**3GPP TSG-RAN WG4 Meeting # 101-bis-e R4-22XXXXX**

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

**Agenda item:** 6.7.1

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for [101-bis-e][122] NR\_TxD

**Document for:** Information

# Introduction

This is a summary of discussions for Tx Diversity WI in RAN4#101-Bis-e. In this meeting, following topics were discussed:

Topic #1: General and TR maintenance

Topic #2: MPRs and 2-layer UL MIMO

Topic #3: SRS Antenna switching

Topic #4: ULFPTx and TxD

# Topic #1: General and TR maintenance

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| **[R4-2200958](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200958.zip)** | TP for TR 38.837 on Power Class clarification | vivo | TP for EN-DC power class discussions |
| R4-2201590 | 3GPP TR 38.837 v0.3.0 | vivo | For email approval after the meeting? |
| R4-2201941 | Big CR for TS 38.101-1 Tx diversity requirements | Huawei, HiSilicon, Qualcomm, vivo | N/A |

## Companies views’ collection for 1st round

### Open issues

Comments on R4-2200958, “TP for TR 38.837 on Power Class clarification”

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| --- | --- |
| **Company** | **Comments** |
| Nokia | As far as the requirements in clause 6.2.1 are referred to, UE declaring PC2 HPUE shall have 26dBm MOP by not using TxD but rather full power chain 1Tx. |
| ZTE | Some texts need to be polished, which are mainly used in discussions, but not suitable for being TR texts). |
| Ericsson | The TR does not have to contain a detailed description of the study process, it suffices to list the options considered for resolving the ambiguity and why these were (not) adopted. For Rel-16 the issue is solved for NSA. |
| Huawei, HiSilicon | Thanks vivo for the detailed information. As we spent a lot of time on the issue, it’s ok to reflect the progress in the internal TR. |
| Samsung | Generally agree with vivo’s very detailed TP to capture existing agreement and discussion process.  One comment for SA part:   * In 5.1.1.1, under agreement which is somehow aligned between R15 and R16, there is one interpretation from TP drafter: “This means that the 1-port fall back of SA UE power class for UL-MIMO is aligned to the power class as indicated by the ue-PowerClass field in capability signalling. E.g. SA UE declaring PC2 HPUE shall have 26dBm MOP, either by full power chain 1Tx or using TxD.” Here, do we need to clarify that even for R15 UE, if it require TxD to achieve the full power, it still needs the capability signaling which is used to indicate to NW? Without that, we have concern that people may think Rel-15 UE can not rely on TxDiversity capability signaling but just use TxD directly, which I believe is not the case. |
| vivo | To Nokia: This comment is reasonable, the current requirements that specific reference 6.2.1 may be difficult to utilize TxD. However, in the study process, this fall back 1 port transmission clearly may need TxD if no full power PA available, for both Rel-15 and Rel-16. The spec may need some further revision to account for this.  To Ericsson: We can somehow make the contents more concise. However, it is still proposed to make some record of the discussion process.  To ZTE: We may further polish the wording and putting it offline.  Since there are still many issues, we may postpone this TR to next meeting. |

## 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.*

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

## Discussion on 2nd round (if applicable)

# Topic #2: MPRs and 2-layer UL MIMO

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| R4-2200340 | Draft CR for fixing MPRs in suffix D | Qualcomm Incorporated | N/A, withdrawn |
| **[R4-2201228](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201228.zip)** | PC2 PA configuration and signalling | Xiaomi | **Observation 1: the capability of Tx diversity is independent of power class**  **Observation 2: the capability of Tx diversity could not be used to distinguish the PA configuration.**  **Proposal 1:** **MPR requirements for 2Tx are assumed for 23+26 dBm with TxD indication**  **Proposal 2: if proposal 1 is acceptable, using the TxD indication together with the supporting power class could distinguish the applicable requirements.** |
| [**R4-2201267**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201267.zip) | R17 FR1 TxD requirements and signaling | OPPO | **Observation 1:** For UE with 23+26 PAs, it can be considered as common case that this UE will apply the full power PA to achieve PC2 from performance perspective.  **Proposal 1: For 23+26 PA configurations the 26 PA will always be applied in single antenna port and the 1Tx PC2 MPR requirements will be applied.**  **Proposal 2: For UE reporting TxD capability, it can be interpreted as this UE only has two half power PAs and the TxD MPR is applied in single antenna port.**  **Proposal 3: For UE with 23+26 PA configurations, when works under UL MIMO, it can follow 26+26 MPR. And use TxD capability to distinguish the requirements UE apply in UL MIMO.** |
| **[R4-2201269](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201269.zip)** | Draft R17 CR on UL MIMO falllback to TxD | OPPO | CR 6.2D.2, 6.2D.3, 6.2D.4  If UE indicating *Tx diversity* [xx, TS 38.306] is scheduled for single antenna-port PUSCH transmission by DCI format 0\_0 or by DCI format 0\_1 for single antenna port codebook based transmission, the requirements in clause 6.2G.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling. |
| [**R4-2200499**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200499.zip) | Requirement and signaling aspect of features requiring two transmit paths | Skyworks Solutions Inc. | **Proposals on MPR requirements:**   * **PC2 2Tx MPR for 1+1/2 is introduced only for 1CC and 2CC UL MIMO reusing existing MPR tables**   **Proposals for 1CC UL MIMO and TxD sections:**   * **Section D UL MIMO:**   + **2Tx PC2 MPR table should use the table provided in R4-2119971**   + **Text in the section should point at 1Tx section for description of inner, outer and edge allocations with an extension to 4RB for edge allocations for PC1.5 (PC1.5 edge allocation specifics should be removed from 1Tx section)**   + **The section should point at Table 6.2.2-2 for 1Tx transmissions for PC2 UEs not declaring *TxD* and declaring *ULFPTx***   + **For PC2 UEs not declaring *TxD* nor declaring *modifiedMPR-Behaviour* (1+1/2 26+23 case): Table 6.2.2-2 applies in both 1Tx and 2Tx operation**     - **Declaring *modifiedMPR-Behaviour* is reserved for PC2 2x1 architecture (26+26dBm) cases if introduced.** * **Section G TxD should point at PC2 and PC1.5 2Tx tables in section D that are applicable to TxD (2x1/2 cases) for both 2Tx and 1Tx transmissions.** |
| [**R4-2201772**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201772.zip) | Draft CR TS 38.101-1 R17: moving 2Tx MPR to clause 6.2D and amending PC2 2TX MPR | Skyworks Solutions Inc. | CR moving MPR tables to section D |

## Open issues summary

### Sub-topic 2-1: MPR requirements for 26+23 implementation

Sub-topic description: Sub topic has two targets

Deciding the MPR applicability for 26+23 that was left open in previous meeting.

Finalizing CR needed to implement the MPRs and correct references

Relevant proposals:

[**R4-2200499**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200499.zip)**:**

**Proposals on MPR requirements:**

* **PC2 2Tx MPR for 1+1/2 is introduced only for 1CC and 2CC UL MIMO reusing existing MPR tables**

**Proposals for 1CC UL MIMO and TxD sections:**

* + **For PC2 UEs not declaring *TxD* nor declaring *modifiedMPR-Behaviour* (1+1/2 26+23 case): Table 6.2.2-2 applies in both 1Tx and 2Tx operation**
    - **Declaring *modifiedMPR-Behaviour* is reserved for PC2 2x1 architecture (26+26dBm) cases if introduced.**
* **Section G TxD should point at PC2 and PC1.5 2Tx tables in section D that are applicable to TxD (2x1/2 cases) for both 2Tx and 1Tx transmissions.**

[**R4-2201267**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201267.zip)

**Proposal 1: For 23+26 PA configurations the 26 PA will always be applied in single antenna port and the 1Tx PC2 MPR requirements will be applied.**

**Proposal 2: For UE reporting TxD capability, it can be interpreted as this UE only has two half power PAs and the TxD MPR is applied in single antenna port.**

**Proposal 3: For UE with 23+26 PA configurations, when works under UL MIMO, it can follow 26+26 MPR. And use TxD capability to distinguish the requirements UE apply in UL MIMO.**

[**R4-2201228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201228.zip)

**Proposal 1:** **MPR requirements for 2Tx are assumed for 23+26 dBm with TxD indication**

**Proposal 2: if proposal 1 is acceptable, using the TxD indication together with the supporting power class could distinguish the applicable requirements.**

**Issue 2-1-1: 26+23 dBm implementation MPR for 1CC without UL MIMO**

* Proposals
  + Option 1: 1Tx PC2 MPR (R4-2201267)
  + Option 2: 2Tx PC2 MPR (R4-2201228)
  + Option 3: Other
* Recommended WF
  + TBA

**Issue 2-1-2: 26+23 dBm implementation MPR 1CC for UL MIMO**

* Proposals
  + Option 1: 1Tx PC2 MPR (R4-2201267)
  + Option 2: 2Tx PC2 MPR (R4-2200499, R4-2201228 with TxD)
  + Option 3: Other
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

Sub topic 2-1-1: 26+23 dBm implementation MPR for 1CC without UL MIMO

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| **Company** | **Comments** |
| Nokia | Option 1:  Clarification: Our answer is based on the assumption that a UE is in the state that UL MIMO is not being conducted.  We believe that it’s more sense not to talk about applicable MPR just only from supported capabilities only, but rather what is being conducted at the instance of measurement…  Better to make sure if we strictly follow the agreements that PC2 with 23 dBm x 2 and PC1.5 with 26 dBm x 2 only can indicate TxD or not.  We think that observations 1 and 2 by Xiaomi are valid. If we follow the discipline of TxD that RAN4 agreed, the table from Xiaomi becomes as follows.   | TxD indication | Supporting Power class | MPR requirements | Possible PA configuration | | --- | --- | --- | --- | | No | PC2 | MPR for 1Tx | 23+26 | | Yes | PC2 | MPR for 2Tx | 23+23~~, 23+26~~ | | Yes | PC2 if PC1.5 is also supported | MPR for 1Tx for release 17 | 26+26 |   Then, MPR for 1Tx applies to 23+26 and this becomes the same as OPPO proposed. |
| ZTE | How to understand “ (26+23) implementation for 1CC without UL MIMO”,  If both PAs are active, does it mean TxD used? However, RAN4 agrees that “Only UE supporting 23+23 for PC2 and UE supporting 26+26 for PC1.5 are allowed to report TxD”.  If only 26dmB PA is active, then 1Tx PC2 MPR (Option 1) should apply. |
| Ericsson | Option 1. For verification of the power class (assume PC2 is indicated) the UE shall meet the requirement according to 6.2 per connector and 1TX MPR with the corresponding tolerances in 6.2.4.  We assume that this UE does not indicate TxD if it supports FP Mode 2 with full-power TPMI or UL-MIMO Rel-15 in the band. |
| Huawei, HiSilicon | Either is ok for us. Prefer to use TxD as indication to differentiate the applicable requirements. |
| Xiaomi | We should have a clear understanding whether TxD could be allowed for 23 +26 PA configuration since from the WF [R4-2119970] in the last meeting, for 23 +26 PA configuration, there is still no agreement whether it can indicate TxD for single antenna port. If TxD is allowed and indicated, we think 2Tx MPR is more reasonable since 2Tx is being used. |
| OPPO | Option 1.  For UE with 23+26, when it is configured with single antenna port, the full power PA should be used, and this UE shouldn’t report TxD capability. This will make the handling of UE architectures easier instead of complex MPR mappings to different UE architectures. |
| Samsung | Option 1 for the question if we know UE implementation is based on 23+26, but for the outcome of this discussion, we have comments:  The discussion of “TxD can be allowed for 23 + 26 PA configuration” means we have the capability or UE claim for that, but is that the intention of this discussion? Even we have agreement here, e.g. allow or forbid 23+26 UE to claim TxDiversity support, how can this be reflected in the spec if we can’t discriminate them from other UE? If we anyway have to rely on TxD support to define requirement applicability rule, then what is the impact from this discussion. We would like Moderator to clarify. |
| Apple | Prefer Option 1. According to the previous agreement only 23+23 for PC2 and 26+26 for PC1.5 should signal TxD. We would need a more detailed signaling if we extend TxD to other architectures. |
| Skyworks | Option 1 which is the same than our proposal in 00499 since TxD in our contribution is only applicable to PC2 23+23 and PC1.5 26+26 as we have already agreed. SO this is why UE not declaring TxD shall use 1Tx MPR table. If we want ful flexibility then we need additional signaling that differentiate at least the case where at least one full power PA is available. The baseline should be that PC3 and PC2 2Tx can be supported without requiring the support of TxD and thus have at least one full power PA. for PC1.5 TxD is implicit |
| Intel | Option 1. Prefer that TxD indicates two half power PAs and the MPR is applied as a single port. |
| Qualcomm | Option 1 |
| LGE | Support option 1 |
| vivo | Option 1.  For the case with no UL-MIMO, 23+26 is more reasonable to use 26dBm link to achieve PC2. |

Sub topic 2-1-2: 26+23 dBm implementation MPR 1CC for UL MIMO

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| **Company** | **Comments** |
| Nokia | Option 2:  Clarification: Our answer is based on the assumption that a UE is in the state that UL MIMO is being conducted.  Apart from TxD, since 2Tx is being used, 2Tx PC2 MPR must apply. |
| ZTE | Option 2, both PAs are active for 1CC with UL-MIMO. |
| Ericsson | Option 1 for single-port fallback if the UE supports FP Mode 2 with full-power TPMI or UL-MIMO Rel-15 in the band, Option 2 for any two-port requirement with tolerances according to 6.2D.4. |
| Huawei, HiSilicon | Option 2. |
| OPPO | Prefer Option 1 (same as 26+26) but Option 2 is also acceptable.  It relates to how we consider 23+26 PA configurations, Option 1 is considering it same as two full power PAs, while Option 2 consider it as two half power PAs. With Option 1 used then TxD capability can be reused to distinguish UE requirements for differentiate UE architectures both in single antenna port and UL MIMO as below: |
| Samsung | Firstly, we would like to clarify that the discussion here is only applied to 2-layer UL-MIMO (as indicated in the section title), which has not relationship with ULPFTx.  Although it is reasonable to follow Option 2 for 23+26dBm UE for UL-MIMO if we know the UE architecture is 23+26dBm, the problem is still how it is known to NW. If it is not known, seems we still need to rely on TxDiversity support to define requirement applicability. If so, it means UE vendors may like to claim TxDiveristy support for 23+26dBm UE to make sure 2TX PC2 MPR table is applied, and then it will make UE use 2TX PC2 MPR table for without UL-MIMO case. If so, it will be further complicated.  Considering that, OPPO’s preference is okay which make the requirement applicability only depends on TxDiversity support and don’t need to further find ways to differentiate 23+26dBm implemention, which it is not preferred to be disclosed from UE vendor perspective. |
| Skyworks | In 00499 we do not propose to use 2Tx MPR as we assume 23+26 shall not signal TxD and thus use 1Tx MPR (**Table 6.2.2-2 applies in both 1Tx and 2Tx operation) and we have agreements MPR should be the same for the same PA configurations. We have provided measurements showing that 1Tx MPR is sufficient in two antenna transmissions with 23+26dBm PA (for 1CC, it is different for 2CC) thus again:** (**Table 6.2.2-2 applies in both 1Tx and 2Tx operation)** |
| Qualcomm | Option 2 |
| LGE | Support option 2 |
| vivo | Either option is ok for us. Option 2 is more technically reasonable with 2Tx transmission. However, since we do not have other singling information except TxD, it is difficult to differentiate between differentiate this 26+23 architecture. Also as OPPO and Samsung explained, in order to keep requirements clear and simple, Option 1 is also acceptable, to let TxD be the only sign. |

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
| R4-2201772  Draft CR TS 38.101-1 R17: moving 2Tx MPR to clause 6.2D and amending PC2 2TX MPR | Ericsson: agreeable, for PC1.5 there should be a reference to 6.2D.2 in the general 6.2.2. |
| Huawei, HiSilicon: We see the main difference of the draft CR with that endorsed in last meeting is the MPR in Table 6.2D.2-1, which is aligned with agreement in last meeting. Draft CR is ok for us. |
| Skyworks: since other companies had sourced the two previous CRs which this CR is merging properly, we are happy to add the initial draft CRs companies as co-source if they wish so. |
| R4-2201269  Draft R17 CR on UL MIMO allback to TxD | Nokia: we don’t think it is necessary to add following texts under ULFPTx table. Requirements for ULFPTx shall be met not matter what a UE is supporting other features. Otherwise, the UE shall not indicate capabilities for ULFPTx at all. Unlike TxD, ULFPTx is configured with a UE by network. The network has a problem if the UE does not follow what’s expected in principle.  Adding texts implies that TxD always supersedes ULFPTx capabilities. If it were allowed, it would not make sense allowing the said UE to indicate both TxD and ULFPTx.  TxD requirements shall be tested under the condition that any ULFPTx are not configured with the UE. |
| Ericsson: not agreed, the TxD and the corresponding MPR requirements should be specified as an exception to the (default) single-antenna port requirements in 6.2. |
| Huawei, HiSilicon: We see only some clarification for MOP would be enough. |
|  | OPPO: Thanks for above comments, this CR is about the requirement application of UE supporting UL MIMO and TxD. When single antenna port is configured then which requirement it will apply. Without this clarification, then UE with TxD capability (23+23) will be pointed to 1Tx requirements in 6.2 rather than TxD section. |
|  | Samsung: Whether or not we need this CR depends on the description in 6.2G is enough to cover the case where UE support both TxD and UL MIMO, and scheduled by the fallback DCI. In the below description is clear enough for that purpose, we are okay not to specify the fallback DCI requirement explicitly for UE supporting TxD.   |  | | --- | | 6.2G.1 UE maximum output power for Tx Diversity For UE supporting Tx Diversity, the maximum output power as indicated by UE power class in Table 6.2.1-1is defined as the sum of the maximum output power from both UE antenna connectors. The period of measurement shall be at least one sub frame (1 ms). | |

## 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.*

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

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #3: SRS Antenna switching

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2200341**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200341.zip) | SRS virtualization for antenna switching | Qualcomm Incorporated | **Observation 1: UE always has knowledge if the usage of the scheduled SRS transmission**  **Observation 2: Usage of the single individual actually transmitted SRS is not shared**  **Proposal: SRS shared usage is not creating ambiguity in SRS virtualization and what ΔTxSRS to apply** |
| [**R4-2200484**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200484.zip) | Relation of TxD and SRS antenna switching | Nokia, Nokia Shanghai Bell | **Observation 1: In terms of keeping consistency between the requirements for signal band/carrier operation and TxD and allowing other than 23 dBm + 23 dBm PA configurations, ∆TRxSRS is more appropriate than ∆PPowerClass.**  **Observation 2: Still some clarification for the existing requirements for ∆TRxSRS is necessary. For instance, PC2 2T4R relaxation value of ∆TRxSRS must not be 6 or 7.5 dB.**  **Observation 3: At this moment, it seems ∆TRxSRS is more suitable while the final decision must be made after seeing the whole picture of the impact of TxD on the SRS related specification as well as the resolutions of existing requirements allowing unnecessary relaxation.**  **Observation 4: For *codebook*, as far as a UE keeps using the same virtualization for UL, the virtualization would not cause the issue. For *nonCodebook* and *beamManagement*, antenna virtualization would not be allowed.** |
| [**R4-2200859**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200859.zip) | SRS antenna switching with antenna virtualization | Ericsson | **Observation 1: the current requirement of the Pcmax requirement for SRS antenna switching allows a blanket relaxation ∆TRxSRS = 6 dB for any PC2 implementation.**  **Proposal 1: the ∆TRxSRS is a maximum allowance due to additional routing loss for RX antennas, the same value for all power classes (but can be band dependent)**  **Proposal 2: for 2 Tx Ues indicating *txDiversity-r16* (TxD) and ULFPTx except when configured for Mode 0 and Mode 2 supporting full-power TPMI, ΔPPowerClass = 3 dB for single-port SRS transmissions with usage set to ‘antennaSwitching’**  **Proposal 3: for 2 Tx Ues indicating ULFPTx Mode 2 supporting full-power TPMI (23PA + 26PA), introduce UE capabilities identifying if 1T4R or 2T4R-1T4R Ues are sounding the antenna connectors with different input power for single-port SRS transmissions e.g. by using ΔPPowerClass.** |
| [**R4-2200860**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200860.zip) | Pcmax for SRS usage set as antenna switching for TxD and UL-MIMO features | Ericsson | CR with the 859 content |
| [**R4-2200959**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200959.zip) | Further discussion on SRS antenna switching for TxD | vivo | **Proposal 1:** With TxD capable UE that with only half-power PA compared to declared power class possible, new relaxation of 3dB should be introduced for the cases of optimum Tx chain, while 2T4R which adapt to TxD can still have no relaxation.  **Observation 1:** *SRS-TxSwtich* can be continued to use in Rel-17, while introducing *SRS-TxSwtich-v1610* parameters would make the requirements more complicated.  **Observation 2:** Requirements depend on other Rel-16 signalling such as *SRS-TxSwtich-v1610* may bring more difficulty for release independency of TxD to be achieved.  **Proposal 2:** Continue to use Rel-15 capability *SRS-TxSwtich* for Rel-17 TxD requirements and do not introduce *SRS-TxSwtich-v1610,* for simpler spec and easier release independency.  **Proposal 3:** Continue to consider lower possible PA configuration as current requirements did.  **Proposal 4: Use 3dB bigger IL rater than delta\_powerclass.**  **Proposal 5: Simply the relation between SRS power relaxations and Rel-16 ULPFTx modes, and minimise the appearance of ULPFTx modes**  **Proposal 6.** A draft text proposal for SRS requirements, the developing procedure is as following, were provided in Annex and also include the CR.   * + Separate and list all the detailed conditions and corresponding insertion loss requirements;   + Group and combine the conditions by different set of requirements, combine TxD capable and non-TxD capable UE;   + Doing editorial refinements to make structure clearer;   **Observation 5:** There is possible contradiction if the same SRS shared by two resource sets was required to not use UL AV in one set while need/mandatory to use UL AV to adapt PUSCH for TxD in another resource set.  **Observation 6:** According to RAN ½ specs, there is no limitation on whether UE is expected to be configured with an SRS resource, which is shared by 2 SRS resource sets with different usage.  **Proposal 7.** Send a LS to RAN1 to explain RAN4 agreements, and ask to clarify the case about SRS resource sharing between resource sets with different usage to avoid contradiction and make revisions if necessary. |
| [**R4-2200960**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200960.zip) | Draft CR on SRS antenna switching for TxD | vivo | CR  UE transmits SRS to a DL-only carrier   * The value of ∆TRxSRS is 4.5dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 3 dB for bands whose FUL\_high is lower than the FUL\_low of n79 * when the device is capable of power class 3 or power class 5 in the band, or * when the device is capable of power class 2 in the band and ΔPPowerClass = 3 dB, or * when the device is capable of power class 1.5 in the band and ΔPPowerClass = 3 or 6 dB * The value of ∆TRxSRS is 7.5dB for bands whose FUL\_high is higher than the FUL\_low of n79 and 6 dB for bands whose FUL\_high is lower than the FUL\_low of n79 * when the device is capable of power class 2 or 1.5 in the band and ΔPPowerClass = 0 dB.   b) UE indicating Tx diversity and transmits SRS on the first SRS resource in every configured SRS resource set when the *SRS-TxSwitch* capability is indicated as ‘t1r2’,  or UE indicating Tx diversity and transmits SRS on the first SRS resource of the total 4 SRS resources from all configured SRS resource set(s) consisting of one SRS port when the *SRS-TxSwitch* capability is indicated as ‘t1r4’ or, ‘t1r4-t2r4’   * The value of ∆TRxSRS is 3dB |
| [**R4-2201227**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201227.zip) | Discussion on Tx diversity SRS antenna switching | Xiaomi | **Proposal 1: For 23+23 and 26+26, additional 3dB power reduction shall be allowed for 1st SRS port for ∆TRxSRs for 1T/2R and 1T/4R for UE indicating TxD**  **Observation 2: For 23+23 and 26+26, the allowed additional power reduction can be 3dB or 3dB+IL pending on UE implementation for 2nd SRS port for ∆TRxSRs**  **Proposal 2: For 23+23 and 26+26, additional 3dB +IL power reduction shall be allowed for 3rd and 4th SRS port for ∆TRxSRs for 1T/4R for UE indicating TxD**  **Proposal 3: For all PC configuration (23+23, 26+26, and 23+26 ), the existing additional power reduction for non TxD could be reused for UE indicating TxD for 2T/2R and 2T/4R**  **Proposal 4: For 23+26 with TxD for 1T/2R and 1T/4R, if no 3dB is allowed for 1st SRS port, this PC configuration needs to be distinguished by signaling.** |
| [**R4-2201271**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201271.zip) | R17 SRS IL for TxD | OPPO | **Proposal 1: Only consider TxD UE with two PC3 PAs for the PC2 SRS IL analysis.**  **Proposal 2: For 1T4R SRS switch, antenna 0 is 3dB lower than power class, antenna ½/3 are 3dB for bands lower than n79 and 4.5dB for n79.**  **Proposal 3: For 2T4R SRS switch, IL is defined only for 3rd and 4th antenna, and it is 3dB for bands lower than n79 and 4.5dB for n79.**  **Proposal 4: For 1T2R SRS switch, antenna 0 is 3dB lower than power class, antenna 1 is 3dB for bands lower than n79 and 4.5dB for n79.**  **Proposal 5: For 1T2R or 1T4R SRS switch**   * **the main antenna Tx power will be modified with 3dB delta Ppowerclass** * **other antennas Tx power will be modified with delta TRxSRS, i.e. 3dB for bands lower than n79 and 4.5dB for n79**   **Proposal 6: For 2T4R SRS switch, total Tx power of antennas other than main antennas will be modified with delta TRxSRS, i.e. 3dB for bands lower than n79 and 4.5dB for n79**  **Observation 1: When SRS resources are shared between different usages, same hardware is used in implementation.**  **Proposal 7: TxD cannot be applied when SRS resources are shared between antenna switching and other usages due to same hardware are used.** |
| [**R4-2201272**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201272.zip) | Draft R17 CR on SRS IL for TxD | OPPO | CR:  - 3dB when UE indicating [*txDiversity-r16*] and is configured with ‘t1r1-t1r2’ or ‘t1r1-t1r2-t1r4’; |
| [**R4-2201799**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201799.zip) | Further discussion on SRS antenna switching requirements for TxD | ZTE Wistron Telecom AB | **Proposal 1: RAN4 to clarify the 3dB power reduction applicable only for the case with no SRS antenna port virtualization.**  **Proposal 2: RAN4 to use ∆PPowerClass to specify the 3dB power reduction for SRS antenna switching.**  **Proposal 3: RAN4 to capture the lower power SRS relaxation due to TxD in TxD subclauses if considering its strong relativeness to TxD.** |
| [**R4-2201940**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201940.zip) | On SRS relaxation | Huawei, HiSilicon | **Proposal 1: Specify the additional power reduction via ∆TRxSRS to better reflect the cause of the power loss.**  **Proposal 2: It is proposed to have all description related to ∆TRxSRS in the general clause, but the parameter can also be mentioned in suffix G for TxD as a clarification.**  **Proposal 3: No SRS antenna port virtualization for the usages other than SRS antenna switching if the SRS resource is reused as that for antenna switching, and no specific requirements need to be considered for other cases.** |
| [**R4-2200499**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200499.zip) | Requirement and ignalling aspect of features requiring two transmit paths | Skyworks Solutions Inc. | **Proposals on transmit path architecture options simplification for R17:**   * **TxD is signalled only for 2x1/2 architecture and is implicit for PC1.5, and thus use 2Tx MPR in all modes and is granted 3dB power relaxation for SRS antenna switching** * **When TxD is not signalled, 1Tx MPR is used for single antenna transmissions and no power relaxation is granted for SRS antenna switching.**   + **As a consequence, 2T2R is not supported for 1+1/2 architecture**   + **It would be logical that a 2x1 architecture implements 2T2R, but 1T2R is not precluded** |

## Open issues summary

### Sub-topic 3-1: SRS ant switching power delta compared to power class

Sub-topic description: SRS antenna switching delta Tx. It has been agreed earlier that the UE that needs to virtualize for full power, does not virtualize for SRS for antenna switching. How does this 3 dB lower power get implemented in the specifications will be discussed.

It should be noted that R4-2200860 changes legacy requirements and that part should be discussed in the earlier release maintenance.

**Issue 3-1-1: Which parameter to use to define the 3 dB power difference?**

* Proposals
  + Option 1: ∆PPowerClass (R4-2200859, R4-2201799,R4-2201271 (main antennas)
  + Option 2: ∆TRxSRS (R4-2200484, R4-2201940, R4-2201227, R4-2200959, R4-2201271 (other than main antennas)
* Recommended WF
  + TBA

**Issue 3-1-2: Is SRS power difference for antenna switching dependent on other features than TxD**

* Proposals
  + Option 1: Yes, ULFPTx (R4-2200859)
  + Option 2: No, only TxD indication (R4-2200499, R4-2201940, R4-2201799, R4-2201271, R4-2201227)
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

**Issue 3-1-1: Which parameter to use to define the 3 dB power difference?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 2.  If RAN4 strictly follows that TxD is only half rated PA x 2 for the declared PC such that 23+23 for PC2 and 26+26 for PC1.5, Option 1 could be an acceptable option. |
| ZTE | Option 1.  The 3dB power difference originates from the fact that a UE needs to relay on TxD to reach its full power, but SRS does not use TxD. And this 3dB power difference applies to all power classes.  ∆TRxSRS describes additional routing loss between PA and non-main-antennas and it does not apply to the main antennas. Thus ∆PPowerClass best fits for the 3dB power difference origin in this case. |
| Ericsson | Option 1 to  a. ensure that a UE does not virtualize during antenna measurements for DL CSI acquisition;  b. avoid the TRxSRS = 6 dB blanket relaxation for PC2 for 23PA + 26PA implementations for any SRS transmission.  The  Moreover, the gNB would be aware that a UE indicating TxD is using 3 dB lower input power that its advertised power class for sounding an antenna connector.  This discussion is only relevant for one-port SRS transmissions. |
| Huawei, HiSilicon | Prefer option 2.  The issue for option 1 is that it also modifies Pcmax,h, which in our view is not necessary. |
| Xiaomi | Either is ok for us as long as the relaxation is the same and reasonable. |
| OPPO | Option 1+Option 2.  If only talk about the 3dB power loss due to TxD capability then delta Ppowerclass should be used since this is the power reduction to main antenna.  If the IL due to SRS antenna switching is also talked here then delta Trxsrs should be used in addition to the main antenna loss, i.e. delta Ppowerclass + delta Trxsrs, and is only apply to other antennas. |
| Samsung | We need more clarification on Ericsson’s option, especially for “For a UE supporting *ul-FullPwrMode2-TPMIGroup-r16*, ΔPPowerClass = 3 dB as indicated by [srs-TxSwitchPwr] during SRS transmission occasions with configured SRS resources in the SRS resource set(s) consisting of one SRS port.” The detailed definition of [srs-TxSwitchPwr], and under which the feature is introduced needs to be clarified. To us, Option 1 is too complicated if we couple this with ULPFTx. |
| Apple | Option 1. Otherwise, due to the usage of two half power amplifiers the UE could use antenna virtualization SRS antenna switching to boost power output which disrupts DL CSI estimation. |
| Skyworks | Preference for Option 1, if we agree that TxD is only for PC2 23+23 and PC1.5 26+26 may a better name is Delta TxD? We do belive that there are still potential issues for 2T2R vs 1T2R for the PC2 26+23 case since in 2T2R case both PA may be mapped to given Rx antennas. We think it is simpler to not allow 2T2R for 26+23. There are case for 26+26 other that PC1.5 as 26+26 is needed for NC ULCA with 2LO that can deliver 26dBm all all Rx antennas with 2T2R. |
| vivo | Prefer option 2. Suppose UE still using antenna virtualization is unreasonable. However, in order to making progress, option 1 is also acceptable if it becomes majority view. |

**Issue 3-1-2: Is SRS power difference for antenna switching dependent on other features than TxD**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Not sure why RAN4 has been discussing this. We suggest to introduce SRS antenna switching requirements specific to ULFPTx. |
| ZTE | Option 2. |
| Ericsson | Option 1.  The ULFPTx modes are implemented with multiple PA all of which can be used for antenna sounding. In particular, the TRxSRS = 6 dB blanket relaxation for PC2 is included to accommodate a 23PA + 26 PA presumably supporting Mode 2 with full-power TPMI.  A FP Mode 1 *might* indicate TxD at least if implemented with two half-power rated PAs (if not to meet the power class requirements for PUCCH). If the latter, the UE must virtualize to meet full power, also for SRS.  Since UEs supporting (full-power) UL-MIMO and TxD can be implemented with different PA architectures (23PA + 23PA etc), it is relevant to define the SRS power requirements in the main clause 6.2.4 since these apply also if the said UE is not configured with UL-MIMO. |
| Huawei, HiSilicon | Option 2. There is no agreement even in RAN1 that ULFPTx modes can be mapped to unique UE implementation. |
| Xiaomi | Option 2 |
| OPPO | Option 2. It was agreed only 23+23 are allowed to report TxD. No matter ULFPTx mode 1 or PC1.5, both apply TxD. |
| Samsung | Option 2. |
| Apple | With the understanding that the SRS power difference can also occur for other operations than TxD (e.g. ULFTP mode 2) option 1 can make sense |
| Skyworks | We agree that UE not declaring UL full power will also have issue on top of UE requiring TxD to meet UL full power. |
| vivo | Option 2 |

### Sub-topic 3-2: SRS shared use ambiguity

Sub-topic description: It has been brought to ran4 attention that the same SRS can be shared and it would be ambiguous if UE needs to virtualize SRS or not.

Open issues and candidate options before e-meeting:

**Issue 3-2-1: Can SRS be shared?**

* Proposals
  + Option 1: yes, SRS symbol can be shared with two different usages and ambiguity if virtualization is needed or not exists
  + Option 2: SRS symbol is never shared and ambiguity does not exist
* Recommended WF
  + TBA

**Issue 3-2-2: Does RAN4 need to send LS to RAN1 about SRS sharing issue**

Issue 3-2-1 will have impact here but we can discuss the text already in 1st round since this is second meeting to discuss this issue

* Proposals
  + Option 1: yes, see proposed draft text in R4-2200959
  + Option 2: No
* Recommended WF
  + TBA

### Companies views’ collection for 1st round

**Issue 3-2-1: Can SRS be shared?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | We are not sure what the fundamental problem is…  So, we guess there could be two meanings of “share”.  Assumption 1: An SRS resource ID can be used under different SRS resource sets with different usage.  As Qualcomm mentioned, process unit is per SRS resource set, so this situation alone is not the problem.  Assumption 2: Obtained estimation from an SRS resource ID under an SRS resource set is referred to for the other usage which wanted to use the same ID(but stopped using it) to reduce signaling overhead.  In this case, virtualization must not be used in any usage not to cause inconsistency between the usage of the obtained estimation |
| ZTE | An SRS resource can be used for different usages, but not simultaneously. |
| Ericsson | Option 1. There is nothing in the RAN1 specifications that prevents that an SRS resource is configured in multiple sets with different usage. However, if these sets are of different resource types (aperiodic etc) then the lower priority SRS transmission is dropped in an OFDM symbol if overlapping with the SRS of the higher-priority type in the same OFDM symbol (the priority order is aperiodic/semi-persistent/periodic). Moreover, the UE capability would be unclear for simultaneous transmission of something other than beam management sets.  We assume that there is no power sharing issue for a (shared) SRS resource triggered for antenna switching. However, virtualization at different times should be consistent. |
| Huawei, HiSilicon | SRS resource can be shared by different usages, but we think that there should be no ambiguity. If the resource is shared with SRS antenna switching, then delta SRS can be considered, otherwise, there is no limitation that SRS cannot be virtualized for other usages. |
| OPPO | There is no restriction in RAN1 to forbidden share SRS resources between different usage. However, we don’t see the ambiguity in antenna virtualization. When SRS resources are shared between antenna switching and other usage, it is expected same hardware will be used among these usages. Then once antenna virtualization is forbidden from antenna switching, it makes virtualization cannot be used in other usages either. Not sure what could be the alternative implementation. |
| Samsung | Option 1 and further clarification is needed, either from RAN1 or another option is to define some requirement applicability in RAN4 to make sure one kind of requirement is applied. |
| Qualcomm | SRS resource id can be shared but SRS transmission is triggered with SRS Resource sets and the usage for set is unique. We are not sure of the case if the SRS is scheduled (in one or two way) overlapping in same symbols which is in our view an error case. Our understanding that UE is not expected to transmit simultaneous SRS on same CC or different CC on same band except if SRSs are for antenna switching. In this case, the SRS id’s would be different since SRS resource id defines the RBs for SRS.  Option 2. |
| vivo | Option 1. We already make examples in our discussion paper. Our understanding is that the status of RAN1 spec does not prevent network from sending RRC command, configuring UE the same SRS resource ID in different SRS sets with different usage.  As long as we can have a clear rule on how to treat this ambiguity, e.g. what Huawei has proposed in their discussion paper “*No SRS antenna port virtualization for the usages other than SRS antenna switching if the SRS resource is reused as that for antenna switching*”, is also a possible WF, and there may not be necessary for specific new requirements. |

**Issue 3-2-2: Does RAN4 need to send LS to RAN1 about SRS sharing issue**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | It depends on the outcome of the discussion. At least this must be discussed not in RAN4 but rather in RAN1. |
| ZTE | Option 2. As long as the multiple usages are not at the same time, the current ignaling design is enough, thus there is no need to send an LS to RAN2. |
| Huawei, HiSilicon | Prefer option 2. Seems no need to send the LS to RAN1. |
| OPPO | Option 2. |
| Samsung | Depends on the outcome from Issue 3-2-1. If no clear RAN4 agreement is obtained, LS to RAN1 is one way to follow. |
| Qualcomm | No, RAN4 does not need a clarification. |
| vivo | Both options are ok.  Although option 1 is proposed by us, it would be also fine if we can align understanding in RAN4 and work on clarifications directly, in case the LS is not needed. |

### 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** |
| R4-2201272  Draft R17 CR on SRS IL for TxD | Nokia:  We need to wait for the outcome of ∆PPowerClass or ∆TRxSRS .In our understanding, network cannot configure a UE with 't1r1-t1r2' or 't1r1-t1r2-t1r4'. Network configures the UE SRS resources with some side conditions based on UE’s capabilities. Is it possible for the network directly to configure the UE with 't1r1-t1r2' or 't1r1-t1r2-t1r4'?  Ericsson: : agreeable in principle, but the case of 23 + 26 dBm should be singled out and allowed an exception (preferable by a capability indication) only for single-port SRS. The Ppowerclass should only be applicable during the SRS transmission occasion.  OPPO:  Thank Nokia comment, you are right NW cannot configure 't1r1-t1r2' or 't1r1-t1r2-t1r4' directly and it actually use configured SRS resources for UE to transmit SRS signals. Then, maybe wording like “3dB when UE indicating [*txDiversity-r16*] and transmit SRS according to *SRS-TxSwitch* capability 't1r1-t1r2' or 't1r1-t1r2-t1r4'”.  Thanks Ericsson comment, with the agreement that only 23+23 can indicate TxD capability, the 23+26 will be rule out from this relaxation already. And regarding during SRS transmission occasion, how about the wording above? |
| R4-2200960  Draft CR on SRS antenna switching for TxD | Nokia:  We need to wait for the outcome of ∆PPowerClass or ∆TRxSRS Ericsson: not agreed. The UE should not virtualize SRS transmissions for antenna measurement. According to item b. a UE indicating TxD is allowed TRxSRS = 3 dB for one-port SRS transmissions, which means that it must virtualize to meet the SRS requirement on an R port according to its power class (also applies for SRS). This contradicts the agreement.  Moreover, a blanket TRxSRS = 6 dB is allowed for any PC2 implementation (and any SRS transmission) – not good for DL MIMO performance. |
| R4-2200860  Pcmax for SRS usage set as antenna switching for TxD and UL-MIMO features | Nokia:  We need to wait for the outcome of ∆PPowerClass or ∆TRxSRS and dependency of ULFPTx and TxD on SRS antenna switching requirements.  Huawei: We see no need to couple ULFPTx modes together with 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** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Topic #4: ULFPTx and TxD

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2200483**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200483.zip) | Relation of MOP between TxD and ULFPTx | Nokia, Nokia Shanghai Bell | **Observation 1: No need to mention a case when a UE does not indicate TxD capability under clause D.**  **Observation 2: Only *ul-FullPwrMode1-r16* could be allowed to have an exception and to meet MOP in 6.2G and the other two modes do not need exceptions.**  **Proposal: Expected spec change for the text under the Table 6.2D.1-3 is as follows.**  If UE is scheduled for single antenna-port PUSCH transmission by DCI format 0\_0 or by DCI format 0\_1 for single antenna port codebook based transmission, the requirements in clause 6.2.1 apply for the power class as indicated by the *ue-PowerClass* field in capability signalling with the following exceptions: for Ues being configured with *ul-FullPwrMode1-r16*, the requirements in clause 6.2G for the power class indicated by the *ue-PowerClass* apply. |
| **[R4-2200861](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200861.zip)** | Single-antenna falback for TxD and UL-MIMO (including ULFPTx) | Ericsson | **Proposal 1: for 2 TX connectors, the single-antenna fallback requirements for UL-MIMO for TxD and the ULFPTx modes should be set as follows**   * **“Default” are the requirements in 6.2 per connector, where the UE can reach full power for a TX connector** * **Mode 2 with full-power TPMI shall meet the requirements in 6.2 with MPR for 1 TX for at least one Tx connector, regardless of any TxD indication, since Ues with full power TPMI support should be able to transmit full power on a Tx connector** * **Mode 0 shall meet 6.2 for both connectors, since such Ues will support full power on both Tx chains.** * **Ues supporting UL-MIMO with TxD and/or ULFPTx Mode 1 shall meet the requirements in 6.2G** * **Ues that support Mode 2 without support of full-power TPMI are not specified in Table 6.2D.1-3 for two-port transmission so are therefore not specified for single-antenna port fallback.** |
| [**R4-2200862**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200862.zip) | TxD and UL-MIMO requirements for single-port antenna transmission | Ericsson | CR:  If the UE is scheduled for single antenna-port PUSCH transmission by DCI format 0\_0 or by DCI format 0\_1 for single antenna port codebook based transmission, the requirements in clause 6.2 apply for at least one antenna connector for the power class as indicated by the *ue-PowerClass* field in capability signalling with the following exceptions: for Ues indicating [*txDiversity-r16*] or *ul-FullPwrMode1-r16*, the requirements in clause 6.2G for the power class indicated by the *ue-PowerClass*.  A UE indicating *ul-FullPwrMode2-TPMIGroup-r16* shall meet the requirement in clause 6.2 for at least one antenna connector when scheduled for single antenna-port transmission by DCI format 0\_0 or by DCI format 0\_1 for codebook-based transmission on a single antenna port.  + 6.2D.2 and 6.2D.3 changes accordingly |
| [**R4-2200961**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200961.zip) | Discussion on ULFPTx with TxD | vivo | **Observation 1:** There are some contradictions of reference architecture for some capability combinations.  **Observation 2:** Those contradictory cases happened to be the same to the cases where the proposals are different.  **Observation 3:** Discuss case by case for contradictory cases may not meaningful and quite complicated.  **Proposal: Unified requirements among different ULFPTx capabilities is preferred.** |
| [**R4-2201268**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201268.zip) | R17 FR1 TxD and ULFPTx | OPPO | **Proposal 1: Spec should cover the typical implementations with reasonable benefits and avoid of sweeping all kinds of capability combinations.**  **Proposal 2: TxD is not allowed when UE has full power PA no matter which ULFPTx modes it supports.**  **Proposal 3: For UE with TxD, 2Tx requirements always apply when fallback from ULFPTx to single antenna port mode, otherwise, single Tx requirements apply.**  **Proposal 4: Update UL MIMO fallback to single antenna port requirement to clarify that UE with Tx diversity capability will apply 6.2G.1 requirements.** |
| [**R4-2201762**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201762.zip) | Further Discussion on Transparent TxD – ULFPTx related | Samsung | **Observation-1: In the Section 6.2D.1 MOP requirement for UL-MIMO, there is not requirement applicable to the UE supporting Tx diversity scheduled for single antenna-port PUSCH transmission by DCI format 0\_0 or by DCI format 0\_1 for single antenna port codebook based transmission.**  **Observation-2: After TxD UE is introduced in Rel-17, MOP requirement of Rel-16 ULFPTx Mode-1 UE needs no revisit.**  **Proposal-1: For UE supporting ULFPTx Mode-1 but not explicitly indicating its support of TxD, UE needs to use single Tx to fulfil MOP for “fallback DCI”.** |
| [**R4-2201798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201798.zip) | Further discussion on ULFPTx with TxD | ZTE Wistron Telecom AB | **Proposal 1: Dual Tx requirements should apply for Case 1 (Mode-1 & No TxD).**  **Proposal 2: Dual Tx requirements should apply for Case 2 (Mode-2 Mechanism 1 & No TxD).**  **Proposal 3: Dual Tx requirements should apply for Case 3 (Mode-2 Mechanism 2 & TxD).**  **Proposal 4: Dual Tx requirements should apply for Case 4 (Full power Mode, TxD).**  **Proposal 5: Unified requirements among different ULFPTx capabilities should be considered.** |
| [**R4-2201942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201942.zip) | On ULFPTx and applicable MPR requirements for different PA configurations | Huawei, HiSilicon | **Observation 1: There is no one-to-one mapping relationship between the UE implementation architectures and the ULFPTx modes.**  **Proposal 1: It is proposed to distinguish the applicable requirements for 2Tx implementation just based on TxD indication.** |
| [**R4-2202051**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2202051.zip) | ULFPTX Mode 2 and TxD | Qualcomm Incorporated | **Observation 1: With scope limited to two antenna connectors, mode 2 can not be supported by UE with TxD**  **Observation 2: UE with at least one full power PA, can not virtualize for full power support.**  **Proposal: UE will support same power class in MIMO as it supports for fall back DCI.** |

## Open issues summary

This topic target is to

1) define requirements for ULFPTx for UE which indicates TxD, or then not explicitly define any couplings.

2) Agree appropriate changes to the TS 38.101-1

### Sub-topic 4-1: Explicit requirements for ULFPTx and TxD

Sub-topic description: Should the requirements be agreed and written case by case or not refer to either suffixless or G or D requirements.

Open issues and candidate options before e-meeting:

**Issue 4-1-1: Should requirements be explicitly defined or not**

* Proposals
  + Option 1: Yes, agree requirements for each ULFPTx case separately
  + Option 2: No, references to other requirements when UE support ULFPTx should not be detailed
* Recommended WF
  + TBA

**Issue 4-1-2: Will requirements depend on UE indicating TxD or not**

* Proposals
  + Option 1: Yes, use TxD indication in requirements for ULFPTx
  + Option 2: No, requirements for ULFPTx and fallback behavior are not referring to TxD indication
* Recommended WF
  + TBA

### Companies views’ collection for 1st round

**Issue 4-1-1: Should requirements be explicitly defined or not**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | It’s straightforward to introduce requirements specific to ULFPTx apart from TxD in Section with suffix D. Only an exception should be written if any. |
| ZTE | Option 2. Unified requirements for ULFPTx and TxD modes are possible. |
| Ericsson | Option 1.  The requirements should be detailed as there are no restrictions in the RAN2 specifications whether a UE supporting a particular full-power mode can indicate TxD. Examples: a Mode 1 UE should be verified according to 6.2G in fallback regardless of TxD indication for its *understood* that this is implemented with two half-power PAs. In fact, such a Rel-16 compliant UE will have to indicate TxD (by early indication) to be verified in accordance with 6.2G specified in the Rel-17 version. A Mode 2 with full-power TPMI, on the other hand, shall meet the single-port fallback requirement per connector regardless of any TxD indication.  The RAN4 agreements on the indication of TxD are not captured in any specification (this is not expected). If captured/specified, then RAN4 requirements could have been be simplified (if a Mode 2 with full-power TPMI is not allowed to indicate TxD then no need to list explicitly this fallback requirement). |
| Huawei, HiSilicon | Option 2. Firstly, there is no specific implementations mapped to corresponding ULFPTx modes, which is already clarified by RAN1. Secondly, we doubt that UE will intendedly to use TxD indication just for using the relatively relaxed MPR requirements. |
| OPPO | Both options are ok. |
| Samsung | Option 2 to be considered as baseline by just trying to use TxD for requirement applicability rule.  If RAN4 want to further clarify above two low priority case, then some further applicability rule could be given. |
| Qualcomm | Option 2 |
| LGE | Option1. For the TxD capability signaling with 23+23 only, the requirements should be explicitly defined for each feature. |
| vivo | Prefer option 2. |

**Issue 4-1-2: Will requirements depend on UE indicating TxD or not**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 2: In principle it should not be. But if there is an exceptional case, it can be written but that is not based on TxD but rather this comes from ULFPTx feature itself. More specifically, we are OK to handle Mode 1 as an exceptional case and apply it to TxD requirements. But this outcome is not based on TxD. Fundamentally, mode 1 assumes half rated PA usage so that just as coincidence, the same requirements of TxD applies to it. Then, in order to save pages, we just refer to TxD requirements for this particular case. |
| ZTE | Option 2. Dual Tx requirements can apply independently from TxD. |
| Ericsson | Option 2.  See comment to Issue 4-1-1, only some of the full-power modes should be verified according to clause 6.2G in fallback. |
| Huawei, HiSilicon | Option 1. See comments for Issue 4-1-1. |
| OPPO | TxD requirements could be applied to mode 1, either with TxD capability or mode 1 capability are ok. |
| Samsung | Option 2. |
| Apple | We see TxD and ULFPTx as independent features even if they share similarities. As Nokia described it might be possible to reuse requirements for mode 1 as those will be the similar. However, we have to consider that for some reason a 23+26 UE declares mode 1 (which to my understanding is allowed). Then TxD requirements cannot be applied as we agreed that only 23+23 and 26+26 UEs can indicate and use TxD requirements. |
| LGE | Option 2. In specific PA architecture, can be applied the same MPR requirements regardless of TxD capability. |
| vivo | Not clear about the question. |

### Sub-topic 4-2. Mode specific requrements

Sub-topic description: Mode specific requirements references case by case

Open issues and candidate options before e-meeting:

**Issue 4-2-1: Mode 1 (*ul-FullPwrMode1-r16*) requirements**

* Proposals
  + Option 1: Mode 1 refers to TxD requirements for fall back DCI
  + Option 2: Mode 1 refers to suffixless requirements for fallback DCI
  + Option 3: Mode 1 refers to suffixless and TxD requirements for fallback DCI
  + Option 4: Other, please explain what constraints
* Recommended WF
  + TBA

**Issue 4-2-2: Mode 2 (***ul-FullPwrMode2-TPMIGroup-r16***) requirements**

* Proposals
  + Option 1: Mode 2 refers to TxD requirements for fall back DCI
  + Option 2: Mode 2 refers to suffixless requirements for fallback DCI
  + Option 3: Mode 2 refers to suffixless and TxD requirements for fallback DCI
  + Option 4: Other, please explain what constraints
* Recommended WF
  + TBA

**Issue 4-2-3: Full power mode (**ul-FullPwrMode-r16**) requirements**

* Proposals
  + Option 1: Fullpower mode refers to TxD requirements for fall back DCI
  + Option 2: Fullpower mode to suffixless requirements for fallback DCI
  + Option 3: Fullpower mode to suffixless and TxD requirements for fallback DCI
  + Option 4: Other, please explain what constraints
* Recommended WF
  + TBA

## Companies views’ collection for 1st round

### Open issues

**Issue 4-2-1: Mode 1 (*ul-FullPwrMode1-r16*) requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 1 |
| ZTE | Option 1. Both PAs are active in Mode 1 at the same time to achieve full power. |
| Ericsson | Option 1 |
| Huawei, HiSilicon | Option 4. The applicable requirements just based on TxD indication. No exclusion that UE with 23+26 can also report mode 1, and no limitation that mode 1 can only be implemented with 23+23 for PC2. |
| OPPO | Option 1. |
| Samsung | Option 4. The applicable requirements just based on TxD indication.  We are not quite sure companies are answering the same question.  If ULFPTx Mode-1 UE also indicate its support of TxD, of course the TxD requirement should be followed: it is a TxD UE as it indicate!  Here we think we need to answer is if an ULFPTx Mode-1 UE but not indicate its support of TxD, then which requirement will be applied if fallback DCI is scheduled.  That is why vivo introduce the table to discuss in vivo’s WF in last meeting. |
| Apple | Similar concerns as Huawei. What happens if a 23+26 UE indicates ULFPTx mode 1? |
| Qualcomm | Agree wirth Samsung, Same companies say in 4-1-2 that no TxD will be referred for requirements in ULPFtx but then here say mode 1 refers to TxD in fallback. We can spec the mode 1 referring to TxD.  New alternative in discussion is to define power class capability for MIMO, same proposals as Apple and MTK made for CA. |
| LGE | 23+26 UE will indicated with mode 2 not mode 1 for ULFPTx mode. So support option 1. |
| vivo | Option 4. We prefer to use TxD indication as a simplified solution, though conceptually not that perfect. |

**Issue 4-2-2: Mode 2 (***ul-FullPwrMode2-TPMIGroup-r16***) requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 2 |
| ZTE | Option 2. Only full power PA is active in Mode 2 at a time. |
| Ericsson | Option 2 |
| Huawei, HiSilicon | Option 4. No reason to couple ULFPTx with specific UE implementations, which is not aligned with RAN1 understanding. |
| OPPO | Option 2. |
| Samsung | Option 4. Again, for UE support ULFPTx Mode-2 Mechanism-2 (*ul-FullPwrMode2-TPMIGroup-r16*), if this UE don’t indicate its support of TxD, no issue at all, and of course the requirement should be one TX antenna connector based as Rel-16 did.  But the problem comes from if this ULFPTx Mode-2 Mechanism-2 also indicate its support of TxD, we proposed in our contribution that it is a low priority case and we are okay even no requirement is defined for that at all. |
| Qualcomm | Option 2 |
| LGE | Option 4. As mentioned Samsung, the mode 2 is operated with 2 Tx antenna, then the UE follow the TxD requirement even though the UE do not indicate TxD signaling. |
| vivo | Option 4. Similar to previous issue.  Conceptually, option 2 is also fine |

**Issue 4-2-3: Full power mode (**ul-FullPwrMode-r16**) requirements**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia | Option 2 |
| ZTE | Option 2. Either of the two full power PAs is active at a time for the “FullPower” power class.  However, for the power class higher than the “FullPower”, e.g., 29dBm for 26dBm+26dBm(FullPower 26dBm), it should be Option 1 for 29dBm power class. |
| Ericsson | Option 2 |
| Huawei, HiSilicon | Option 4. No reason to couple ULFPTx with specific UE implementations, which is not aligned with RAN1 understanding. |
| OPPO | Option 2. |
| Samsung | Option 4. Similar comments as Issue 4-2-2. |
| Qualcomm | Option 2 |
| LGE | Option 4. For 2Tx antenna UE will follow TxD requirements. |
| vivo | Option 4. Similar to previous issue.  Conceptually, option 2 is also fine. |

### 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** |
| R4-2200862  TxD and UL-MIMO requirements for single-port antenna transmission | Nokia: Our views on this CR is written in our paper of R4-2200483.  We don’t see the reason to mention “for UEs indicating [*txDiversity-r16*]” and “A UE indicating *ul-FullPwrMode2-TPMIGroup-r16*”.  Regarding the latter, we understand the motivation but current Table 6.2D.1-3 does not mention anything on *ul-FullPwrMode2-TPMIGroup-r16* so that it may look odd suddenly to mention only this here. In addition, if we handle only *ul-FullPwrMode1-r16* as an exception*,* it seems UE is being configured with *ul-FullPwrMode2-TPMIGroup-r16* shall meetthe requirement in clause 6.2. Thus, we don’t think it is mentioned here, though mentioning itself is not harmful…  Ericsson to Nokia: the requirement for Mode 2 with full-power TPMI listed separately shall be met regardless of any TxD indication (even if the *understanding* is that a 23PA + 26PA implementation does not indicate TxD).  Huawei, HiSilicon: Disagree to couple specific ULFPTx modes with TxD or not.  Samsung: Still prefer only to use TxD capability to indicate the correct fallback DCI behavior. Furthermore, for MPR and A-MPR requirement defined for UL-MIMO, the revision gives the fallback DCI clause to 6.2D.1, rather than the suffixless clasue for MPR and A-MPR, why is that? |

## Summary for 1st round

### Open issues

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

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

## Discussion on 2nd round (if applicable)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

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

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
|  |  |  |  | Topic#1 |
| [**R4-2200958**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200958.zip) | TP for TR 38.837 on Power Class clarification | vivo | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-2201590 | 3GPP TR 38.837 v0.3.0 | vivo |  |  |
| R4-2201941 | Big CR for TS 38.101-1 Tx diversity requirements | Huawei, HiSilicon, Qualcomm, vivo |  |  |
|  |  |  |  | *Topic#2* |
| R4-2200340 | Draft CR for fixing MPRs in suffix D | Qualcomm Incorporated |  |  |
| [**R4-2201228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201228.zip) | PC2 PA configuration and signalling | Xiaomi |  |  |
| [**R4-2201267**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201267.zip) | R17 FR1 TxD requirements and signaling | OPPO |  |  |
| [**R4-2201269**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201269.zip) | Draft R17 CR on UL MIMO falllback to TxD | OPPO |  |  |
| [**R4-2200499**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200499.zip) | Requirement and signaling aspect of features requiring two transmit paths | Skyworks Solutions Inc. |  |  |
|  |  |  |  | *Topic #3* |
| [**R4-2200341**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200341.zip) | SRS virtualization for antenna switching | Qualcomm Incorporated |  |  |
| [**R4-2200484**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200484.zip) | Relation of TxD and SRS antenna switching | Nokia, Nokia Shanghai Bell |  |  |
| [**R4-2200859**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200859.zip) | SRS antenna switching with antenna virtualization | Ericsson |  |  |
| [**R4-2200860**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200860.zip) | Pcmax for SRS usage set as antenna switching for TxD and UL-MIMO features | Ericsson |  |  |
| [**R4-2200959**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200959.zip) | Further discussion on SRS antenna switching for TxD | vivo |  |  |
| [**R4-2200960**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200960.zip) | Draft CR on SRS antenna switching for TxD | vivo |  |  |
| [**R4-2201227**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201227.zip) | Discussion on Tx diversity SRS antenna switching | Xiaomi |  |  |
| [**R4-2201271**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201271.zip) | R17 SRS IL for TxD | OPPO |  |  |
| [**R4-2201272**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201272.zip) | Draft R17 CR on SRS IL for TxD | OPPO |  |  |
| [**R4-2201799**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201799.zip) | Further discussion on SRS antenna switching requirements for TxD | ZTE Wistron Telecom AB |  |  |
| [**R4-2201940**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201940.zip) | On SRS relaxation | Huawei, HiSilicon |  |  |
|  |  |  |  | *Topic#4* |
| [**R4-2200483**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200483.zip) | Relation of MOP between TxD and ULFPTx | Nokia, Nokia Shanghai Bell |  |  |
| [**R4-2200861**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200861.zip) | Single-antenna falback for TxD and UL-MIMO (including ULFPTx) | Ericsson |  |  |
| [**R4-2200862**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200862.zip) | TxD and UL-MIMO requirements for single-port antenna transmission | Ericsson |  |  |
| [**R4-2200961**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2200961.zip) | Discussion on ULFPTx with TxD | vivo |  |  |
| [**R4-2201268**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201268.zip) | R17 FR1 TxD and ULFPTx | OPPO |  |  |
| [**R4-2201762**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201762.zip) | Further Discussion on Transparent TxD – ULFPTx related | Samsung |  |  |
| [**R4-2201798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201798.zip) | Further discussion on ULFPTx with TxD | ZTE Wistron Telecom AB |  |  |
| [**R4-2201942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2201942.zip) | On ULFPTx and applicable MPR requirements for different PA configurations | Huawei, HiSilicon |  |  |
| [**R4-2202051**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_101-bis-e/Docs/R4-2202051.zip) | ULFPTX Mode 2 and TxD | Qualcomm Incorporated |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

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** | **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

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
| Nokia | Hiromasa Umeda | hiromasa.umeda@nokia.com |

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)