**3GPP TSG-RAN WG4 Meeting # 97-e R4-2016959**

**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

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| **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 , then , where and with P1, P2 and and defined above.**Proposal 1**: Take 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 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.***
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| [**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 bywhere is given byandAlternatively, the EVM can be calculated as where **Proposal 2:** If the test equipment cannot measure the covariance of transmitter noise at the two antenna connectors, then is measured as |
| [**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. |

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| [**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.**
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## 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
	+ 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

where is given by

and

Alternatively, the EVM can be calculated as

where

If the test equipment cannot measure the covariance of transmitter noise at the two antenna connectors, then is measured as

* 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

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| --- | --- |
| **Company** | **Comments** |
| ZTE | 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 .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. |
| Anritsu | Sub topic 1-1: **Issue 1-1-2: Declaration for default TX connector**Prefer Option 2b. As mentioned in R4-2014686, under the situation that the total number of antenna connector in a UE is unknown, to connect cables between all the possible Tx antenna connectors in a UE and test equipment is not a practical way to test, and there is a concern of increase with test time depending on the number of antennas to measure sequentially due to a limited number of measurement antenna port. To answer to the question in the summary from moderator, we suppose that whether primary Tx connector need to be declared separately or not can be further discussed in RAN5.**Issue 1-1-3: UE behaviour under conformance testing**Prefer Option 1(a+b) or 1a as the second choice on condition that we do not need to test both UE characteristics with TxD and without TxD. **Issue 1-1-4: Power splitting behavior**No strong view on the choice of option 1 or 2. For Question 2, power split ratio shall not be changed since the measurement results are derived by sum of powers or derived by the ratio of power between antenna connectors when measuring EVM. Sub topic 1-2:**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.* + - 1. Prefer Option 1b but can compromise as far as it is signalled.
 |
| OPPO | **Issue 1-1-2: Declaration for default TX connector**Option 1b and Option 2b, both are same since one is from TE perspective the other is from UE perspective. With many times discussion, it should be clear that UE connector under test is unchanged. Then TE needs to detect the ACK/NACK from the activated antenna connector for the testing. There is nothing new. For example, UE declares antenna connector 1 and two will be activated then tests are at these connectors. We do not understand what the “default Tx connector” means and the meaning of defining the default connector since it is clear based on UE declaration.**Issue 1-1-3: UE behaviour under conformance testing**Option 1a, the testing specific configurations like test mode signalling is out of RAN4 scope, should be decided by RAN5, there is no point of discussing it here.**Issue 1-1-4: Power splitting behaviour**Power splitting behaviour is something within UE implementation scope, not understand why we discuss it here. What matters to RAN4 is the requirement definition condition, like equal power between connectors assumption can be used as MPR in CA discussions.**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.** Option 1, Yes.**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD.**For clarification the meaning of “without transparent TxD” is it still TxD or it means single antenna Tx?If it means single antenna Tx, then our understanding is Option 2. Not understand how a TxD specific requirements can be applied to single antenna Tx UE.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled.**Option 1a or Option 2.**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**No strong view as long as requirements application is clear.**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE.**Option 2. |
| Huawei, HiSilicon | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**Option 1. In real application, it’s not necessary to force the UE split the power equally, thus the EVM should consider the power weighting factor in the formula. **Issue 1-1-2: Declaration for default TX connector**Option 1b.**Issue 1-1-3: UE behaviour under conformance testing**Option 2. No need to introduce a test mode which is different from the real application and it also introduces unnecessary development workload.**Issue 1-1-4: Power splitting behavior**Option 2. Split ratio is not necessary. Artificial split ratio is identical to a test mode, which may not reflect the real implementation. **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**Option 1.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 1. We need to distinguish the UE capability/declaration and the operation configuration. There is no way for network to configure the UE to operate at TxD mode, otherwise, similar to UL MIMO, huge RAN1/RAN2 spec impact are foreseeable. Requirements should be defined for UE supporting 2 Tx which can be indicated by UE capability or can be declared during the test. However, even for 2Tx implementation, the UE may fall back to 1Tx transmission, e.g. at the low output power. Thus the requirements for TxD and 1Tx are somehow combined under the 2Tx capability. **Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Option 1a with ModifiedMPRbehavior bits or Option 2. ModifiedMPRbehavior bit can be used to distinguish the applicability of 1T or 2T MPR requirement. It is also fine for us to declare whether to use 2Tx requirements during the test.**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 2. No need to define explicit RF requirements.  |
| Skyworks | We need to agree which implementation cases we will develop TxDiv Requirement for:PC1.5 is doneBut two PC2 options: * PC2+PC2 (can be derived from PC1.5)
* PC3+PC3 (to be developed but can also derive P3 based on PC3+PC3 for UL MIMO/TxDiv)
* This has also a consequence on which power split we allow as non equal power split have a different RIMD behavior

Issue 1-1-3: UE behavior under conformance testing: TxDiv status should not change during test thus it may possible to allow both option 1a and 1bIssue 1-1-4: Power splitting behavior* First for 2 antennas the power splitting should be equal power with some tolerance
* Second for antenna nuber >2 some non-equal split solution may be allowed but the power split must stay unchanged (with some tolerance) with power control in the network and during test. Not sure this is needed for R15/16 and could be looked at for R17
* If UE also supports UL MIMO which calls for equal power split the UE should use the same for TxDiv

Issue 1-1-5: This is already the case for PC1.5 MPR and since we may many cases for nTX and PCX implementations MPR table for 2Tx should be the same for TxDiv and UL MIMO and thus may be moved into the UL MIMO section wit note for applicability to TxDivIssue 1-2-1: we should only instruct RAN5 how to test TxDiv for the requirements that requires a different test method than 1TxIssue 1-2-2: Option 1c is preffered as it may also allow to clarify implementation and which MPR to apply. For example PC2 based on PC3+PC3 (PCX) or PC2+PC2 (PC2). This can also apply to UL MIMO. Rather than a “full” PC maybe some PC2.x is used (x=a,b)Issue 1-2-3: If signaling (PC or other) is used a separate section is OK but it could still point at UL MIMO MPR/AMPR section if tables are re-usedIssue 1-2-4: The requirement is not needed if the test procedure prevents any cancellation issue under CDD (this is anyhow also an issue for UL MIMO). How to verify that some TxDiv technique is implemented still needs consideration. |
| Rohde & Schwarz | **Issue 1-1-1: EVM for Transparent TxD**Agree with Option 1. Like we said in the past meetings, coherent receivers in the TE are currently not an option and require further RAN4 discussions and investigations.**Issue 1-1-2: Declaration for default TX connector**From TE point of view Options 2, 2a or 2b would be preferable. We understand test mode as in Option 2a is not preferred so hopefully Option 2b proposed by Anritsu can be a compromise.**Issue 1-1-3: UE behaviour under conformance testing**Based on the agreements from last meeting, our understanding is that power and emissions need to be measured on each connector and then summed up afterwards. However, in some TC when there are big power steps this can lead to inaccuracies and issues in the testing, therefore it would be preferable if the UE would keep its diversity status unchanged (Option 1a)**Issue 1-1-4: Power splitting behaviour**No strong view on either Option. |
| Xiaomi | **Issue 1-1-1: EVM for Transparent TxD**Prefer option 1, it seems that 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 test method proposed in option 2**Issue 1-1-2: Declaration for default TX connector**Basically share the same view as intel. If TE has only one test port for conducted testing, only one Tx antenna connector can be used as Tx feedback since if switching Tx antenna connector is used, some feedback would be missed.**Issue 1-1-3: UE behaviour under conformance testing**Option 1a or 1b**Issue 1-1-4: Power splitting behavior**No strong view on this proposal. But if equal splitting can simplify the test during testing, we prefer option 1a or 1b**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.** Option 1: Yes.**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 1. Some of requirement can be as general for TxD, and some TxD specific requirement may need to be define separately.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Prefer option 1a, but can also accept option 1b.**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**Option 2 |
| Nokia | **Issue 1-1-3: UE behaviour under conformance testing**Option 1b or Recommended WFRegarding Option 1a, it is not sure how UE will keep TxD status unchanged and how UE is instructed to enter TxD status.**Issue 1-1-4: Power splitting behavior**Clarification is needed such as “where power is equally split”.Suppose RF front end losses after respective PAs to antenna connectors are different.One is 4 dB and the other is 6 dB. If “equal power split between connectors” is assumed, it seems the power should be 20dBm + 20dBm at each of the connectors. That means after the PAs, the powers should be 24dBm + 26dBm. These are not equal at least right after the PAs.If equal power split means equal power right after PAs such that 24dBm each, then, we see 20dBm + 18 dBm at the antenna connectors.Not sure how we can confirm “equal split” whichever is selected but, it is beneficial to have common understanding of the definition of power split and expected requirements.**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.** It depends on how close required MPRs for TxD and UL MIMO is. Thus, better to compare required MPR for TxD and UL MIMO first.**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.Challenging to understand the intention. Some of written requirements for 1Tx and TxD may be the same but 1Tx and TxD should be separately tested. We cannot say that UE passed all the requirements in TxD status can pass all the requirements in 1Tx status and vice versa.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Whichever 1a or 1b is selected, in the end, declaration of power class in TxD status is needed. Otherwise, pass or fail cannot be decided. Thus, if we go with signaling, Option 1c is natual.Or we need to set up a clear rule such that TxD power class follows UL MIMO etc… |
| vivo | Sub topic 1-1: **Issue 1-1-1: EVM for Transparent TxD**Slightly prefer option 1, both from simplicity and majority view.**Issue 1-1-2: Declaration for default TX connector**Option 2b +option 1b. We suppose with the UE declaration of option 2b, the option 1b can be supported by TE. Just as oppo’s comments, that these two options can be regarded as behavior description from TE side and UE side. If is proposed to align the understanding that these two options are not contradicting, preferably from TE vendor.**Issue 1-1-3: UE behaviour under conformance testing**It seems that option 1a is not clear to be achieved and 1b is one way to satisfy it. We do not have strong view on this one, it is suggested to postpone this test mode related issue until all other issues have been solved. **Issue 1-1-4: Power splitting behavior**Not fully clear the meaning of equal power split, and there do exists testability / UE implementation issues.it is suggested to postpone the discussion of this test mode related issue until all other issues have been solved. **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**Option 1 should be fine. Share with Qualcomm’s view that care has to be taken to some how distinguish the TxD applicability case with single Tx case.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**.This question may not be well drafted and it seems that people have different understanding for this question. The intention is by providing test requirements applicability, to have some guidance for how testing should be done, e.g. either clearly differentiate TxD mode and verification using a specific procedure and requirements, or do not make special differentiation and even not require a constant TxD mode. This may also closely related to UE behavior, and how testing would be done. May be a preference based on this further clarification would be helpful. However, this is somehow test specific, and still may be not being able to be fully answered in RAN4.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**.Option 2 is first choice. Option 1a is also acceptable.We think this signaling is not that really necessary beside testing purpose, as long as MPR could correctly applied and correct Pcmax/PHR could be obtained. UE declaration can solve the current problem of requirements applicability and is a minimum change for the spec.**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**No strong view. Share Anritsu’s view that as long as applicability is clear.**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE**.Option 2. It is problematic both for the need and the testability. |
| CMCC | Sub topic 1-1: **Issue 1-1-3: UE behaviour under conformance testing**Option 2. **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**Option 1.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 1.  |
| Samsung | Sub topic 1-1: Issue 1-1-1: EVM for Transparent TxDPrefer option 2, but aside from core requirement (we can define per-port definition for EVM), and we would like to know more how TE vendors will perform test if per-port definition is adopted. Issue 1-1-2: Declaration for default TX connectorOption 2 and 2a, and need more clarification for 2b for primary TX port. Issue 1-1-3: UE behaviour under conformance testingPrefer option 1b.Issue 1-1-4: Power splitting behaviorPrefer option 1aIssue 1-1-5: Whether 2 Tx MPR should be the same MPR requirement for TX Diversity and UL MIMO for the same power classOption 1 is 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.Prefer option 2. Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled.Prefer option 1a with ModifiedMPRbehavior bitsIssue 1-2-3: Whether dedicated section is needed for TxD requirements?Prefer option 2Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE.Option 2. We observed the difficulty to define explicit RF requirements for TAE+CDD. |
| Ericsson | General: our main concern with transparent TxD is signal cancelation of correlated inputs and uncertain power capability. RAN1 should be involved in S-CDD discussions.**Sub-topic 1-1****Issue 1-1-1: EVM for Transparent TxD**A tough one. Option 2 represents a case with the TE emulating an gNB single-layer receiver that may give a more representative metric in terms of the expected UL demodulation performance. The noise in an equivalent (linear) model of the non-linear transmitter with two connectors is not uncorrelated (nor Gaussian). This noise covariance would be captured by the TE receiver, which is attractive. Now, if this receiver cannot estimate this noise covariance, an upper bound of the port EVM equal to the minimum of the connector EVM is used. Given this, then Option 1 may be more attractive if support of the MIMO receiver in the TE is uncertain.Yet another alternative is to require that maximum of the connector EVM meet the minimum requirement but may be pose an unnecessarily stringent UE requirement.**Issue 1-1-2: Declaration for default TX connector**Option 2b appears attractive and liked by test vendors.**Issue 1-1-3: UE behaviour under conformance testing**The behavior should represent operation in the field as much as possible, but we recognize that Option 2 implies difficulties in testing. **Issue 1-1-4: Power splitting behaviour**Option 2 not restricting implementations, while recognizing that the behavior could be different within the power range (including disabling chains).**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, RAN4 specification should state where there is a difference in requirements for UEs implemented with TxD (two transmit connectors)**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled**Option 1b (and possibly 1c) the most attractive given the concerns with signal cancellation and actual power capability in the field. Not clear what the gNB is supposed to do with a *modifiedMPRbehavior* other than for awareness that the single port performance may not be up to the advertised power class. Declaration can only be used if the UE complies with the advertised power capabilities.**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE**This is a difficult one, RAN4 should involve RAN1. The results in R4-2014849 show S-CDD performance but the assumption on the time alignment error and antenna correlation is unclear. While recognising the virtue of transparent S-CDD for avoiding signal cancellation, the performance for small bandwidths (few RB at cell edge) is uncertain and will depend on the allocation within the bandwidth.RAN4 should not set any requirements on the (transparent) S-CDD, consult with RAN1 on the issue of S-CDD and signal cancellation. |
| Apple | **Issue 1-1-1: EVM for Transparent TxD**Option 1**Issue 1-1-3: UE behaviour under conformance testing**Option 1b: There is no fundamental need for the UE to equally split the power between the Tx chains. If the TE might have issues with strong unequal power split a test mode signalling could be used to indicate that the UE has to apply equal power split on all Tx chains during the test.**Issue 1-1-4: Power splitting behaviour**Option 1a: Similar reasoning as Issue 1-1-3**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.**Option1: TxD can use the same MPR as UL-MIMO.**Issue 1-2-1: The applicability of the specific requirement (if any, e.g. MPR) for transparent TxD to UE implementation without transparent TxD.** Testing procedure for UEs with TxD should be different than for single antenna transmission. While TxD has its own requirement it also shares some requirements with single antenna transmission.**Issue 1-2-2: Whether and how a UE implementation use transparent TxD should be signalled.**Option1c: We have strong view that a UE has to signal usage of TxD. The UE with TxD is not fully transparent as it features different behaviour and performance than single Tx and requires additional power backoff. A new power class for TxD would provide clear signalling for the network in all cases (e.g. also UL MIMO). With PC1.5 there exists a 29dBm power class defined by dual Tx architecture with PC2+PC2 assumption. Similar, a new power class should be defined for 26dBm with PC3+PC3 assumption and even including other configurations.**Issue 1-2-3: Whether dedicated section is needed for TxD requirements?**We would be fine with having a separate section for TxD.**Issue 1-2-4: Whether CDD related requirements, e.g. TAE+CDD, is need to be specified for transparent TxD UE.**Option1: During last RAN4 meeting a paper from Intel showed that TAE+CDD could impact UL performance. Therefore, agreeing on a requirement seems to be reasonable. |

### 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 | Qualcomm: We would prefer to add a distinguishing capability for txd UE’s so we prefer to have txd requirement clearly separated. Not ok to ahgree this CR.  |
| Ericsson: not agreed, open issues remain. |
| 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 | Qualcomm: It seems groups converges to the capability for TxD so this would need to be added. If moderator agrees, we can revise this and add a tentative TxD capability name to this CR.  |
| Ericsson: not agreed, open issues remaining. |
| 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 | Qualcomm: This CR precludes UE’s and bands with one logical port from implementing TxD which is then violating with the RAN1 LS R4-2013040. It is mildly confusing that proponent refers to a Ran1 LS to justify a Ran4 CR but then conflicts with the LS text in the CR. Could Huawei kindly explain why the first case in LS was excluded by this CR?Also, this CR implements two MPR tables in to the general section, one labeled “one Tx” and the other “dual Tx”. How does TE or network know which UE is in question? It seems defining a new capability is almost unavoidable.Furthermore, power class 3 seems to be also excluded against agreement we have to include it for NR-U. And only MPR is defined for “dual Tx”. So e.g. n41 is excluded from “dual Tx”. Was this the intention? Could proponent clarify how to handle A-MPR and maybe share simulation assumptions so the A-MPR work can be started. Our understanding power class ambiguity concerns EN-DC 41+n41 especially and the reason for ambiguity is TxD implementation and lack of 26 dBm PA for n41 but now n41 is excluded from TxD. Seems too many unclear items to agree this CR and there are better CR’s proposed.  |
| Ericsson: not agreed, open issues remaining. |
| 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.”Huawei, HiSilicon:To Intel’s comments on TxD only with one-port SRS, RAN4 has received LS from RAN1 in R1-2007245, which confirms that both single port and two-port SRS are feasible implementation for TxD.  |

## 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#1-1** | **Issue 1-1-1: Summing the power and emissions*** + Option 1: As in agreed WF R4-2008465
	+ Option 2: As has been provided in R4-2016288:

Majority companies support option 1, while in GTW session, there is also supportive argument for option 2, which could be better reflection of actual receiver. Though some company have a preference, it is not that strong.Option 1: ZTE, Intel, LGE, Huawei, R&S, Xiaomi, vivo, [Ericsson], AppleOption 2: Motorola Mobility, Samsung, *Tentative agreements:**No conclusion in GTW session.* *Candidate options:**Recommendations for 2nd round:**Continue discussion and try to clarify any remaining technical problems or questions based on what had been discussed in GTW.***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.

Most companies prefer option 1b and/or option 2b, with discussion, it is found that these two options are not contradicting each other and are generally fine for both TE and UE. Agreement reached in GTW session.*Agreements in GTW:**The basic idea of [option 1b+option 2b] is accepted and wording were further refined as following as agreement in GTW session. The primary Tx connector** + *UE declares which connectors will be active per band under test. TE needs to detect ACK and NACK and any other expected response from UE from all declared TX antenna connectors.*

*Candidate options:**Recommendations for 2nd round:**None. Already concluded.***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

Most companies prefer option 1a and/or option 1b. It is generally accepted that option 1b is one implementation of option 1a, and there is no other implementation identified yet. However, the test mode is still controversial and some companies are not like this idea for extra work and not useful in acutal field. There is also some argument that test specific discussion could be done in RAN5. In addition, there are still a few companies chose option2, however, this option 2 may have testability issues.This topic was not discussed in the GTW session.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Try to narrow down options. See if option 2 which is least supported could still be kept or not.***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?

Views are divided and slight majority prefer option 1 or 1a. Many companies do not have strong views on this one,Option 1 or 1a: ZTE, Intel, LGE, [Skyworks], Samsung, AppleOption 2: Qualcomm, Huawei, Ericsson,No strong view/No need discuss: Anritsu, OPPO, R&S, Xiaomi,Since this is controversial and also related to whether introducing test mode or not, the discussion of this one is closely related to previous issue.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Continue discuss this question, also considering previous issue together with the test mode.***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.

Almost all companies chose option 1 and quite well aligned. Agreements reached in GTW session,*Agreements in GTW:**Option 1.**Recommendations for 2nd round:**None. Already concluded.**Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |
| **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.**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.

This question may not be well drafted and it seems that people have different understanding for this question. Companies are still quite divergent on the understanding on how requirments would be defined and how the test should be done.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Change the discussion question to what was drafted for previous WF.***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.

This is one of the most basic and controversial issue among all the remaining requirements. All options have strong supporters.It is proposed by some companies that for the differentiation of test requirements, the UE declaration is enough. However, this is not confirmed yet.Another basic question was arise in during the discussion and GTW session, that what is the signaling is for testing purpose / differentiation of requirements, or used by the network in the field. Among companies chose Option 1b/1c, it is generally because want the network to know the detailed structure and the actual working mode of the UE. This is quite different from some other companies’s understanding.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Discuss some more basic topics, such as: a) Whether UE declaration is sufficient for differentiation of test requirements; b) Whether UE TxD structure/implementation should be reported to network or not;***Issue 1-2-3: Whether dedicated section is needed for TxD requirements?*** Proposals
	+ Option 1: Yes
	+ Option 2: No.

Not discussed in GTW. Basic situation is :Option 1: ZTE, Qualcomm, Skyworks, AppleOption 2: LGE, Intel, Motorola, Huawei, Xiaomi, Samsung,No strong view: OPPO, vivo*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Continue discuss this with previous Issue 1-2-1***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.

Views still divided in this issue. Though majority companies prefer option 2, there are still several companies prefer option 1. People’s position is basically stable compared to last meeting.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:*Postpone the discussion on this topic. Since no progress is foreseen in this meeting and not that high prioritized. |

*Recommendations on WF/LS assignment*

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| --- | --- | --- |
|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | Way Forward on NR TxD & Power Class | vivo |

### 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”* |
| [**R4-2015341**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015341.zip) | *Returned to* |
| [**R4-2014713**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2014713.zip) | *Returned to* |
| [**R4-2016478**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016478.zip) | *Returned to* |

## Discussion on 2nd round (if applicable)

### Open issues

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|  | **Status summary**  |
| **Sub-topic#1-1** | **Issue 1-1-1: EVM for Transparent TxD** * + Option 1: As in agreed WF R4-2008465
	+ Option 2: As has been provided in R4-2016288:

Majority companies support option 1, while in GTW session, there is also supportive argument for option 2, which could be better reflection of actual receiver. Though some company have a preference, it is not that strong.**Option 1**: ZTE, Intel, LGE, Huawei, R&S, Xiaomi, vivo, [Ericsson], AppleOption 2: Motorola Mobility, Samsung, *No conclusion in first GTW session.* *[Moderator suggestion]:**Continue discussion and try to clarify any remaining technical problems or questions based on what had been discussed in first GTW.**From the proponent of option 2, there is possible two following differentiation of option2:* ***Option 2a****: Use the unbiased linear MMSE to define and measure the EVM.**where* *With the picture below as description:*cid:image007.png@01D6B494.60D8F8C0***Option 2b:****This simply use minimum value between EVM1 and EVM2, with the understanding that EVMport for the linear unbiased MMSE receiver will less than or equal to this value.*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 1  | Option 2 cannot reflect real receiver performance since receiver noise is not considered. An example is EVM1 = 1%, EVM2= 8%, but P1 (Tx power associated with EVM1) is only 1dBm and P2 = 25.99dBm. Apparently EVM1 is much better. When receiver noise is as high as received signal from P1, then P1 signal is with 0dB SNR, while P2 signal still has ~8% EVM at same noise level (assume same channel response). So receiver signal quality is dominated by P2, not P1. Option 2 cannot used as EVM criterion unless we have certain power split assumption, for example, equal power split.To: Lenovo, Motorola Mobility: The criterion is the evaluate Tx EVM, it also needs to reflect true receiver performance as much as possible. In our example, we don’t see the connection between them in Option 2.  |
| Lenovo, Motorola Mobility | Option 2a or 2b | To Intel: Typically, receiver noise is not included in the definition of transmitter EVM. Transmitter EVM is used to set the lower bound on link performance due to transmitter noise. Is receiver noise included in the definition of EVM for the single antenna transmitter?The formula in Option 2 applies in the high SNR domain for two receive antennas and is correct whenever the receiver noise is negligible relative to the transmitter noise and for any propagation channel **H** thatis invertible. For Option 2, the channel includes the transmitter powers, the propagation channel and the UE and gNB antenna gains.However, if the desire is to include real receiver noise in the definition of transmit EVM, then it is surely also necessary to include the real propagation channel and the real antenna gains (both UE and gNB) that lie between the UE and the gNB as well. These are completely unknown, so how is this reflected in the argument above? For a single receive antenna, what is the argument if the channel is [1 0.1]? For two receive antennas what is the argument if the channel israther than the identity matrix? In general, the EVM definition should be completely independent of the channel **H.**In order for the EVM definition in Option 1 to be correct, it must be that EVM = 100/sqrt(SNR), or equivalently, it must be that the link SNR is given byWe have been trying to figure out when this condition is met (since no derivation was ever given for Option 1), and it seems that **all of the following conditions are required in order for Option 1 to be correct**1. A single receive antenna is used at the gNB
2. The transmitter noise ***must be uncorrelated*** so that it adds in power
3. The composite channel (Tx powers, UE antenna gains, propagation channel) **must all combine to yield an effective channel which is either [1 j] or [1 -j]**
4. No receiver noise

Condition (iii) is needed so that the desired signals add in power and do not add either constructively or cancel*. So,* ***if all of four of these conditions are met,******then the formula in Option 1 is correct***. Otherwise Option 1 is **incorrect**.Now let’s consider Options 2a and 2b.In our contribution from the last meeting R4-2011519, we showed that in the absence of receiver noise (equivalently high receiver SNR relative to the transmitter noise) the EVM definition using a linear unbiased MMSE receiver **is *independent of the channel between the transmitter and receiver*** (assuming two receiver antennas and invertible channel **H**) and thus is also independent of the difference in the transmitted power on the two antennas. Thus, Option 2 is correct for1. Two receive antennas
2. Any transmit powers
3. Any correlation of the transmitter noise
4. Any invertible propagation channel **H**
5. No receiver noise

Since Option 2 is correct for any invertible channel **H** and any noise correlation , we think Option 2 should be preferred. |
| Rohde & Schwarz | Option 1 or Option 2b | From TE point of view, as we have already explained in first round and in the GTW session, MMSE receiver requires more in depth discussions and definitions in the spec, as well as further analysis.So we suggest to keep the EVM measurement per connector as it is defined in the current 38.101/38.521-1 and then apply some “post processing” to the values to achieve some meaningful results for TxD. From TE point of view, therefore Option 1 and 2b can be acceptable. |
| Ericsson | Prefer Option 1 or same as for the DL (BS with multiple antenna connectors) in the absence of a TE reference receiver | Still a tough one. If the TE implements the ZF reference receiver we could accept Option 2a, the background to the EVM requirements would be known. However, if the TE does not implement the ZF reference receiver, then the upper bound in Option 2b may be too relaxed (to be considered further) noting that the gNB may use a different implementation. In the latter case we could consider the standard DL definition with antenna connectors availablein the absence of a TE implementation of a reference receiver.Option 1 is less attractive, but preferable to Option 2b.We note that a reference receiver (e.g. MMSE) for the TE would be needed in case of two-port transmissions with antenna virtualization (two connectors). |
| Huawei | Option 1 | The power could be imbalanced for the two antenna connectors, thus the weighting factor of powers should be considered. The larger output power may result in higher EVM value, which is determining factor for the total EVM, this has been considered in option 1. EVM1 and EVM2 can be measured according to existing procedure. The requirement should be complied independent from the specific TE implementation.  |
| ZTE | Option 1 | If a receiver like the proposed LMMSE more advanced than zero force, it is actually relaxing the EVM core requirements when the same requirements apply, thus 95% throughput may not be guaranteed. |

 |
| **Issue 1-1-2: Declaration for default TX connector***Agreements in first GTW:**The basic idea of [option 1b+option 2b] is accepted and wording were further refined as following as agreement in GTW session. The primary Tx connector** + *UE declares which connectors will be active per band under test. TE needs to detect ACK and NACK and any other expected response from UE from all declared TX antenna connectors.*

*[Moderator suggestion]: It is proposed to answer the following question:**In addition to the first GTW agreement, can we confirm following points as supplementary information?*1. *The word “active” can be replaced by “used for TxD during one test procedure”. (Not necessarily to have transmission all the time.)*
2. *UE declaration needs to describe* ***exact******two*** *antenna connectors under test.*

*Bullet a) seems have already clarified in the first GTW session by Intel, while bullet b) is needed for TE to have a clear understanding.*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | a) + b) | a) and b) are not conflict.  |
| Anritsu | a) + b) | b) is important from the viewpoint of avoiding misdetection by TE and also to avoid longer test time due to the measurement with multiple antenna connectors. |
| LGE | a) + b) | Both are needed |
| Qualcomm | a)+b) | Question to LGE, if you say in 1-2-1 that behavior is transparent, why declaration is needed?  |
| ZTE | a)+b) | As supplementary information, a) and b) are consistent. |

 |
| **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

Most companies prefer option 1a and/or option 1b. It is generally accepted that option 1b is one implementation of option 1a, and there is no other implementation identified yet. However, the test mode is still controversial and some companies are not like this idea for extra work and not useful in acutal field. There is also some argument that test specific discussion could be done in RAN5. In addition, there are still a few companies chose option2, however, this option 2 may have testability issues.This topic was not discussed in the first GTW session.*Tentative agreements: None.**Recommendations for 2nd round:**Try to narrow down options. See if option 2 which is least supported could still be kept or not.*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 1a or 1b | Ideally option 1a. But if some UEs cannot keep TxD during test, such signaling is required for such UEs. |
| Anritsu | Option 1b | Option 1a also can work. But as mentioned in our paper (R4-2014686), the necessity of the test mode (opt 1b) may depend on a policy whether there is a need of measurement without TxD activated even though the UE declares the support of TxD. Since this feature is transparent, TE cannot judge whether the UE is operating with TxD activated or not unless receiving signaling. Also it is not possible to deactivate TxD without the test mode in a case we need to measure the UE without TxD. If the UE which supports TxD will always utilize this feature and never deactivate it, then test mode is not mandatory.Issue 1-2-2 (necessity of signaling) may vary depending on the policy above.  |
| LGE | Option 1a or 1b | Need to keep TxD during confirmance test. If UE do not keep the TxD mode, then TE can signal to UE as option 1b. |
| Qualcomm | Option 2 | Can discuss either option 1 if the test procedure is dedicated and there is a capability to inform TE that this UE implements TxD  |
| Huawei | Option 2 | Test mode cannot reflect the real implementation of TxD. How to allocate the power at each antenna connector is up to UE implementation.  |
| ZTE | Option 2 | Even if going for some kind of assistant capability signaling, it should act as only for facilitating testing purpose. A gNB should not be assumed to use the signaling pragmatically. |

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| **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?

Views are divided and slight majority prefer option 1 or 1a. Many companies do not have strong views on this one,Option 1 or 1a: ZTE, Intel, LGE, [Skyworks], Samsung, AppleOption 2: Qualcomm, Huawei, Ericsson,No strong view/No need discuss: Anritsu, OPPO, R&S, Xiaomi,Since this is controversial and also related to whether introducing test mode or not, the discussion of this one is closely related to previous issue.*Tentative agreements: None.**Recommendations for 2nd round:**Continue discuss this question, also considering previous issue together with the test mode.**[Moderator’s suggestion]: Try to confirm:**Whether or not unequal power splitting would exist in TxD implementation.**Whether or not equal power splitting is needed for the test*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 1 | In practice, TxD is mainly based on UL-MIMO architecture which requires equal power split. |
| LGE | Option 1 | Same as 1st round comment |
| Qualcomm | Option 2 | Agreements already made accommodate unequal power split from requirements perspective |
| Huawei | Option 2 | Similar to issue 1-1-2, as long as the measurement procedure can deal with the measurement results at two antenna connectors, there is no need to have fixed power at the connectors. In our view, no need to have the ratio as well.  |
| ZTE | Option 1 | If unequal power splitting is allowed, does it play impact on performance? Should a new requirement be created for specifying its inequality? |

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| **Sub-topic#1-2** | **Issue 1-2-1: Applicability of Transparent TxD Requirement (Revised from 1st round):**This original question may not be well drafted and it seems that people have different understanding for this question. Companies are still quite divergent on the understanding on how requirements would be defined and how the test should be done.*[Moderator suggestion]:**Change the discussion question to what was drafted for previous WF, which is listed as following in the bold face:****The applicability of the newly introduced test procedure (if any) and specific requirement (if any) for transparent TxD UE :*** * + ***FFS whether or not applicable to UE implementation without transparent TxD***

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Not applicable | If UE with UL-MIMO capability supports one Tx antenna for fallback mode, there is no need to test the other ‘power off’ connector.  |
| LGE | Not applicable  | Transparent TxD is up to UE implementation. There was no need to define specific requirements in RAN4. |
| Ericsson |  | It should be verified that TxD meets requirements in accordance with the advertised power class of the UE. |
| Qualcomm | Not applicable | Once dedicated capability is introduced, only UE which declare that capability will be subject to this new test procedure.  |
| Huawei | Applicable | For a UE supporting TxD does not mean the UE is always on the TxD mode. And it is transparent to the network, since TxD cannot be configured by the gNB, which is different from UL MIMO. Also as discussed above for other issues, UE supporting TxD can still operate at 1Tx status especially for the low power. The test procedure should be designed flexible enough to consider the real application cases. We can say a set of requirements for UE supporting 2Tx but not for TxD mode.  |
| ZTE | Not applicable | The tests should not apply to UEs without transparent TxD. |

 |
| **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.
	+ Option 3: Using existing signalling to indicate the 2Tx implementation capability.

This is one of the most basic and controversial issue among all the remaining requirements. All options have strong supporters.It is proposed by some companies that for the differentiation of test requirements, the UE declaration is enough. However, this is not confirmed yet.Another basic question was arise in during the discussion and GTW session, that what is the signaling is for testing purpose / differentiation of requirements, or used by the network in the field. Among companies chose Option 1b/1c, it is generally because want the network to know the detailed structure and the actual working mode of the UE. This is quite different from some other companies’s understanding.*Tentative agreements:**None.**Recommendations for 2nd round:**Discuss some more basic topics, such as: a) Whether UE declaration is sufficient for differentiation of test requirements; b) Whether UE TxD structure/implementation should be reported to network or not;**[Moderator suggestion]:**Further clarify following two questions:*1. *For testing prupose, whether UE declaration is sufficient for differentiation of different e.g. MPR, requirements or not?*
2. *Whether UE TxD structure/implementation need to be reported to network or not? And what is the pros and cons to do so?*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 2, 1b or 1a | We think UE declaration is sufficient |
| Anritsu | Option 1b or 2 | We think this depends on the outcome of the issue 1-1-3. |
| LGE | Option 1a or 3 | No need to define new signaling or Power class since there was no specific NW behavior when received the specific signaling from UE. So UE declaration is enough in test mode.  |
| Ericsson | 1b or 1c | The network is not aware of any declarations in conformance testing. The risk of signal cancellation with correlated inputs should be considered, the UE shall meet its advertised power capability.  |
| Qualcomm | Option 1b | More we learn from EVM discussion and infra and TE concerns, the need for capability become more clear.  |
| Huawei | Option 1a, 2, 3 | The requirements in the end may depends on multiple options rather than a single option. If the purpose is for measurement, declaration is a simple solution. If the UE also needs the network to be aware that it may work under TxD mode and 2Tx requirements are applied, option 1a or option 3 can be considered.  |
| ZTE | Option 1 | Only for testing purpose. A gNB is not assumed to use such signaling in real life. |

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| **Issue 1-2-3: Whether dedicated section is needed for TxD requirements?*** Original proposals
	+ Option 1: Yes
	+ Option 2: No.
* Proposals
	+ Option 1: Yes
	+ Option 2: No.

Not discussed in GTW. Basic situation is :Option 1: ZTE, Qualcomm, Skyworks, AppleOption 2: LGE, Intel, Motorola, Huawei, Xiaomi, Samsung,No strong view: OPPO, vivo*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:**Continue discuss this with previous Issue.*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| LGE | Option 2  |  |
| Ericsson |  | Can be decided once the outstanding issues have been resolved. |
| Qualcomm | Option 1 | If there is a capability, requirements can be embedded in to other sections but separated in to paragraphs with “For UE which supports capability *TranmissionsDiversityforAllPortConfigurations* requirements ….” |
| Huawei | Option 2 | During the test, even based on UE declaration, for UE supporting TxD, it can still use 1Tx for some cases. Thus the measurement procedure should consider the power could be different between two antenna connectors. Requirements should be general as well, e.g. EVM, ACLR to consider these possible application cases. No need to have specific clauses.  |
| ZTE | Option 1 | Dedicated to transparent TxD. |

 |
| **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.

Views still divided in this issue. Though majority companies prefer option 2, there are still several companies prefer option 1. People’s position is basically stable compared to last meeting.*Tentative agreements:**None.**Candidate options:**Recommendations for 2nd round:*Postpone the discussion on this topic. Since no progress is foreseen in this meeting and not that high prioritized.*However, comments and further explanations are still welcome and can be documented here.*

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| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 1 | The purpose to have transparent TxD is to expect its performance should be better than single Tx transmission. Requirements on TAE+CDD can provide certain warranty. |
| Lenovo, Motorola Mobility | Option 1 | As above, we believe some upper limit on TAE+CDD should be specified due to potential impact on gNB channel estimation if the delay is too large. |
| Ericsson |  | Specification of limits for CDD would also need RAN1 involvement. There is also potential impact on UL channel estimation. |
| Qualcomm | Option 1 | Impact of CDD nees to be understood and accommodated. Agreements already made accommodate CDD in conformance test.  |
| Huawei | Option 2 | Not necessary. What’s the expectation of the network? It is transparent to the network.  |
| ZTE | Option 1 | A simple way to avoid cancelling effects. |

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### CRs/TPs comments collection

*Moderator’s note: The* ***CRs were currently not revised*** *compared to 1st round, thus* ***duplicate comments were not necessary****. The tables are listed here to document any related information if necessary.*

|  |  |
| --- | --- |
| **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 | Intel: Need to resolve open issues |
| Qualcomm: Agree with Intel. Better agree full package and then CR. This CR does not distinguish TxD requirements properly |
|  |
| **[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 | Intel: Need to resolve 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 | Intel: Need to resolve open issues |
| Qualcomm: Agrtee with intel. Better agree full requirements before CR. This CR does not distinguish TxD requirements properly  |
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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*

|  |  |
| --- | --- |
| **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.  |
| OPPO | Option 5. Before agreements achieved for TxD, not sure how to proceed with this discussion. |
| Huawei, HiSilicon | Prefer Option 4. After the requirements are settled down, we can also consider whether the requirements can be used for Rel-15. If no NBC issues are identified, Option 2 could also be a choice.For option 1, it is based on UE declaration, however, declaration is used for measurement and network can never know the UE declaration. For two UEs with same SA power class, the applicable requirements could be different based on declaration, which is still ambiguous. Since the change of Pcmax is to define the low bound, a UE with higher 1Tx power can certainly set a higher configured power. With a lower bound, the requirement is consistent both for measurement and network expectation. Also we need to address PC1.5 for SA and PC2 for NSA requirement in the spec.  |
| Vivo | Sub topic 2-1: Issue 2-1-1: Whether and how Rel-15 NSA power class should be revised.Option 5 may be still be chosen in this meeting, since we also shares some of Qualcomm’s view that this may actually also related to the applicability of release of TxD in Rel-15. However, both Option 1 and 3 can be considered as refinement since they would at least clarify PHR in case of need.  |
| CMCC | **Prefer Option 5:** Further revision not needed. |
| Samsung | Prefer Option 5, and we have concern on Option 1 which gives NBC issues.  |
| Ericsson | Option 1. There are no backwards compatibility issues, UEs in the field we cannot do anything about. The PHR would become correct for new UEs compliant with the latest version of this specification and the behaviour consistent with NSA UEs of later releases. Part of the ambiguity problem solved, SA remaining. What is the downside? |
| Apple | At the moment we tend to keep it as is. Therefore, Option 5. |

### 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 | Qualcomm: Will need to time to check since this is a change in the power control for rel-15. It is also little unclear why this change is needed since spec, terminals and network have been there for a while. Could Ericsson share some network date showing we have a problem? |
| 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 | Qualcomm: Why Wi code is V2X? And CR template is old. We believe there was rule on two errors in the coversheet. But regardless bureaqracy, this is NBC change to the power control so prefer not to agree this CR now. It also seems this unnecessary relaxes requirements for the regular UE that meets PC2 despite the configured mode.  |
| Ericsson: we prefer the changes according to R4-2015977 (the conditions for reducing the NR configured power) |
| Intel: UE behavior is not right. This will force NR always to be PC3 even NR can be PC2 in EN-DC.OPPO: Cover sheet WI code incorrect?  |

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#2-1** | **Issue 2-1-1: 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.

Slight majority companies still prefer option 5, while option 1/3 do have consider support now. Option 1/3 are based on similar intention that PHR reporting be refined without a complete new signaling. However, considering it is still Rel-15 revision that would have an impact for UE implementation, at least for this meeting the revision in option 1/3 seems not likely.In addition, one company had been argued that if Rel-15 do not support TxD, then the possible ambiguous scenario with 23+23 used as PC2 would be not longer exist. Then the whole discussion is simpler, it is also proposed to confirm this issue.This is also discussed in the GTW session.*Tentative agreements:** + *[Keep option 5 for this meeting]*
	+ *[Identify the relationship of this revision with Rel-15 TxD applicablity]*
	+ *[Study the impact and need for option [1]/[2]/[3]]*

*Recommendations for 2nd round:**Discuss the tentative agreements.**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 | None |  |

### 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”* |
| [**R4-2015977**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015977.zip) | *Returned to* |
| [**R4-2016482**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2016482.zip) | *Returned to* |

## Discussion on 2nd round (if applicable)

### Open issues

|  |  |
| --- | --- |
|  | **Status summary**  |
| **Sub-topic#2-1** | **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.

Slight majority companies still prefer option 5, while option 1 & 3 do have considerable support now. Option 1 & 3 are based on similar intention that PHR reporting be refined without a complete new signaling. However, considering it is still Rel-15 revision that would have an impact for UE implementation, at least for this meeting the revision in option 1 & 3 seems not likely.In addition, one company had been argued that if Rel-15 do not support TxD, then the possible ambiguous scenario with 23+23 used as PC2 would be no longer exist. Then the whole discussion is simpler, it is also proposed to confirm this issue.This is also discussed in the first GTW session, but no conclusion reached.*Tentative agreements:** + *[Keep option 5 for this meeting]*
	+ *[Identify the relationship of this revision with Rel-15 TxD applicablity]*
	+ *[Study the impact and need for option [1]/[2]/[3]]*

*Recommendations for 2nd round:**Discuss the tentative agreements. Provide comments**[Moderator suggestion]: It is proposed to make the following WF.** *Keep the spec unchanged for this issue in this meeting.*
* *Confirm that if TxD cannot applied to Rel-15, then the ambiguity issue would no longer exist.*
* *Further study the impact and feasibility for option 1/2/3.*

|  |  |  |
| --- | --- | --- |
| Company | Preference in 2nd Round | Further Comments in 2nd Round |
| Intel | Option 1 | We don’t see this issue related to TxD. And option 1 does not conflict with Rel-15 ‘famous sentence’. Option 1 just defines UE behavior allowed by ‘famous sentence’. |
| Ericsson | Option 1 | We do not see any issues with the proposed change, the PHR for the SCG (NR) would be correctly set based on the actual UE capability. No issues with UEs in the field. Furthermore, the behavior is consistent with Rel-16 (with a reported NR power capability for the EN-DC configuration). What is the downside?That the Pcmax for the SCG is set in accordance with the vendor declaration and that the resulting SCG PHR is correct can be tested.  |
| Qualcomm | Option 5  | Agree with moderator proposal, wait until TxD is agreed and then analyse the impact to NSA power class.  |
| Huawei | Option 3 | Option 1 or option 3 can be further considered. In our view, option 3 is simpler than op1, and it just has a lower bound for Pcmax,L, which does not exclude UE to use a higher configured power based on the implementation. |
| ZTE | Option 1 | Necessary revision but with minimum specs impact. |

 |

### CRs/TPs comments collection

*Moderator’s note: The* ***CRs were currently not revised*** *compared to 1st round, thus* ***duplicate comments were not necessary****. The tables are listed here to document any related information if necessary.*

|  |  |
| --- | --- |
| **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 |  |
|  |
|  |
| **[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 | Intel: Intel: UE behavior is not right. This will force NR always to be PC3 even NR can be PC2 in EN-DC.Huawei: to Intel, it is the lower bound of Pcmax, not to change Pcmax,h. |
|  |
|  |

## 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”* |