{1}\*EVM\_{1}^{2}+ P\_{2}\*EVM\_{2}^{2})/(P1 + P2)}$
	+ Option 2: As has been provided in R4-2016288:

The EVM requirement is applied to the **antenna port**. The antenna port EVM **is defined** as the output of an unbiased linear MMSE receiver for which the EVM is given by

$$EVM\_{port}=100∙\sqrt{\left(w^{H}Σ^{-1}w\right)^{-1}}$$

where $Σ$is given by

$$Σ=\left〈n n^{H}\right〉$$

and

$$n=\left[\begin{matrix}w\_{1 }n\_{1}^{'}\\w\_{2 }n\_{2}^{'}\end{matrix}\right] .$$

Alternatively, the EVM can be calculated as

$$EVM\_{port}=100∙ \left(\left[\begin{matrix}1&1\end{matrix}\right]^{H}Σ^{'}^{-1}\left[\begin{matrix}1\\1\end{matrix}\right]\right)^{-\frac{1}{2}}$$

where

$$Σ^{'}=\left〈n^{'} n^{'H}\right〉 .$$

If the test equipment cannot measure the covariance of transmitter noise $n$ at the two antenna connectors, then $EVM\_{port}$ is measured as

$$EVM\_{port}=min\left(EVM\_{1},EVM\_{2}\right)$$

* Recommended WF
	+ TBA

**Issue 1-1-2: Declaration for default TX connector**

* Background: Motivation is to clarify what is UE behavior and TE assumptions in RX and BB tests
* Proposals:
	+ Option 1a: TE needs to detect all antenna connectors for ACK and NACK and any other expected response from UE
	+ Option 1b: TE needs to detect all declared TX antenna connectors for ACK and NACK and any other expected response from UE
	+ Option 2: UE declares which connector is primary TX connector from which ACK and NACK and any other expected response from UE is transmitted in all cases
	+ Option 2a: Per instructed as test mode, UE should keep its default connector (based on UE declaration) unchanged from which ACK and NACK and any other expected response from UE is transmitted in all test cases
	+ **Option 2b (new). UE declares which connectors will be active (both the primary TX connector and the other active Tx connector) per band under test.**
	+ Option 3: Regardless of the above options, it should be clarified only tested Tx connector is used as 1Tx transmission.
* Recommended WF
	+ Option 2b?
		- **Question**: Whether primary Tx connector need to be declared separately?
		- Based on option 2, as proposed by TE vendor from testability view of point;
		- Do not depend on the introduction of a Test mode
		- Seemingly simple and also adaptive to UE implementation

**Issue 1-1-3: UE behaviour under conformance testing**

* Background: Motivation is to guide how to test requirements that require power changes such as relative power control
* Proposals:
	+ Option 1a: UE will keep the tx diversity status unchanged in conformance testing.
	+ Option 1b: Test mode signalling is implemented to instruct UE to keep TX div status unchanged
	+ Option 2: TE will detect and sum for every power step and change in condition from all connector
* Recommended WF
	+ Option 1(a+b)?: UE will keep the tx diversity status unchanged in conformance testing, whether test mode signalling is implemented or not can be postpone with test procedure design in RAN5.
		- Option 1 receive majority support in last meeting.
		- Option 2 has testability issues that rejected by TE vendors;
		- Test mode is not defined in RAN4 requirements, thus may be postponed with test procedure design.

**Issue 1-1-4: Power splitting behaviour**

* Background: Motivation is to guide how to test requirements that require power changes such as relative power control
* Proposals:
	+ Option 1: Only allow equal power split between connectors
	+ Excludes 17+17+20 dBm implementations
	+ Excludes power control optimizations
	+ Option 1a: Per instructed as test mode, UE should keep equal power split between connectors in all cases.
	+ Option 2: Allow any power split between connectors
		- Question: Is power split ratio allowed to be changed during test?
* Recommended WF
	+ **Question 1:** What would be the impact for the requirements and testability with tentative equal power split restriction?
	+ **Question 2**: If option 2 is preferred, is power split ratio allowed to be changed during test?
		- Based on the discussion of this question, try to decide whether further discussion and/or restriction is needed or not.
		- The option preference can be provided with the discussion of this question.
		- TE vendors currently seems have no views on this issue.

**Issue 1-1-5: Whether 2 Tx MPR should be the same MPR requirement for TX Diversity and UL MIMO for the same power class.**

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

### Sub-topic 1-2: Signaling and others

*Sub-topic description*

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

**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD.**

Note: The intention is try to provide RAN5 with clear guidance what requirements and/or procedures would applied for TxD. Whether requirements could be reused for 1Tx/other 2Tx case can be discussed later.

* Proposals
	+ Option 1: Yes (TxD and 1Tx test requirements/procedures are somehow combined)
	+ Option 2: No. (TxD requirements/procedures are solely for TxD)
	+ Option 3: No need to discuss or define.
* Recommended WF
	+ TBA

**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled.**

* Proposals
	+ Option 1: Introduce some sort of signaling by UE
		- Option 1a. Use ModifiedMPRbehavior bits to signal additional relaxations;
		- Option 1b: Introducing a new (capability) signalling for TxD
		- Option 1c: Introducing a new power class (e.g. PC2.5) for TxD
	+ Option 2: Based on UE vendor declaration.
		- **Question**: Whether separate requirements (e.g.MPR) could be used based on this option,
			* Note: If this answer is affirmative, this could be a promising compromise。
	+ Option 3: Using existing signalling to indicate the 2Tx implementation capability.
* Recommended WF
	+ TBA

**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**

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

**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE.**

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

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**We are ok with keeping the current agreements. Option 2 proposes a receiver-specific calculation and may deviate from the ultimate origin of EVM definition, which allows for 5% throughput degradation.**Issue 1-1-2: Declaration for default TX connector**Option 1a. If allowing which connector active during testing, then testing only with the declared antenna connector does not represent the practical use of the transparent TxD, thus the performance with transparent TxD cannot be guaranteed in real networks.**Issue 1-1-3: UE behaviour under conformance testing**Option 1a since it requires the least efforts.**Issue 1-1-4: Power splitting behaviour**We support Option 1 with equal power splitting. Option 2 may require additional core requirements in order to guarantee the performance, and more testing efforts as well.**Issue 1-1-5: Whether 2 Tx MPR should be the same MPR requirement for TX Diversity and UL MIMO for the same power class.**Yes, it looks more reasonable.Sub topic 1-2:**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD.**Yes**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled.**None of the option. Firstly, we understand that the need to distinguish 1Tx and transparent TxD is mostly for testing purpose only, not in real fields. Besides the testing aspects, transparent TxD should provide equality to 1Tx so network scheduler does not need to know whether or not a UE works in transparent TxD mode. So if some sort of UE signalling is introduced, its purpose is just for facilitating testing.**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**Yes (Option 1) , only related to CDD, nothing else. **Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE.**Yes (Option 1). CDD is a convenient way to avoid cancellation.….Others: |
| Intel | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**Option 1**Issue 1-1-2: Declaration for default TX connector**If TE has only one test port for conducted test, option 3 is followed. If TE has two test ports supporting MIMO operation, option 1b is followed**Issue 1-1-3: UE behaviour under conformance testing**Tentative WF Option 1a + 1b can be considered under the condition that signaling in 1b is optional**Issue 1-1-4: Power splitting behavior**Option 1Sub topic 1-2:**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD**.Option 2**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Option 1a**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**Option 2**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE**.Option 1. Performance needs to be guaranteed to some extents. ….Others: |
| LGE | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**Prefer option 1**Issue 1-1-2: Declaration for default TX connector**Agree with Intel. But baseline for test configuration is 1b.**Issue 1-1-3: UE behaviour under conformance testing**Prefer option 1a or combination with option 1a + 1b according to test procedure by TE supporting.**Issue 1-1-4: Power splitting behavior**Prefer option 1**Issue 1-1-5: Whether 2 Tx MPR should be the same MPR requirement for TX Diversity and UL MIMO for the same power class**Prefer option 1Sub topic 1-2:**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD**.Prefer option 2. No need to define specific requirements for TxD. Only need to decide how to determine the test condition in RAN5.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Prefer option 1a with ModifiedMPRbehavior bits**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**Prefer option 2**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE**.Option 2. No need to define explicit RF requirements. RAN4 can verify the TAE+CDD related requirements by demodulation requirements. |
| Qualcomm | Sub topic 1-1: Issue 1-1-2: Prefer option 1b but can compromise to others too to get this item resolved. Do not understand the meaning of option 3.Issue 1-1-3: Option 2 is our preference but can compromise to others if agreement is possibleIssue 1-1-4: Option 2. Equal split is infeasible since then we need to define limits whats is considered “equal”. On the moderator question, if we resolve issue 1-1-3, it answer to this q too.Issue 1-1-5: Option 1 seem feasible but since TxD MPR will be applicable to UE configured for single antenna port, there needs to be a way to distinguish when UE complies with the TxD MPR and then UE complies with the general MPR. Also, AMPR needs to be handled. Sub topic 1-2:Issue 1-2-1: TxD may reuse requirements written for general case, but the parts that are different for txd need to be targeted for txd UE’s alone. For example, the EVM or ACLR we have already agreed. And the fact that TE needs to measure power and emissions from two connectors. Note that txd is not same as general UE nor UL MIMO UE. It is a UE with 2 tx antenna connectors when it is configured for 1 SRS antenna ports. So neither option 1 or 2 is perfectly feasible alone but normal way to write requirements such as for v2x where there are separate sections for the feature but some of them point to general requirements is feasible way forward. Issue 1-2-2: Prefer Option 1b since it would be clear and information available to all, TE and networkIssue 1-2-3: Option 1. TxD requirements need to be distinguished somehow. Separate section is preferred but if a capability is defined, then also we can denote all the requirements by sentence “UE declaring support for *TxD capability*” but in practice both, separate section and capability is preferred. Issue 1-2-4: We think there is no need for dedicated “CDD requirements” but requirement need to accommodate CDD. As in our paper, if we test per connector and combine results in post processing, CDD is accommodated.  |
| Lenovo, Motorola Mobility | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**Our preference is Option 2. The benefit of Option 2 is that the *per antenna EVM can be relaxed* for transmit diversity.For Option 1, how does this EVM definition relate to link quality (e.g., link SNR) for ***any*** gNB receiver type (i.e., not the unbiased linear MMSE)? This EVM definition is more appropriate if the signals are summed and transmitted from a single antenna.If there is no identifiable relationship between this EVM and link SNR, then *what is the basis of the EVM requirement?* Without this, *how do you know you should use the same EVM requiremen*t for *TxD* (for a given modulation type) as for single antenna transmission?For single antenna transmission, the relationship between transmit EVM and link SNR (with only transmitter impairments) is known, even if not specified, and it is given by $EVM=100∙\sqrt{{1}/{SNR}}$.Additionally, the single antenna EVM definition requires the use of a zero-forcing equalizer in the test equipment, so the receiver type *is specified*.Sub topic 1-2:**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD**.Option 2**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Option 1b**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**Option 2**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE**.Option 1. Some upper limit on TAE+CDD should be specified due to potential impact on gNB channel estimation if delay is too large. |

### CRs/TPs comments collection

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

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2015341**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015341.zip)(OPPO) CR on TxD requirements | Company A |
| Company B |
| Intel: wait for the conclusions to the open issues |
| [**R4-2014713**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014713.zip)(Qualcomm) Introduction of Tx diversity into 38101-1 | Company A |
| Company B |
| Intel: wait for the conclusions to the open issues |
| [**R4-2016478**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016478.zip)(Huawei) CR for TS 38.101-1 Tx diversity requirements | Company A |
| Company B |
| Intel: Intel: wait for the conclusions to the open issuesIt is not clear that if the following sentence includes transparent TxD. In our understanding, it should not since transparent TxD should have one-port SRS“Unless otherwise stated, if UE indicates IE *maxNumberSRS-Ports-PerResource* with n2, transmitter requirements for dual Tx shall apply.” |

## Summary for 1st round

### Open issues

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

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

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

|  |  |
| --- | --- |
| **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)

## 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*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Power Class related req.

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| *R4-20xxxxx* | *Company A* | *Proposal 1:**Observation 1:* |
| [**R4-2015322**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015322.zip) | Vivo | Remaining issues in Power class & UL MIMO related requirments**Proposal 1**: Prefer to allow fall back to PC3 for 1-port transmission for PC2 capable UE for 2-layer transmission. If no consensus still cannot be reached, prefer to stop the discussion and keep the spec as it is.**Proposal 2**: Continue discussion to find new solution. If no consensus can be reached, keep the current wording.**Proposal 3**: It is proposed to use R4-2008046 as a baseline and update R15 UL MIMO emission requirements. |
| [**R4-2015976**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015976.zip) | Ericsson | PHR and Pcmax verification for NR PC2 devices supporting NR PC3 for EN-DC**Proposal 1: remove the NR power-capability ambiguity in 38.101.3.****Proposal 2: for Rel-15, verify that the Pcmax and PHR are reported correctly according to a declared NR power capability for NSA.** **Proposal 3: for Rel-15, the Pcmax for NR is modified according to the declared NR power capability for NSA so that the PHR becomes correct.****Proposal 4: the parameters PPowerClass and PPowerClass, EN-DC are identical to the UE signalled power classes (cannot be anything else).****Proposal 5: answer RAN5 in line with the above for NSA (Rel-15).**  |
| [**R4-2015977**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015977.zip) | Ericsson | Correction of Pcmax for an NR PC2 UE supporting NR PC3 for EN-DCClause 6.2B.4.1.1 and 6.2B.4.1.3: the PPowerClass,NR modified by PPowerClass,NR = 3 dB for intra-band and inter-band EN-DC when the UE indicates PC2 by *UE-NR-Capability* but only complies with PC3 for the NR part of the EN-DC band combination configured |
| [**R4-2016479**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016479.zip) | Huawei, HiSilicon | Discussion and draft reply LS on EN-DC power class***Observation 1: Introduce the Rel-16 defined power class UE capability for Rel-15 UE will not cause the backward compatibility issue but to improve the network performance if the network is updated to support such UE capability.******Observation 2: Indication of UE implementation, e.g. 2x23dBm, 26+26dBm or 26+23dBm together with SA power class is an indirect way to indicate the possible power class in MR-DC, which is not as flexible as a direct power class for NR and cannot reflect the UE implementation evolution capability.******Observation 3: Without a power class to indicate the difference between SA and NSA for the NR band, it’s ambiguous which power class would be used for*** *PCMAX\_L,f,c,,NR****, either the value is determined by UE declaration during the measurement or to use the lower possible power class to decide the lower bound of the configured power.***  |
| [**R4-2016482**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016482.zip) | Huawei, HiSilicon | As clarified in the specifcation if UE indicates IE maxNumberSRS-Ports-PerResource = n2 in NR standalone operation mode, the said UE shall meet the NR requirements for either power class 2 or power class 3 in EN-DC within FR1 if UE indicates IE maxNumberSRS-Ports-PerResource = n1 for EN-DC on this NR band. However, there is no UE capabiliity to indicate the power class if it is different from that of SA mode. Since the requirements should be implementation agnostic, the lower bound of PCMAX\_L,f,*c,,NR* can only take that for PC3. |

## 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

*Sub-topic description:*

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

**Issue 2-1-1: Whether and how Rel-15 NSA power class should be revised.**

* Proposals
	+ Option 1: The Pcmax for NR is modified according to the declared NR power capability for NSA so that the PHR becomes correct. (Based on R4-2015976 & R4-2015977)
	+ Option 2: Introduce the Rel-16 defined power class UE capability for Rel-15, and Indication of UE implementation by declaration. (Based on R4-2016479 observation 1)
	+ Option 3: The Pcmax for NR is modified to use the lower possible power class to decide the lower bound of the configured power. (Based on R4-2016479 observation 3 & R4-2016482)
	+ Option 4: Any other combined/refined revision.
	+ Option 5: Further revision not needed.
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | Sub topic 2-1: **Issue 2-1-1: Whether and how Rel-15 NSA power class should be revised.**Option 1 which may have minimum specs impact.Sub topic 2-2:….Others: |
| Intel | Sub topic 2-1: Issue 2-1-1: Whether and how Rel-15 NSA power class should be revised.Option 1. But we have different view on proposal 4 in R4-2015976. We think parameter PPowerClass and PPowerClass, EN-DC are different. PPowerClass is for NR RAT in PCMAX\_L,f,c,NR, while PPowerClass, EN-DC is per UE. |
| Qualcomm | This introduces a non-backwards compatible change in to rel-15 power control and we see this for the first time now so therefore **we prefer option 5** and no changes at this time. We can come back in the next meeting if TxD requirements are agreed and are applicable from Rel-15. Clarification is that we do not see this power class is ambiguous only if UE implements TxD to realise PC2 in a certain band. Otherwise UE would have 26 dBm PA and can meet power class regardless of the 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.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| [**R4-2015977**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015977.zip)(Ericsson) Correction of Pcmax for an NR PC2 UE supporting NR PC3 for EN-DC | Company A |
| Company B |
|  |
| [**R4-2016482**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016482.zip)(Huawei) CR for TS 38.101-3: correction of power class for EN-DC | Company A |
| Company B |
| Intel: UE behavior is not right. This will force NR always to be PC3 even NR can be PC2 in EN-DC. |

## Summary for 1st round

### Open issues

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

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

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 |  |  |

### 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)

## 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*

|  |  |
| --- | --- |
| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |