**3GPP TSG-RAN WG4 Meeting #104-bis-e R4-22XXXXX**

**Electronic Meeting, Oct. 10th – 19th, 2022**

**Agenda item:** 6.6.5

**Source:** Moderator (vivo)

**Title:** Email discussion summary for [104-bis-e][128] FR1\_enh2\_part2

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary.*

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

* 1st round: TBA
* 2nd round: TBA

It is appreciated that the delegates for this topic put their contact information in the table below.

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Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)

# Topic #1: Issues for 4Tx (Agenda 6.6.2)

## Companies’ contributions summary

|  |  |  |  |
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| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2215377**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215377.zip) | 4 Tx RF issues | Qualcomm Incorporated | **Observation 1:** It is possible to use MPR values for power class 2 with dual Tx given in table 6.2D.2.-1 of [2] for the 4 PA high antenna isolation scenario.**Proposal 1:** Vehicular UEs due to their large form factor compared to UE handheld devices should have high antenna isolation characteristics similar to CPE and FWA devices.**Observation 2:** current specifications define PC1.5 as the sum of the power from 2 PAs only for UEs that declare TxD capability**Proposal 2**: RAN4 to further discuss whether to redefine PC1.5 to be the sum of power from all PAs regardless of whether a UE supports TxD or not |
| [**R4-2215782**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215782.zip) | Discussion on 4Tx UE RF requirements | LG Electronics | **Proposal 1:** Consider MPR as provided in Table 3 for PC1.5 4Tx (4x23dBm) for Vehicular UE or other industrial devices with antenna isolation of 10dB.**Proposal 2:** Consider MPR as provided in Table 4 for PC1.5 4Tx (4x23dBm) for CPE/FWA or other industrial devices with antennal isolation of 20dB or above.Table 3. Proposed MPR for PC1.5 with quadruple Tx (Antenna Isolation = 10dB)

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 8.0 | ≤ 3.0 | ≤ 2.0 |
|  | QPSK | ≤ 8.5 | ≤ 3.5 | ≤ 2.0 |
|  | 16 QAM | ≤ 8.5 | ≤ 4.0 | ≤ 2.5 |
|  | 64 QAM | ≤ 8.5 | ≤ 4.7 | ≤ 4.5 |
|  | 256 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
| CP-OFDM | QPSK | ≤ 9.5 | ≤ 5.0 | ≤ 3.5 |
|  | 16 QAM | ≤ 9.5 | ≤ 5.0 | ≤ 4.0 |
|  | 64 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
|  | 256 QAM | ≤ 9.5 | ≤ 9.5 | ≤ 9.5 |

Table 4. Proposed MPR for PC1.5 with quadruple Tx (Antenna Isolation = 20dB)

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 7.5 | ≤ 1.5 | ≤ 0.5 |
|  | QPSK | ≤ 8.0  | ≤ 2.0  | ≤ 0.5  |
|  | 16 QAM | ≤ 8.0 | ≤ 2.5  | ≤ 1.5  |
|  | 64 QAM | ≤ 8.0  | ≤ 3.0 | ≤ 3.0  |
|  | 256 QAM | ≤ 8.0  | ≤ 6.0  | ≤ 6.0 |
| CP-OFDM | QPSK | ≤ 8.0  | ≤ 3.5  | ≤ 2.0  |
|  | 16 QAM | ≤ 8.0  | ≤ 3.5  | ≤ 2.5  |
|  | 64 QAM | ≤ 8.0  | ≤ 5.0  | ≤ 5.0  |
|  | 256 QAM | ≤ 8.0  | ≤ 8.0  | ≤ 8.0 |

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| [**R4-2215888**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215888.zip) | Discussion on CEP/FWA/vehicle/industrial devices | ZTE Corporation | ***Proposal 1.*** *The existing component assumptions for handheld UE can be reused, and the requirements which would be different with handheld UE which should be defined separately.****Proposal 2.*** *Additional regulation requirements may need to be considered when define the related RF requirements.*  |
| [**R4-2216115**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216115.zip) | Discussion on 4Tx UE RF requirements | vivo | **Proposal 1:** 1-layer configuration is used for ULFPTx mode 1 in the 1st stage.**Proposal 2:** Using the following TPMI=13 (1 layer, ) for ULFPTx mode 1 verification.**Proposal 3:** Clarify 4Tx co-exist with CA do not included in this WI. **Proposal 4:** A very draft text proposal attached in the Annex was submitted for review. |
| [**R4-2216143**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216143.zip) | Discussion on 4Tx on for CPE FWA vehicle industrial devices | Xiaomi | **Observation 1:** the UE types like FWA, CPE, vehicle has been already allowed in current spec. And the spec doesn’t differentiate the Tx RF requirements between these UE types and handset UE except MPR requirement**Observation 2:** whether separated requirements are needed or not rely on the further study on how much MPR difference among UE types considering the potential larger form factor comparted to handset UE**Observation 3**: although the form factor for CPE/FWA/vehicle/industrial devices may be greatly improved compared with normal handset UE, there should be little difference in the Form factor between them.**Proposal 1**: in order to simplify the spec, and to consider that RF requirement is just the minimum requirements, only defining one set of requirements for CPE/FWA/vehicle/industrial devices is preferred.**Proposal 2**: only P-MPR approach is considered for CPE/FWA/vehicle/industrial devices to comply with SAR compliance if needed. |
| [**R4-2216158**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216158.zip) | Views on 4Tx for Rel-18 RF FR1 enhancements | NTT DOCOMO INC. | **Proposal:** At least per UE basis requirements in case of 2Tx are also per UE basis in case of 4Tx.* Max power/MPR/A-MPR/Pcmax/Minimum output power/Power control/OBW/OOBE/SE
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| [**R4-2216436**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216436.zip) | R18 Discussion on 4Tx FWA | OPPO | *Observation 1: Vehicle UE has used different antenna isolation assumption comparing to CPE/FWA devices.**Proposal 1: No differentiation of CPE/FWA in FR1 enhancement requirements.**Proposal 2: Consider separate requirements for vehicle UE in FR1 when necessary.**Observation 2: Many types of industrial devices exist and form factors could be diverse, further clarifications are needed from proponents.**Proposal 3: Reuse CPE/FWA assumptions for industrial devices before clear definition is made for it.**Proposal 4: SAR issue can be left to UE implementation for at least CPE/FWA/vehicle devices.**Observation 3: Some of CPE devices could be roaming to other countries, while some may not.**Proposal 5: International roaming can be supported by some of CPEs, and the NS value based requirement definition approach can be applied if there is different requirements among countries.**Proposal 6: Align the understanding that UE power class is per band defined, rather than per antenna port.**Observation 5: It is not clear whether 4Tx UE has to meet 2Layer UL MIMO requirements.**Observation 6: Rel-17 TxD only defined for 2Tx and not support (4Tx TxD) or (2Tx TxD +UL MIMO).**Observation 7: 3Layer UL MIMO is supported in RAN1 for 4port UE by configuring three-layer four port codebooks.**Observation 8: 3Layer UL MIMO is not supported in Rel-18 RAN4 requirements though can be supported by UE in implementation.**Proposal 7: 4Tx capable UE only need to meet requirement for 4Layer UL MIMO and single antenna port. The 2Layer UL MIMO can be supported by UE but no need to be tested similar as handling of 3Layer UL MIMO where RAN1 support this feature but no requirement in RAN4.* |
| [**R4-2216673**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216673.zip) | Further consideration on 4Tx | Huawei, HiSilicon | ***Observation 1:*** *TxD is necessary for PC1.5 UE supporting 4Tx for 4x23dBm implementation assumption.****Observation 2:*** *The applicable PC2 fallback MPR requirement agreed in last meeting is only for 2Tx PC1.5 case.****Proposal 1****: TxD requirements shall be considered in phase 1 to support PC1.5 UE delivering the max output power.****Proposal 2:*** *It is proposed to consider dual Tx PC2 requirement as the fallback requirement for 4Tx PC1.5.****Proposal 3:*** *It is proposed to use MPR in Table 6.2D.2-2 as baseline to do the measurement evaluation for PC1.5 with 4Tx.* |
| [**R4-2216674**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216674.zip) | draft CR to TS 38.101-1 4Tx requirements (phase 1) | Huawei, HiSilicon |  |
| R4-2216874 | EVM Definition for Conductive MIMO Testing | Lenovo |  |
| [**R4-2216879**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216879.zip) | EVM Definition for 4x4 UL MIMO | Lenovo | **Proposal 1**: Define the EVM for 4 Tx UL MIMO transmission on a per layer basis. **Proposal 2**: For full-rank transmission, measure the EVM using a zero-forcing MIMO receiver.**Proposal 3**: For less than full-rank transmission, measure the EVM using a pseudo-inverse receiver.**Proposal 4**: To account for antenna correlation not observed in conductive measurements, increase the conductive EVM measurement by some fraction of the square root of the maximum combining gain so that$$EVM\_{i}^{'}=EVM\_{i} ∙f ∙\sqrt{G\_{i}}$$ where *f* is in the interval (0, 1].**Proposal 5**: Alternatively, in the case that increased MPR is defined for multi-antenna transmission, increase the conductive EVM measurement by $$EVM\_{i}^{'}=EVM∙f∙2^{ \left({∆MPR}/{2}\right)} ,$$where *f* is in the interval (0, 1]. |
| [[**R4-2215381**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2215381.zip)**]\*** | On international roaming possibility of CPE/FWA/vehicle/industrial devices | SoftBank Corp. | **[Proposal-1]** A clarification is requested whether four types of devices under this WID are subject to international roaming. |
| [[**R4-2216154**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216154.zip)**]\*** | Views on assumption for CPE/FWA/vehicle/industrial devices for 4Tx and 8Rx | NTT DOCOMO INC. | Observation 1: RF components assumptions for 4 types of UEs should be considered during discussion for 4Tx and 8Rx RF requirements, which is also mentioned in [2], and whether sets of requirements are different or not depends on how the requirements of 4 types of UEs look like based on the outcome of the discussion.Observation 2: Approved WF for 4Tx and 8Rx in last meeting already made some agreements on RF components for 4 types of UEs.Observation 3: In our view, it is preferable to have common requirements among 4 types of UEs, but it depends on what differences of the requirements will be identified and interested companies for each type of UE want to differentiate them.Observation 4: Although SAR compliance may be removed/relaxed for CPE/FWA/vehicle/industrial devices in some cases, it depends on those device types and use cases.Observation 5: Since values of P-MPR and UL duty cycle capability is up to UE implementation, if a device does not have any issues on SAR, the device can apply zero P-MPR and indicate larger UL duty cycle capability.Proposal: Confirm existing solutions such as P-MPR and UL duty cycle scheme are still valid for CPE/FWA/vehicle/industrial devices with 4Tx. |

\* The documents were moved from agenda 6.6.1.

## Open issues summary

### Sub-topic 1-1: Assumptions for different UE type

***Issue 1-1-1: RF parts/performance***

* **Proposal 1:** The existing component assumptions for handheld UE can be reused, and the requirements which would be different with handheld UE which should be defined separately. (ZTE, R4-2215888)
* **Proposal 2**: in order to simplify the spec, and to consider that RF requirement is just the minimum requirements, only defining one set of requirements for CPE/FWA/vehicle/industrial devices is preferred. (Xiaomi, [R4-2216143](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216143.zip))
* **Proposal 3:** Vehicular UEs due to their large form factor compared to UE handheld devices should have high antenna isolation characteristics similar to CPE and FWA devices. (Qualcomm, R4-2215377)
* **Proposal 4:** (OPPO, [R4-2216436](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216436.zip))
	+ No differentiation of CPE/FWA in FR1 enhancement requirements;
	+ separate requirements for vehicle UE in FR1 when necessary;
	+ CPE/FWA assumptions for industrial devices before clear definition is made for it.
* Proposal 5: It is preferred to have common requirements among 4 types of UEs, but depends on other factors (DCM, R4-2216154)
	+ Observation 1: RF components assumptions for 4 types of UEs should be considered during discussion for 4Tx and 8Rx RF requirements, and whether sets of requirements are different or not depends on how the requirements of 4 types of UEs look like based on the outcome of the discussion.
	+ Observation 2: Approved WF for 4Tx and 8Rx in last meeting already made some agreements on RF components for 4 types of UEs.
	+ Observation 3: In our view, it is preferable to have common requirements among 4 types of UEs, but it depends on what differences of the requirements will be identified and interested companies for each type of UE want to differentiate them.

***Moderator’s recommendation:***

* Recommended WF
	+ Reuse existing component assumptions for handheld UE unless otherwise stated;
	+ No differentiation of CPE/FWA;
	+ FFS whether vehicular UE should have high antenna isolation characteristics similar to CPE and FWA
	+ FFS one set of requirements for CPE/FWA/vehicle/industrial devices;

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| **Company** | **Comments** |
| OPPO | Ok with recommended WF. For the antenna isolation for vehicular UE, it was agreed in last meeting that same as handheld UE, this is different from CPE/FWA, and may lead to different requirements like MPR. But what does vehicular UE means actually is not quite clear, is it another kind of CPE/FWA? |
| Skyworks | We have a preference for Xiaomi ([R4-2216143](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216143.zip)) proposal 2 to define only one set of requirements for all device types. |
| Qualcomm | 1) Reuse existing component assumptions for handheld UE unless otherwise stated 2) No differentiation of CPE/FWA. 3) Vehicular devices should have high antenna isolation characteristics similar to CPE/FWA 4) One set of requirements for CPE/FWA/Vehicular devices/industrial devices to greatly simplify development.  |
| Xiaomi | Our preference is option 2 and agree that vehicular UE should have high antenna isolation characteristics similar to CPE and FWA. |
| Huawei | We are fine with the first two bullets of the moderator recommendation. For the last two bullets, we prefer to consider one set of RF requirements for all these mentioned UE types.  |
| LG Electronics | For moderator’s recommended WF,- Reuse existing component assumptions for handheld UE unless otherwise stated : Support- No differentiation of CPE/FWA : Support- FFS whether vehicular UE should have high antenna isolation characteristics similar to CPE and FWA : RAN4 agreed with same antenna isolation as handheld UE for vehicular UE. So, further discussion is not necessary. - FFS one set of requirements for CPE/FWA/vehicle/industrial devices : Based on the different antenna isolation, we think that two set of requirement for CPE/FWA and for vehicular UE are needed.  |
| ZTE | The first two bullet are fine to us.For 3rd bullet, as commented by LG, RAN4 already agreed that high antenna isolation compared to handheld UE(equals to vehicular UE) is applied FWA/CPE. For 4th bullet, share other comments’ view that two sets of requirements maybe needed, like PC1.5 dual Tx MPR requirements for different antenna isolation. |
| AT&T | We are generally OK with the recommended WF if the first bullet does not preclude the use of better PCB isolation, better antenna isolation, and better performing components commonly used in larger form-factor and/or externally powered devices such as CPE/FWA. |
| Intel | We agree with the moderator’s recommended WF. This seems like a reasonable balance between the desire to have individual specs tailored to each use case and having the simplicity of a common approach. We agree with Proposal 5’s point that the approved WF already made some agreement on re-using RF components.Perhaps, just distinguishing the use cases by antenna isolation requirements would be feasible, since it has been difficult to agree on one antenna isolation value in previous discussions on FWA. |
| Verizon  | We can accept Qualcomm suggestion as WF! |
| NTT DOCOMO | We support moderator’s recommendation. |
| CMCC | We are OK with the recommended WF. For the two FFS, we are fine with QC proposal. |
| T-Mobile USA | We are OK with the recommended WF and with the Qualcomm proposals for the two FFS. |
| Sony | Support moderator’s proposal.  |

***Issue 1-1-2: SAR compliance***

* Proposal 1: Additional regulation requirements may need to be considered when define the related RF requirements. (ZTE, R4-2215888)
* Proposal 2: only P-MPR approach is considered for CPE/FWA/vehicle/industrial devices to comply with SAR compliance if needed. (Xiaomi, [R4-2216143](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216143.zip))
* Proposal 3: SAR issue can be left to UE implementation for at least CPE/FWA/vehicle devices. (OPPO, [R4-2216436](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216436.zip))
* Proposal 4: Confirm existing solutions such as P-MPR and UL duty cycle scheme are still valid for CPE/FWA/vehicle/industrial devices with 4Tx. (DCM, R4-2216154)

***Moderator’s recommendation:***

* Recommended WF
	+ Option 1: Only consider P-MPR approach for CPE/FWA/vehicle/industrial devices
	+ Option 2: Confirm existing solutions including P-MPR and UL dutycycle scheme for CPE/FWA/vehicle/industrial devices since P-MPR number is flexible and dutycycle is or optional.

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| **Company** | **Comments** |
| OPPO | Option 1. Only consider PMPR approach for simplicity. |
| Xiaomi | Option 1 considering SAR issue is not serious compared with handhold UE |
| Huawei | Prefer option 1. |
| Nokia | This is the same discussion like PC2 FDD and causes a problem later.What does Option 1 mean? Do we prevent a UE from reporting duty cycle capability? If so, we need to clarify it in the spec. If it’s allowed, the option we need to take must be Option 2.When it comes to UL duty cycle, does it include the following two or one of them? Which one(s) we are talking about? Companies are talking about SAR so that the former one is considered?*maxUplinkDutyCycle-PC1dot5-MPE-FR1**maxUplinkDutyCycle-PC2-FR1* |
| ZTE | Prefer Option 1. |
| Intel | We prefer Option 1 |
| NTT DOCOMO | Option 2 as proponent.We don’t have intention to introduce something new. For UL duty cycle, our proposal is to confirm that already defined solution such as UL duty cycle for PC2 and PC1.5 for TDD bands is also applicable to 4Tx CPE/FWA/vehicle/industrial devices. We just try to confirm it in response to the last meeting WF. We are not sure what is the concern on option 2. |
| CMCC | We are open to discuss option2. The UL duty cycle signaling for PC2 and PC1.5 may can be resued. However, would the CPE/FWA/vehicle/industrial devices have the same default UL duty cycle assumption as handheld UE? If not, then we need to update the RAN4 spec descriptions. |
| T-Mobile USA | Option 1. CPE/FWA/vehicular devices should meet FCC MPE requirments with up to 32 dBm Tx power and > 20 cm distance.  |

***Issue 1-1-3: International operation***

* Proposal 1: A clarification is requested whether four types of devices under this WID are subject to international roaming (SBM, R4- 2215381).
* Proposal 2: International roaming can be supported by some of CPEs, and the NS value based requirement definition approach can be applied if there is different requirements among countries. (OPPO, [R4-2216436](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216436.zip))

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

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| **Company** | **Comments** |
| OPPO | Proposal 2. And if understand correctly the purpose of this discussion is to decide whether global requirements/regulations need to be considered, if it is then the usual approach can be applied, i.e. NS based. |
| Qualcomm | Proposal 3: We think that CPE and vehicular devices can be subjected to international roaming. However, FWA and industrial devices are normally stationary for most use cases but there could be a few use cases where they too could be configured in various countries. So, we think there is a possibility where all 4 types of devices could be subjected to international roaming. |
| Xiaomi | Same view as Qualcomm |
| Huawei | We agree with observations by QC for typical applicable scenarios for the UE tpyes, and think international roaming can be considered for these UE types during the discussion. What matters is what’s the impact of the assumption. So far, we think the existing methods in the spec, e.g. P-max, NS would be enough to address the international roaming issue.  |
| LG Electronics | Fine with QC’s comment. |
| Nokia | We are not against the discussion. But would what RAN4 agrees that no international roaming is assumed or not be useful? Even if we agreed that no internal roaming is assumed now, perhaps, the outcome might just come from that people just don’t have a plan to do now. No one knows the future…This is nothing new and somehow MRA and/or UE vendors/operators have addressed it somehow to meet regulations. Or if we agree that there may be internal roaming, what is the next step that we take as 3GPP?  |
| ZTE | We think CPE may need to be deployed in different country which may relays on the demands from the operators, which means additional regulation requirements may need to be considered to define the related RF requirements (like NS\_XX).  |
| SoftBank-K | Thank you very much for the valuable comments. It seems that we should take care of all the types of UEs subject to international roaming in the long run…To Nokia: We would like to make clear 1) if a regulatory enforcement is sufficient for a certain type of UE when the type of UE is marketed in Japan or we need to be prepared even before the UE is sold in Japan. In addition, 2) if we need to prepare in advance in 1), the preparation would depend on UE types and their RF performances. As mentioned in various comments (including my contributions), all we could do in the current framework is P-max/NS. But when the whole picture becomes clear (not merely about roaming, such as PowerClass or UE type designations), we could consider something different to make the control easier. |
| CMCC | We agree with QC’s proposal. |
| T-Mobile USA | We agree with Qualcomm |
| Sony | We agree with Qualcomm. |
| Ericsson | We agree with Qualcomm |

### Sub-topic 1-2: Scope and configurations

***Issue 1-2-1: Layer number and ULFPTx mode 1 configurations***

* Proposal 1: (vivo, R4-2216115)
	+ 1-layer configuration is used for ULFPTx mode 1 in the 1st stage.
	+ Using the following TPMI=13 (1 layer, ) for ULFPTx mode 1 verification.
* Proposal 2: 4Tx capable UE only need to meet requirement for 4Layer UL MIMO and single antenna port. The 2Layer UL MIMO can be supported by UE but no need to be tested similar as handling of 3Layer UL MIMO where RAN1 support this feature but no requirement in RAN4. (OPPO, [R4-2216436](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216436.zip))
* Proposal 3: 1/2/3 layer cases are considered for ULFPTx mode 1. (Huawei, draft CR R4-2216674)

***Moderator’s recommendation:***

* Recommended WF
	+ 1-layer configuration is considered for ULFPTx mode 1 and using the following TPMI=13 (1 layer, )
	+ FFS whether consider 2/3 layer case for ULFPTx mode 1.

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| **Company** | **Comments** |
| OPPO | To clarify, the proposal 2 is not for ULFPTx mode 1, it is a general discussion of fallback from 4Layer to 3Layer, 2Layer, and 1Layer. These are all supported by 4Tx UE in RAN1 and in the field. If we omit 3Layer requirements and tests for 4Tx UE then 2Layer can also be omitted in our view. This means 4Tx UE can be tested only for 4Layer requirements (UL MIMO) and 1Layer requirements (basic requirements). |
| Qualcomm | Only handle 1-layer case for now with TPMI 13. 2 and 3 layer cases for ULFPTX mode 1 can be FFS for now |
| Huawei | We are fine with the moderator’s recommendation. 1 layer for ULFPTx mode1 can be considered as starting point.  |
| LG Electronics | For moderator’s recommended WF,- 1-layer configuration is considered for ULFPTx mode 1 and using the following TPMI=13(1 layer): Generally ok. However, if TMPI = 12 (1 layer, 1/2\*[1 1 1 1]T ) is applicable, we prefer TPMP = 12.- FFS whether consider 2/3 layer case for ULFPTx mode 1 : RAN4 agreed not to consider layer 3 in this WI in the last meeting. So, 2 layers for ULFPTx mode 1 can be FFS. |
| CMCC | We support to also consider 2/3 layer case. So far, OK with the recommended WF at this moment to further discuss 2/3 layer case. |
| T-Mobile USA | We are OK with the moderator’s proposal.  |
| Sony | We support moderator’s proposal.  |

***Issue 1-2-2: TxD support***

* **Proposal 1:** TxD requirements shall be considered in phase 1 to support PC1.5 UE delivering the max output power. (Huawei, R4-2216673)

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

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| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok with proposal 1, and if understand correctly this means UE with 4x23 will apply TxD among the 4 antennas to achieve PC1.5. |
| Skyworks | Ok with proposal 1. Our understanding is that PC1.5 with 4x23 can only be supported for all uplink physical channels using TxDiv, this justifies proposal 1. |
| Qualcomm | Proposal 1 |
| Xiaomi | Ok with proposal 1 |
| Huawei | Proposal 1. Besides MIMO modes, the UE also needs to consider how to deliver max power for single port transmission with 4x23dBm implementation.  |
| LG Electronics | Support proposal 1 with 4 Tx Diversity (4x23dBm). |
| Nokia | The recommendation is OK. Regarding proposal 2, we don’t see the reason to discuss testing coverage now. |
| ZTE | Ok with proposal 1 (4\*23dBm). |
| AT&T | OK with Proposal 1. |
| Intel | Support proposal 1 for Tx Diversity |
| Verizon | We agree Proposal 1 |
| CMCC | We agree with Proposal 1. |
| Lenovo | Support Proposal 1. |
| T-Mobile USA | Supportt proposal 1 |
| Sony | Proposal 1 |

***Issue 1-2-3: Power class fallback***

* Proposal 1: It is proposed to consider dual Tx PC2 requirement as the fallback requirement for 4Tx PC1.5. (Huawei, R4-2216673)

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | FFS, because when UE has 26dBm Pas then when fallback to 2T, it still can achieve PC1.5. |
| Qualcomm | In principle this is ok, but it should be clarified whether 2 PA fallback is to l layer operation or 2-layer operation or whether both types of fallbacks are permissible? |
| Huawei | For current stage we only consider 4x23dBm to support PC1.5, thus the fallback PC2 is also for this implementation assumption. Regarding the supported MIMO layer, we think it depends on what are supported by the PC1.5 power class. In our view, both types are permissible.  |
| LG Electronics | Need to consider all possible fallback. For example, 2 PA fallback to 1 / 2 layer, 1 PA fallback to 1 layer. |
| Nokia | We need more discussion on this to agree with this. And this is related to UL duty cycle discussion as well. Does this mean that if UL duty cycle (if allowed to be reported) exceeds e.g., 50%, UE shall not be allowed to fallback to PC3, but it shall stay PC2 and needs to reduce power? |
| AT&T | Agree with other comments that this item requires more discussion and that all possible fallbacks need to be considered. |
| Intel | Not sure we need to prioritize 4x23dBm by treating 2x26dBm as a fallback mode. More discussion is needed |
| Verizon | Agree with Oppo and Qualcomm! More clarification seems needed |
| CMCC | More discussion is needed.  |
| T-Mobile USA | More discussion is needed. |
| Sony | More discussion is needed. |
| Ericsson | More discussion is needed |

### Sub-topic 1-3: Others

***Issue 1-3-1: MPR requirements***

* **Proposal 1:** It is proposed to use MPR in Table 6.2D.2-2 as baseline to do the measurement evaluation for PC1.5 with 4Tx. (Huawei, R4-2216673)
* **Proposal 2:** (LG, R4-2215782)
	+ Consider MPR as provided in Table 3 for PC1.5 4Tx (4x23dBm) for Vehicular UE or other industrial devices with antenna isolation of 10dB.
	+ Consider MPR as provided in Table 4 for PC1.5 4Tx (4x23dBm) for CPE/FWA or other industrial devices with antennal isolation of 20dB or above.

Table 3. Proposed MPR for PC1.5 with quadruple Tx (Antenna Isolation = 10dB)

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 8.0 | ≤ 3.0 | ≤ 2.0 |
|  | QPSK | ≤ 8.5 | ≤ 3.5 | ≤ 2.0 |
|  | 16 QAM | ≤ 8.5 | ≤ 4.0 | ≤ 2.5 |
|  | 64 QAM | ≤ 8.5 | ≤ 4.7 | ≤ 4.5 |
|  | 256 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
| CP-OFDM | QPSK | ≤ 9.5 | ≤ 5.0 | ≤ 3.5 |
|  | 16 QAM | ≤ 9.5 | ≤ 5.0 | ≤ 4.0 |
|  | 64 QAM | ≤ 9.5 | ≤ 7.0 | ≤ 7.0 |
|  | 256 QAM | ≤ 9.5 | ≤ 9.5 | ≤ 9.5 |

Table 4. Proposed MPR for PC1.5 with quadruple Tx (Antenna Isolation = 20dB)

|  |  |
| --- | --- |
| Modulation | MPR (dB) |
|  | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| DFT-s-OFDM | Pi/2 BPSK | ≤ 7.5 | ≤ 1.5 | ≤ 0.5 |
|  | QPSK | ≤ 8.0 | ≤ 2.0 | ≤ 0.5 |
|  | 16 QAM | ≤ 8.0 | ≤ 2.5 | ≤ 1.5 |
|  | 64 QAM | ≤ 8.0 | ≤ 3.0 | ≤ 3.0 |
|  | 256 QAM | ≤ 8.0 | ≤ 6.0 | ≤ 6.0 |
| CP-OFDM | QPSK | ≤ 8.0 | ≤ 3.5 | ≤ 2.0 |
|  | 16 QAM | ≤ 8.0 | ≤ 3.5 | ≤ 2.5 |
|  | 64 QAM | ≤ 8.0 | ≤ 5.0 | ≤ 5.0 |
|  | 256 QAM | ≤ 8.0 | ≤ 8.0 | ≤ 8.0 |

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | For clarification of Proposal 2, if understand correctly these are simulation results then how the cross impact among Pas are modeled in the simulation? |
| Skyworks | Proposal 1 seems a good baseline to start the evaluations. We also would like to suggest evaluating what is the minimum level of antenna isolation at which the reverse IMD contribution can be neglected. If this level is, say, greater than 10 and less than 20dB, and that the value can be representative of all UE types under consideration, we could eliminate the parameter “antenna isolation” and hence produce a single set of requirements as discussed in issue 1-1-1 proposal 2. This approach could also be in-line with proposal 3 issue 1-1-1 for the example of “vehicle” (Qualcomm, R4-2215377).  |
| Qualcomm | For proposal 2 from our understanding the MPR numbers in table 3 and 4 are derived from simulation results? How were the PA-to-PA interference modeled and what isolation values were assumed between them? We think that the PA modeling and the PA-to-PA isolation assumptions will greatly impact the simulation results and needs further discussion.For proposal 1 what does it mean to adopt the MPR numbers in table 6.2D.2-2 as baseline? Will they be revised based on future results from companies? We think that it is better not to adopt any tentative numbers until the isolation assumptions for 4 Tx are discussed further. We understand that the 4Tx case could have worse MPR compared to 2Tx, however whether it will be better or worse than the 2Tx low antenna isolation case it difficult to say at this time without looking into it further. |
| Huawei | MPR can be evaluated by simulation or measurement. For the measurement evaluation, at least we need a set of requirements to check whether the values can be complied with or any margins are necessary to be considered. Values could be revised based on further evaluation. If we understand correctly, proposal 2 is based on simulation results. To align the further simulation evaluation, some assumptions may need to be considered.  |
| LG Electronics | We’re fine to continue to discuss 4Tx MPR with other companies’ MPR in next meeting. For comment on proposal 2, PA-to-PA interference is modeled with R-IMD factor. R-IMD from 3 PAs are assumed to input 1 PA. * Antenna isolation of 10dB/20dB
* FEPL = 4dB
* Sum of RIMD interference from 3 PAs to 1 PA

= 23 – 2\*4 – 10 + 4.7 for Antenna Isolation of 10dB,= 23 – 2\*4 – 20 + 4.7 for Antenna Isolation of 20dBBased on the proposal 2, the difference of up to 2dB is observed between antenna isolation of 10dB and 20dB. For Proposal 1,it seems to be for antenna isolation of 10dB and is not clear what does it mean as baseline. So, in this meeting, we don’t have to consider baseline. |
| Intel | We are ok with Proposal 1 as a starting place, yet we agree with Skyworks that we need to clarify the isolation level. We haven’t agreed on isolation levels per use case yet. Secondly, we would like to see measured results. |
|  |  |

***Issue 1-3-2: Per-UE basis requirements*** (NTT Docomo, R4-2216158)

* **Proposal:** At least per UE basis requirements in case of 2Tx are also per UE basis in case of 4Tx.
	+ Max power/MPR/A-MPR/Pcmax/Minimum output power/Power control/OBW/OOBE/SE

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Ok |
| Qualcomm | The meaning of the term “per UE basis” should be clarified. Reading paper R4-2216158 it seems that some specifications are the sum of 4 connectors (Max power, Pcmax, power control,OBW,OOBE, spurious emissions), others are resuse of single port values (AMPR) or are definition of new values ( MPR). |
| Xiaomi | We think Per UE basis means the sum of 4 antenna connectors here. We are ok with the proposal. |
| Huawei | Ok with the proposal. Sum manner of the output power for each antenna connector is also valid for 4Tx. |
| LG Electronics | Same view with Xiaomi. |
| ZTE | It was somehow discussed in last meeting, and seems no objections. So we are ok with this proposal. |
| AT&T | We are OK with the proposal in principle. However, we agree with QC that there needs to be clarification on the term “per UE basis” for A-MPR as written in the proposal. Is the intent to follow the general approach for 4Tx as for 2Tx in clause 6.2D.3? |
| SoftBank-M | We support the proposal.  |
| Verizon | In principle this is ok! |
| NTT DOCOMO2 | Thank you for the comments from Qualcomm and AT&T. Our proposal seems unclear.For Max power/Pcmax/Minimum output power/Power control/OBW/OOBE/SE, Per UE basis means that the requirement is defined as the sum of power from four antenna connecters. We would like to agree on this.For MPR/A-MPR, we can further discuss. |
| T-Mobile USA | We support the proposal |

***Issue 1-3-3: EVM related*** *(Lenovo,* [*R4-2216879*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216879.zip)*)*

* **Proposal 1**: Define the EVM for 4 Tx UL MIMO transmission on a per layer basis.
* **Proposal 2**: For full-rank transmission, measure the EVM using a zero-forcing MIMO receiver.
* **Proposal 3**: For less than full-rank transmission, measure the EVM using a pseudo-inverse receiver.
* **Proposal 4**: To account for antenna correlation not observed in conductive measurements, increase the conductive EVM measurement by some fraction of the square root of the maximum combining gain so that$EVM\_{i}^{'}=EVM\_{i} ∙f ∙\sqrt{G\_{i}}$ where f is in the interval (0, 1].
* **Proposal 5**: Alternatively, in the case that increased MPR is defined for multi-antenna transmission, increase the conductive EVM measurement by $EVM\_{i}^{'}=EVM∙f∙2^{ \left({∆MPR}/{2}\right)} ,$ where f is in the interval (0, 1].

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Proposal 1 and 2 seem ok in principle. We think that less than full rank scenarios should be FFS. |
| Huawei | Similar view with Qualcomm. P3~P5 can be further discussed.  |
| Rohde & Schwarz | We agree in principal with proposal 1 and 2. We should follow the same methodology we are using for 2Tx UL MIMO, since it can extended to 4Tx. Especially proposals 4 and 5 need better understanding and discussion. |
| Lenovo | Proposal 3 is consistent with FR2. Proposal 4 assumes worst-case correlation of the transmitter noise in a manner similar to that used for TxD EVM definition. This applies in the case that the transmitter noise is uncorrelated in the conducted measurement but is highly correlated with radiative coupling. Alternatively, Proposal 5 increases EVM based on increased MPR allowed for multi-antenna transmission and based on modeling of radiative coupling. |

***Issue 1-3-4: PC 1.5 clarification***

* **Proposal 2:** RAN4 to further discuss whether to redefine PC1.5 to be the sum of power from all Pas regardless of whether a UE supports TxD or not. (Qualcomm, R4-2215377)
* **Proposal 6:** Align the understanding that UE power class is per band defined, rather than per antenna port.(OPPO, R4-2216436)

***Moderator’s recommendation:***

* Recommended WF
	+ TBA based on 1st round discussion

|  |  |
| --- | --- |
| **Company** | **Comments** |
| OPPO | Proposal 6 is our understanding, i.e. power class is per band defined. Regarding proposal 2, for clarification of the meaning that PC1.5 is defined as the sum power from all Pas? Does it mean the concurrent transmission Pas? TxD is necessary for UE achieve PC1.5 in single antenna port. |
| Skyworks | Same question for clarification than Oppo on proposal 2. |
| Qualcomm | We think that Proposal 2 and 6 are the same in that per band definition means the sum of power from all Pas for that band of operation. To Oppo and SkyworksCurrently PC1.5 cannot be achieved with a single PA and can only be achieved by summing powers from several Pas. Based on our interpretation of the current specification we find that “the sum of the maximum output power from both UE antenna connectors” is mentioned for TxD in section 6.2G.1, TS38.101-1 for Tx diversity. Based on this we think that TxD is necessary to achieve PC1.5. However, as we mentioned in our paper this can be redefined as we have indicated in Proposal 2 of R4-2215377. |
| Huawei | We think the issue is relevant to the issue 1-2-2 on TxD support. The power class is per band defined thus the output power should be added together from all transmit connectors to comply with the supported power class.  |
| LG Electronics | Support proposal 2.Need to consider the following cases for forward compatibility. * 4x23dBm
* 2x23dBm +2x26dBm
 |
| ZTE | We would like to know if there is different between sum of the PAs and sum of the antenna connectors? If sum of the PAs, does it means 2\*23+2\*26 = 30.8dB? |
| Intel | We do not favor redefining PC1.5. This may seem convenient now but would have potential complications in the future when more flexibililty or a new mode is desired. |
| Verizon | We support Proposal 2 |

## Companies views’ collection for 1st round

### Open issues

Please add the comments to the respective tables in previous clause.

### 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** |
| [**R4-2216674**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216674.zip)Huawei | Qualcomm: We think that TPMI indexes 13,6 and 1 for Mode-1 in table 6.2D.1-3 have to be agreed prior to approving this CR In the last meeting it was agreed that 3-layer transmission would be deprioritized so we think that it should not be included in table 6.2D.1-3. Also, the adoption of table 6.2D.2-4 has not been agreed to as yet. |
| Huawei: Regarding the comments from QC on TPMI, we are open to further discuss the indexes. The draft CR is to facilitate the requirements discussion, may not need to be endorsed for this meeting. Comments for the proposed changes are welcome.  |
| LG Electronics:For table 6.2D.1-3, TMPI index depends on the agreement in Issue 1-2-1. And, index for layer 3 is not necessary based on the RAN4#104-e agreement (not consider layer 3 in this WI).For table 6.2D.2-4, it is not yet agreed. So, it’s better to remove the table. |
| [**R4-2216115**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_104bis-e/Docs/R4-2216115.zip)(Annex)vivo | Company A |
| Company B |
|  |

## 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** | Sub-topic 1-1:*Tentative agreements:**Candidate options:**Recommendations for 2nd round:*Sub-topic 1-2: *Tentative agreements:**Candidate options:**Recommendations for 2nd round:*Sub-topic 1-3:*Tentative agreements:**Candidate options:**Recommendations for 2nd round:* |

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation**  |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
|  |  |  |

1. Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |  |
| --- | --- | --- | --- |
| **New Tdoc number** | **Title** | **Source** | **Comments** |
|  | WF on … | YYY |  |
|  | LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |  |

**Existing tdocs**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |
|  |  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Tdoc number** | **Revised to** | **Title** | **Source** | **Recommendation**  | **Comments** |
| R4-22xxxxx |  | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-22xxxxx |  | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-22xxxxx |  | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
	1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
	2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents