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

**Electronic Meeting, Aug. 15 – 26, 2022**

**Agenda item:** 13.4

**Source:** Moderator (Apple)

**Title:** Email discussion summary for [104-e][140] NR\_reply\_LS\_UE\_RF

**Document for:** Information

# Introduction

This email thread treats the following topics:

R15/16

1. Lower humidity limit in normal temperature test environment (R5-221604)
2. Modified MPR-Behaviour clarification for different power classes (R5-223635)
3. FR2 requirement applicability over ETC

R18

1. UE power limitation for STxMP in FR2 (R1-2205639)
2. UE antenna gain for NR NTN coverage enhancement (R1-2205623)

# Topic #1: Lower humidity limit in normal temperature test environment (R5-221604)

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

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2211994 | Samsung | **Proposal 1: it is agreed in RAN4 that the humidity inconsistency issue among specifications should be resolved.**  **Proposal 2: It is proposed to remove the explicit humidity range and normal temperature test is required to be performed under room humidity condition unless otherwise stated.**   |  |  | | --- | --- | | +15C to +35C | for normal conditions (under room humidity conditions unless otherwise stated) | | -10C to +55C | for extreme conditions (see IEC publications 68‑2‑1 and 68‑2‑2) |   A draft LS is attached. |
| R4-2213373 | Huawei, HiSilicon | RAN4 thanks RAN5 LS on the plan to remove lower humidty limit in normal temperature test environment.  RAN4 specified the test environment based on the assumption that UEs need to satisfy relevant requirements while working under the environment for a long term. The test environment has been used for UTRA, E-UTRA and 5G NR. In order to maintain the consistent industry expectation, RAN4 will not update the definition of test environment.  Since RAN5 has decided to remove the lower humidty in conformance test specification of GSM and E-UTRA, RAN5 is encouraged to continue discussing and deciding whether the same approach could apply to 5G NR in the context of conformance testing. |
| R4-2213618 | ZTE | **Observation 1: The high or low humidity limit for the normal conditions may have potential impacts on some test items and cannot be ignored.**  **Proposal 1: It is suggested to select Option 4, i.e. to keep the current description in RAN4 spec with the relative humidity range of “25% ~ 75%” as the solution to resolve the inconsistencies among the specs.**  A draft reply LS is attached |

## Open issues summary

### Sub-topic 1-1: On possible ways to resolve the inconsistency

* Proposals
  + Option 1: remove the explicit humidity range and normal temperature test is required to be performed under room humidity condition unless otherwise stated.
  + Option 2: RAN4 will not update the definition of test environment. RAN5 is encouraged to continue discussing and deciding whether the same approach could apply to 5G NR in the context of conformance testing.
  + Option 3: keep the current description in RAN4 spec with the relative humidity range of “25% ~ 75%” as the solution to resolve the inconsistencies among the specs.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section “Open issues summary” above.

### CRs/TPs comments collection

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

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2208488/ R4-2208489/ R4-2208490 | Company A |
| Company B |
|  |
| R4-2208491/ R4-2208492/ R4-2208493 | 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.*

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

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

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| **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)

# Topic #2: Modified MPR-Behaviour clarification for different power classes (R5-223635)

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212595 | Xiaomi | **Question a): For Rel-15 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 applicable if the UE supports *modifiedMPR-Behaviour* bit 0 UE capability?**  **Answer a): Yes, for Rel-15 PC3 UE, the MPR as defined in 38.101-2 v16.2.0 is applicable if the UE supports *modifiedMPR-Behaviour* bit 0 UE capability.**  **Question b): For Rel-15 PC2 and PC4 UEs, is *modifiedMPR-Behaviour* bit 0 capability applicable?**  **Answer b): No, *modifiedMPR-Behaviour* bit 0 capability is not applicable for Rel-15 PC2 and PC4 UEs**  **Question c): For Rel-16 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 mandatory or optional? In case it is mandatory then is the Rel-16 UE expected to signal *modifiedMPR-Behaviour* bit 0=true?**  **Answer c): The MPR as defined in 38.101-2 v16.2.0 is optional for Rel-16 PC3 UE, the Rel-16 UE is optional to signal *modifiedMPR-Behaviour* bit 0=true.**  **Question d): For Rel-16 PC3 UE, which version of specification is taken as default MPR requirement, 38.101-2 v16.2.0 or latest version (v16.11.0 released in Apr 2022)? What are the Rel-16 MPR requirements if the UE signals respectively *modifiedMPR-Behaviour* bit 0=false and *modifiedMPR-Behaviour* bit 0=true?**  **Answer d): For Rel-16 PC3 UE, 38.101-2 v16.1.0 and earlier versions are taken as default MPR requirement. The PC3 UE need meet the MPR as defined in 38.101-2 v16.2.0 if the PC3 UE signals respectively *modifiedMPR-Behaviour* bit 0=ture, if not, the PC3 UE just need meet the default MPR requirement.**  **Question e): For Rel-16 PC2, PC4 and PC5 UEs is *modifiedMPR-Behaviour* bit 0 capability applicable?**  **Answer e): For Rel-16 PC2, PC4 and PC5 UEs, *modifiedMPR-Behaviour* bit 0 capability is not applicable.**  **Question f): For Rel-17 PC3 UE, what are the MPR requirements if the UE signals respectively *modifiedMPR-Behaviour* bit 0=false and *modifiedMPR-Behaviour* bit 0=true?**  **Answer f): For Rel-17 PC3 UE, it needs meet the MPR as defined in 38.101-2 v16.2.0 if it signals respectively *modifiedMPR-Behaviour* bit 0=ture, if not, it just needs meet the default MPR requirement.** |
| R4-2213729 | Huawei, HiSilicon | **Question a)** *For Rel-15 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 applicable if the UE supports modifiedMPR-Behaviour bit 0 UE capability?*  **Answer:** Yes, for Rel-15 PC3 UE, MPR defined in 38.101-2 v16.2.0 is also applicable if the UE reports modifiedMPR-Behaviour bit 0 UE capability, but this modified MPR is optional for a Rel-15 UE.  **Question b)** *For Rel-15 PC2 and PC4 UEs, is modifiedMPR-Behaviour bit 0 capability applicable?*  **Answer:** Since MPR for PC2 and PC4 refers to the PC3 MPR requirement, the modifiedMPR-Behaviour bit 0 capability is also applicable for Rel-15 PC2 and PC4 UEs.  **Question c)** *For Rel-16 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 mandatory or optional? In case it is mandatory then is the Rel-16 UE expected to signal modifiedMPR-Behaviour bit 0=true?*  **Answer:** For Rel-16 PC3 UE, the MPR as defined in 38.101-2 v16.2.0 is optional according to the current specification.  **Question d)** *For Rel-16 PC3 UE, which version of specification is taken as default MPR requirement, 38.101-2 v16.2.0 or latest version (v16.11.0 released in Apr 2022)? What are the Rel-16 MPR requirements if the UE signals respectively modifiedMPR-Behaviour bit 0=false and modifiedMPR-Behaviour bit 0=true?*  **Answer:** For Rel-16 PC3 UE, the latest Rel-16 version of specification can be taken for the MPR requirement. A Rel-16 PC3 UE is still allowed to signal modifiedMPR-Behaviour bit 0=false and use the previous MPR requirement before v16.2.0 specification, otherwise, if modifiedMPR-Behaviour bit 0=true is indicated, the modified MPR is applied for a Rel-16 PC3 UE.  **Question e)** *For Rel-16 PC2, PC4 and PC5 UEs is modifiedMPR-Behaviour bit 0 capability applicable*?  **Answer:** Yes, modifiedMPR-Behaviour bit 0 capability is also applicable for Rel-16 PC2, PC4 and PC5 UEs, the behaviour is similar to that of PC3 UE.  **Question f)** *For Rel-17 PC3 UE, what are the MPR requirements if the UE signals respectively modifiedMPR-Behaviour bit 0=false and modifiedMPR-Behaviour bit 0=true?*  **Answer:** For a Rel-17 PC3 UE, applicable MPR requirement depends on the indicated capability, i.e. original MPR (before v16.2.0) for UE signals modifiedMPR-Behaviour bit 0=false while the modified MPR (requirement in latest Rel-17 specification) for UE signals modifiedMPR-Behaviour bit 0=true. |
| R4-2213320 | OPPO | ***Proposal 1: Proposed to reply RAN5 as the annex for each question, and the key information as below:***   1. ***The improved MPR was only considered for PC3 UE, thus should not be applicable to PC2/4/5 in Rel-15 and Rel-16.*** 2. ***Rel-15 and Rel-16 PC3 UE can optionally support the improved MPR and indicate modifiedMPR-Behaviour bit 0=1*** 3. ***Rel-17 PC3 UE mandatory support the improved MPR, and no need to further define the modifiedMPRbehavior***   ***Proposal 2: Proposed to use the latest version of 38.101-2 Rel-16 specification as the reference MPR requirement in modifiedMPRbehavior IE for Rel-15 and Rel-16, considering modifications /updates could happen after the improved MPR was introduced in v16.2.0:***  ***From: FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 v16.2.0***  ***To: FR2 power class 3 MPR as defined in clause 6.2.2.3 of 38.101-2 from v16.2.0 and onwards***  ***Proposal 3: Proposed to remove the modifiedMPRbehavior of PC3 MPR from Rel-17 since there is only one MPR defined for PC3 which means the improved MPR in Rel-17 is mandatory for PC3 UE.***   1. **For Rel-15 PC3 UE, is the** **MPR as defined in 38.101-2 v16.2.0 applicable** **if the UE supports *modifiedMPR-Behaviour* bit 0 UE capability?**   **[RAN4 Answers]:** The *modifiedMPR-Behaviour* table also introduced in Rel-15 to allow Rel-15 UE leverage the improved MPR. Therefore, if the UE supports *modifiedMPR-Behaviour* bit 0 UE capability the MPR as defined in 38.101-2 from v16.2.0 and onwards apply.   1. **For Rel-15 PC2 and PC4 UEs, is *modifiedMPR-Behaviour* bit 0 capability applicable?**   **[RAN4 Answers]:** The improved MPR was only considered for PC3 UE, thus should not be applicable to PC2/4 in Rel-15.   1. **For Rel-16 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 mandatory or optional? In case it is mandatory then is the Rel-16 UE expected to signal *modifiedMPR-Behaviour* bit 0=true?**   **[RAN4 Answers]:** The improved MPR was introduced from 38.101-2 v16.2.0, it makes different MPRs exist in Rel-16, thus *modifiedMPR-Behaviour* bit 0 was defined to indicate which MPR apply. Therefore, it is not mandatory in Rel-16.  However, UEs comply with 38.101-2 v16.2.0 and onwards is expected to support the improved MPR and signal modifiedMPR-Behaviour bit 0=true.   1. **For Rel-16 PC3 UE, which** **version of specification is taken as default MPR requirement, 38.101-2 v16.2.0 or latest version (v16.11.0 released in Apr 2022)? What are the Rel-16 MPR requirements if the UE signals respectively *modifiedMPR-Behaviour* bit 0=false and *modifiedMPR-Behaviour* bit 0=true?**   **[RAN4 Answers]:** The improved MPR was introduced from Rel-16 v16.2.0, and after that modifications/updates could happen. For Rel-16 PC3 UE the latest version of specification can be taken as default MPR requirement.  If Rel-16 UE signals *modifiedMPR-Behaviour* bit 0=false, the v16.1.0 MPR requirements apply.  If Rel-16 UE signals *modifiedMPR-Behaviour* bit 0=true, the Rel-16 latest version MPR requirements apply.   1. **For Rel-16 PC2, PC4 and PC5 UEsis *modifiedMPR-Behaviour* bit 0 capability applicable?**   **[RAN4 Answers]:** The improved MPR was only considered for PC3 UE, thus should not be applicable to PC2/4/5 in Rel-16.   1. **For Rel-17 PC3 UE, what are the MPR requirements if the UE signals respectively *modifiedMPR-Behaviour* bit 0=false and *modifiedMPR-Behaviour* bit 0=true?**   **[RAN4 Answers]:** Rel-17 PC3 UE should comply with the improved MPR defined in the latest Rel-17 version of 38.101-2, and RAN4 will remove the *modifiedMPR-Behaviour* for PC3 MPR from Rel-17 spec since there is only one MPR defined for PC3. |
| R4-2213757 | Nokia | 1. For Rel-15 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 applicable if the UE supports *modifiedMPR-Behaviour* bit 0 UE capability?   Proposed answer: Yes it is.   1. For Rel-15 PC2 and 4 UEs, is *modifiedMPR-Behaviour* bit 0 capability applicable?   Proposed answer: Yes it is.   1. For Rel-16 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 mandatory or optional? Also, is the Rel-16 UE expected to signal *modifiedMPR-Behaviour* bit 0=true?   Proposed answer: The changes introduced to PC3 MPR in v16.2.0 are optional to REL16 UE   1. For Rel-16 PC2, 4 and 5 UEs, is the PC3 MPR as defined in 38.101-2 v16.2.0 applicable? Also, is *modifiedMPR-Behaviour* bit 0 capability applicable?   Proposed answer: MPR as defined in v16.2.0 is applicable also to Rel-16 PC2 and PC4 UEs if they indicate with modifiedMPR-Behaviour bit 0 that they support this feature. PC5 was defined during REL17.   1. Is any kind of Rel-16 UE supposed to support MPR as defined in 38.101-2 version v16.11.0?   Proposed answer: There are two CRs implemented to MPR section between 16.11.0 and 16.2.0:   * R4-2111524 #99e (QCOM/SKWS): CR to 16.7.0: editorial change to address RAN5 concerns on ambiguity for PC3 MPRnarrow. * R4-2207884 #103e (KS/SKWS): CR to 16.11.0: technical correction on RBstart equation for PC3 MPRnarrow.   As first CR is editorial and second is necessary correction there were no modifiedMPR-Behaviour introduced. When REL16 UE indicates that it supports MPR as defined in v16.2.0 it means that it supports MPR as defined in latest version of REL16 38.101-2. which is currently 16.12.0.   1. For Rel-17 PC3 UE, is the MPR as defined in 38.101-2 v16.2.0 applicable if the UE signals *modifiedMPR-Behaviour* bit 0=true?   Proposed answer: Rel17 38.101 Annex-H is not correct. It should state This bit SHALL be set to 1 instead of MAY. There is a RAN4 CR in this [1]   1. For Rel-17 PC3 UE, what is the MPR requirement if the UE signals *modifiedMPR-Behaviour* bit 0=false?   Proposed answer: REL17 UE may not set this bit 0 to false, see [1] |

## Open issues summary

### Sub-topic 2-1: Can we agree ”The improved MPR was only considered for PC3 UE, thus should not be applicable to PC2/4/5 in Rel-15 and Rel-16.”?

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

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 2: No.  Emissions requirements are applicable in a TRP sense, and the Rel-15 MPRs were calculated per max. allowed TRP. PC2/4/5/6 share the same TRP limit as PC3, so it follows that PC3 MPR would apply to PC2/4/5/6 also. Any changes made to PC3 automatically apply to other power classes unless explicitly recorded otherwise. |

### Sub-topic 2-2: Can we agree ”Rel-15 and Rel-16 PC3 UE can optionally support the improved MPR and indicate modifiedMPR-Behaviour bit 0=1.”?

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

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: Yes |

### Sub-topic 2-3: Can we agree ”Rel-17 PC3 UE mandatory support the improved MPR, and no need to further define the modifiedMPRbehavior.”?

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

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | The intent is correct, but the language needs to be amended in the annex. See Nokia, Skyworks, QC CR for Rel-17 (R4-2213755) |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section “Open issues summary” above.

### 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.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2209369/ R4-2209370/ R4-2209371 | Company A |
| Company B |
|  |
| R4-2210208/ R4-2210209 R4-2210210 | 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.*

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

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| **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)

*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: FR2 requirement applicability over ETC

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212325 | Qualcomm | **Observation: RAN4 must resolve what aspects of TS38.101-2 are core requirements, and what are merely verification guidelines before RAN4 can provide a definitive reply to RAN5 on this subject.**  **Proposal: If no common understanding is established on the subject of ETC applicability of an FR2 UE’s spherical coverage requirements, the LS reply on this subject shall be patterned after the precedent reply LS R4-2206586 (proposal included in the annex.)**  A draft LS is attached.  RAN4 would like to thank RAN5 for the LS on FR2 extreme temperature conditions.  According to the discussion in RAN4 for several meetings, the RAN5 understanding that RAN4 core requirements for spherical coverage is exempt from ETC applicability is not the common understanding in RAN4. RAN4 confirms that core requirements not explicitly limited to Nominal Temperature conditions are applicable to Extreme Temperature conditions, per Annex E.2 in TS38.101-2. |
| R4-2213372 | Huawei, HiSilicon | **Proposal 1: Sending a simple LS as provided in the Annex.**  **Proposal 2: If the consensus couldn’t be achieved in RAN4#104-e meeting, the discussion on this topic should be stopped, and no LS will be sent to RAN5.**  A draft LS is attached.  RAN4 thanks RAN5 LS on FR2 Extreme temperature conditions clarifications.  RAN4 would like to confirm with RAN5 that the core requirements in TS 38.101-2 without explicit limitation to Nominal Temperature conditions are applicable to Extreme Temperature Conditions. |
| R4-2212821 | vivo | **Proposal 1: Approve the simple reply LS to RAN5 with the same specification wording in the Annex of TS 38.101-2 without any further interpretation.**  **Proposal 2: If simple reply LS even with the same specification wording is not agreeable in this meeting, RAN4 should stop the discussion of Rel-15 FR2 ETC applicability and avoid wasting further meeting efforts.**  A draft LS is attached.  3GPP RAN4 would like to thank RAN5 for their LS on FR2 RF ETC testing in R4-2111716.  RAN4 confirm that the UE shall fulfil all the requirements in the temperature range for extreme conditions, unless explicitly stated otherwise in any requirement. |

## Open issues summary

This issue has been discussed for many meetings without an agreement, and the contributions to this meeting are repeating the previous arguments. As such, Moderator proposes to ask RAN4 chair to treat it in GTW if there is no agreement after the first round email discussion.

### Sub-topic 3-1: Which version to use in the reply LS?

* Proposals
  + Option 1: According to the discussion in RAN4 for several meetings, the RAN5 understanding that RAN4 core requirements for spherical coverage is exempt from ETC applicability is not the common understanding in RAN4. RAN4 confirms that core requirements not explicitly limited to Nominal Temperature conditions are applicable to Extreme Temperature conditions, per Annex E.2 in TS38.101-2.
  + Option 2: RAN4 would like to confirm with RAN5 that the core requirements in TS 38.101-2 without explicit limitation to Nominal Temperature conditions are applicable to Extreme Temperature Conditions.
  + Option 3: Using exactly the same wording in TS 38.101-2 in the LS without interpretation, i.e., RAN4 confirm that the UE shall fulfil all the requirements in the temperature range for extreme conditions, unless explicitly stated otherwise in any requirement.
  + Option 4: Others
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section “Open issues summary” above.

### 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.*

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| --- | --- |
| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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.*

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

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

*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: UE power limitation for STxMP in FR2 (R1-2205639)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212065 | Nokia, Nokia Shanghai Bell | **Answer 1**: Assumption 1 is feasible. There can be a TRP test for each panel individually and sequentially, where each panel must be below e.g. 35 dBm for power class 1. Peak EIRP requirement is applicable to a single direction for the best UE panel only.  **Answer 2**: Assumption 2 is feasible. There is TRP requirement for UL MIMO which is applicable to the whole UE across all simultaneously transmitting panels e.g. 35 dBm for for the UE with STxMP in power class 1, where each panel is transmitting a maximum of 29 dBm for 4-layer UL MIMO.  **Answer 3:** Exceeding the power class power limit with simultaneously active panels is not possible as this is a regulatory requirement. Furthermore, note that UL CA requirements (on two different CC for inter-band UL CA) lead to PA power relaxations, so it is unlikely that the sum of per-panel power larger than current requirements, see tables below.  **Answer 4:** For STxMP, per panel limitation scales with the number of panels as the UE power limit is fixed. If a single panel is active, it is limited to 35 dBm for power class 1. If two panels are active, they are each limited to 32 dBm such that the UE is limited to 35 dBm still for power class 1. Similarly, if 4 streams are transmitted simultaneously, then each is limited to 29 dBm such that the UE TRP with all active panels is still 35 dBm. The sum of per-panel power limitation cannot be larger than the total power limitation per UE. |
| R4-2212116 | InterDigital Communications | ***Observation 1:*** *Case A (UE non-coupled panels) may support overlapping RB allocations for simultaneous UL transmissions as they are far enough to avoid mutual interference.*  ***Observation 2:*** *Case B (UE coupled panels) may require mutual exclusive RB allocations (an FDM scheme) per TRP/UL panel to avoid self-interference.*  ***Observation 3:*** *Each linked TRP and UE panel have a separate power control loop.*  ***Proposal 1:*** *Add in the LS reply the feasible cases considered in RAN4 discussion and answers.*  ***Proposal 2:*** *Consider the following answers for the LS reply:*  **Question 1**: From RAN4 perspective, is Assumption 1 is feasible?  **Answer 1:** If the UE panels are sufficiently separated in space, so they don’t mutually interfere (non-coupled), then Assumption 1 is feasible, and each panel may follow sub-clause 6.2.4 in 38.101 in terms of EIRP and TRP power limits.  **Question 2**: From RAN4 perspective, is Assumption 2 is feasible?  **Answer 2:** If the UE panels are collocated or very closed in space, so they mutually interfere (coupled), then Assumption 2 is feasible, with the condition that the RB allocations are mutually exclusive(FDM allocation), and each panel may follow sub-clause 6.2.4 in 38.101 in terms of EIRP limits while maximum TRP power is limited per UE. (Similar to max TRP for UL CA case.)  **Question 3:** In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class?  **Answer 3:** The answer to this question is related to the panel -based architecture of the UE as explained in Answer 1 and 2 respectively based on described cases A and B.  **Question 4:** If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can/shall be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?  **Answer 4:** Both Assumptions are feasible, but under different antenna/panel architecture, and thus they cannot be applied to the same UE if the UE don’t support both Case A and B at the same time (meaning more than 2 panels on the UE). For the relation between per-power limitation and total power limitation, see Answers 1 and 2. |
| R4-2212327 | Qualcomm | ***Question 1****: From RAN4 perspective, is Assumption 1 is feasible?*  Yes, assumption 1 is feasible.  ***Question 2****: From RAN4 perspective, is Assumption 2 is feasible?*  Assumption 2 feasibility is FFS due to uncertainty in how to optimally implement a per-UE EIRP limit for a 2 panel UL.  ***Question 3:*** *In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class?*  RAN4’s main concern is regulatory compliance, and legacy RAN4 UE requirements already ensure those. Consequently, the sum over all panels of the per-panel power limitation for STxMP can be chosen to be greater than the existing power limitation for a given power class without consequence to legality.  ***Question 4:*** *If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can/shall be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?*  Feasibility of assumption 2 is FFS. Assumption 1 is viable with the same limits as the power class of the UE and the detail of regulatory compliance can be left to UE implementation. |
| R4-2212594 | Xiaomi | **Proposal 1: max EIRP, min peak EIRP and EIRP spherical coverage should be limited per-panel, max TRP can be limited either per-panel or per UE over all UE panels, it depends on UE types.**  **Proposal 2: The output power for the UE types which don’t need consider the total power consumption, can be limited per-panel. And the per-panel power limitation for STxMP including max TRP, max EIRP, min peak EIRP can be the same with the existing power limitation for a given power class.**  **Proposal 3: The output power for the UE types which need consider the total power consumption, the total power limitation should be considered per UE over all UE panels. How to consider the total power limitation based on per UE over all UE panels need further study.** |
| R4-2212808 | vivo | **Observation 1:** Current RAN4 requirements have the upper limitations for max TRP and max EIRP.  **Observation 2:** Current EIRP concept is intrinsically combined with one beam direction.  **Observation 3a:** Regulatory requirements exist for EIRP, which are per-UE based for a band.  **Observation 3b:** Though no regulation basis for TRP, the current TRP requirements are also preferred to be kept as per-UE, otherwise more assessment would be needed for basic requirements.  **Observation 4:** There is no specific “panel” based requirements in the spec.  **Observation 5:** TRP concept can easily be extended to simultaneous multiple transmissions from multiple panels, while EIRP may need further clarification when extended to simultaneous multi-beam/multi-panel transmission. The current concept may lead to sum of two equal Tx beams to different directions have a same peak EIRP as the case of one beam transmission.  **Observation 6:** The current understanding of “sum of per-panel power limitation” is the “limitation of sum of per-panel power”, it is an actual reachable upper limit of the sum, not simple arithmetic summation of two per-panel power limitations which is 3dB larger than the per-UE limitation.  ***Question 1****: From RAN4 perspective, is Assumption 1 is feasible?*  Answer: Yes.  ***Question 2****: From RAN4 perspective, is Assumption 2 is feasible?*  Answer: Yes.  ***Question 3:*** *In either of Assumption1 or Assumption 2, whether the total power limitation per UE over all UE panels used for STxMP or the sum of per-panel power limitation for STxMP can be different from (greater than) the existing power limitation for a given power class?*  For both TRP and EIRP, both the total power limitation per UE, and the upper limit of sum of per-panel powers should be the same to (no greater than) the existing power limitation for a given power class.  ***Question 4:*** *If both Assumption 1 and Assumption 2 are feasible, whether both assumptions can/shall be applied to a same UE, and what is the relationship between the per-panel power limitation and total power limitation if both are applied (e.g., the sum of per-panel power limitation can be larger than the total power limitation per UE, or should be always the same)?*  It is believed that both assumptions are feasible, and both assumptions shall be applied to a same UE. The per-panel power limitation can be the same to total power limitation, while both of them should be satisfied simultaneously. E.g., the limitation of sum of per-panel power should be always the same to the per UE power limitation.  Note 1: The current understanding of “sum of per-panel power limitation” is the “limitation of sum of per-panel power”, which is an actual reachable upper limit of the sum, not simple arithmetic summation of two per-panel power limitation which is 3dB larger than the per-UE limitation.  Note 2: EIRP is defined based on one direction. For example, sum of two beam with different directions would still comply with the same peak EIRP. |
| R4-2213420 | OPPO | ***Proposal 1: To response to Question 1 in LS:***  ***Yes, Assumption 1, i.e. power limitation per panel for STxMP, is feasible from hardware ability point of view.***  ***Proposal 2: To response to Question 2 in LS:***  ***Yes, Assumption 2, i.e. total power limitation per UE over all UE panels used for STxMP, is feasible from hardware ability point of view.***  ***Proposal 3: To response to Question 3 in LS:***  ***The situation is considered on both TRP and EIRP.***  ***For max TRP, the requirement is coming from regulation and UE should guarantee its total radiated power shall be below this requirement, therefore, no matter the power limitation is per UE or per panel shall comply with the existing power class definition.***  ***For max peak EIRP, the requirement is also coming from regulation, and is a directive requirement, thus it can be per panel defined. RAN4 doesn’t see the meaning of sum the EIRP power from different panels.***  ***Proposal 4: To response to Question 4 in LS:***  ***From RAN4 perspective, the max TRP requirement can be per UE based, while the max peak EIRP can be per panel based.*** |
| R4-2213626 | Samsung | Regarding the FR2 UE power control for STxMP in following two assumptions of RAN1:   * Assumption 1: Power limitation per panel for STxMP * Assumption 2: A total power limitation per UE over all UE panels used for STxMP   RAN4 identifies that the UL power limitation in FR2 should be clarified first. Unlike conventional FR1 power class specified as a nominal value with +/- tolerance, the power class of FR2 UEs is specified as a package of the minimum peak EIRP, maximum allowed TRP, maximum allowed EIRP and EIRP spherical coverage as specified in 6.2.1 of 38.101-2. Although each requirement contains a different sense of signification, it should be taken into account together for STxMP since they are all related to one another from the aspect of UE implementation.  *Lower limits (peak EIRP and EIRP spherical coverage):*  *The peak EIRP and EIRP spherical coverage are the minimum requirements for the FR2 UE conformance test without any tolerance. Both peak EIRP and EIRP spherical coverage assure that UE can transmit EIRP no lower than the defined EIRP limit in one direction and over the required percentile on the CDF curve, respectively. These existing EIRP-based requirements are defined with the assumption for single panel transmission at a time.*  *Upper limits (max TRP and max EIRP):*  *On the other hand, an upper limit of FR2 UE power class requirements are introduced in conjunction with EIRP-based power class for lower limitations, i.e., max TRP (total radiated power) and max EIRP. Since countries/regions have regulatory requirement on the maximum allowed power level with TRP/EIRP depending on FR2 UE types, UE shall not exceed the maximum allowed TRP/EIRP value to comply with the regulatory requirement which is based on per UE regardless of the number of panels that UE has.*  Based on the understanding above, RAN4 had discussed and concluded with the following responses:  **Response to Question 1**: Existing EIRP-based power class for the lower limitation is specified with single panel transmission assumption. Therefore, from RAN4 perspective and implementation perspective, the power limitation per panel for STxMP is also feasible for lower limitations as long as it still meets the regulatory requirement, i.e., upper limitation. However, the potential feasibility of power limitation per-panel for STxMP does not necessarily mean that it has to be the same as existing lower limit values.  **Response to Question 2**: Given that most regulatory requirements on UL power limitation are based on total power concept regardless of the per-panel UL power, e.g., max TRP/EIRP, a total power limitation per UE over all UE panels used for STxMP should also be available to comply with the regulation.  **Response to Question 3:** As mentioned above, the lower limitation for STxMP can be different from the existing requirement assumed as single panel transmission in either case of Assumption 1 or 2. However, the upper limit requirements shall be kept unchanged whichever is considered as they are based on the regulation.  **Response to Question 4:** From RAN4’s perspective, both assumptions should be applied to a same UE to follow existing framework of each power class requirement in FR2. In addition, RAN4 normally presumes that per-panel power limitation can apply to the peak EIRP, and total power limitation can apply to max TRP/EIRP. In that sense, the sum of per-panel power limitation is not comparable with total power limitation.  However, it should be noted that the response to Question 3 and 4 might need further discussions in RAN4 based on the clearer understanding of the simultaneous transmission scenario that RAN1 will consider. |
| R4-2213740 | Huawei, HiSilicon | Regarding the single carrier scenario in which RAN1 is interested, the response from RAN4 is:  **Answer to Question 1 & Question 2:**  The power limitation mechanism, e.g. P-MPR reporting for MPE is defined per UE, which has been discussed and not changed in Rel-17 WI FeMIMO. Furthermore, the basic assumption for RAN4 requirements definition is single panel and they will be verified per band. So for the single carrier scenario, ONLY assumption 2 is feasible from RAN4 perspective.  **Since only Assumption 2 is feasible, the answer to Question 3 could be provided as below:**  As explained above, for single carrier scenario, the total power limitation per UE over all UE panels used for STxMP shall not exceed the existing power limitation for a given power class. |

## Open issues summary

### Sub-topic 4-1: Is assumption 1 (Power limitation per panel for STxMP) feasible? Any issue that could make it infeasible?

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

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 2: No  The RAN1 understanding of ‘panel’ is a radiating structure made of one or more elements dedicated to one TCI-state. From an implementation perspective assumption 1 is a natural extension of legacy operation (single TCI-state) |
| vivo | Option 1. From feasibility point of view, assumption 1 should be feasible. The current Rel-15 is basically already per-panel since only one panel would be activated.  Of course, feasible doesn’t mean this has to be defined in this way. It should be a separate discussion on whether per-panel power limitation should be used or not.  It is also noted that no matter minimum or max power, the feasibility is likely to be equally feasible. |

### Sub-topic 4-2: Is assumption 2 (A total power limitation per UE over all UE panels used for STxMP) feasible? Any issue that could make it infeasible?

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

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 3: It is possible to implement assumption 2 (per UE) but if it implies enforcing 3- or 6-dB lower targets per TCI-state, it can severely hamper the feature in what is understood to be a severely UL limited network. So ‘feasibility’ has to be discussed in further detail to investigate if blanket per TCI-state reductions are possible. |
| vivo | Option 1. As discussed before, it is admitted that there might be some difficulty in TRP/EIRP control. However, as there are already such regulation requirements currently for single panel case.  In addition, it should be noted that EIRP is based on one direction, and the peak EIRP of “sum” of two beam may still consist with one of them. |

### Sub-topic 4-3: On Question 3 from RAN1, if the existing power limitation for a given power class is violated, is there any issue on regulatory compliance?

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

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Legacy UE requirements will continue to apply to any new feature, and existing test methods can accommodate 2 TCI states. These requirements safeguard legality of the UE. With this context, it is OK to allow per TCI-state limits to equal power class limits or any other high convenient number and leave compliance details to UE implementation. |
| vivo | Option 3.  It seems there are some different understanding of the wording “*the sum of per-panel power limitation for STxMP*” , and two understandings seems to be:  Sum of (per-panel power limitation)  This is simple arithmetic summation of two per-panel power limitation.  (sum of per-panel power) limitation = the limitation of (sum of per-panel power)  This would be the actual reachable upper limit of the per-UE power.  The basic rule is per-UE regulatory requirements can not be violated. Depending on different understanding, there could be different answers. For i) the answer is yes, and for ii) the answer would be no. |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section “Open issues summary” above.

### 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** |
| XXX | Company A |
| Company B |
|  |
| YYY | 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** | *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)

*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 #5: UE antenna gain for NR NTN coverage enhancement (R1-2205623)

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2212307 | CMCC | In theory, UE antenna gain is assumed as 0dBi and RAN4 assume 0dBi UE antenna gain for S band RF requirements definition. But some loss should also be considered to reflect actual antenna performance. OTA loss with typical 5dB assumption is used in link budget for actual network deployment. So, -5dBi antenna gain is valid. |
| R4-2212656 | Ericsson | RAN4 would like to thank RAN1 for the LS R1-2205623 on UE antenna gain for NR NTN coverage enhancement. Regarding the following action:  RAN1 respectfully asks RAN4 to provide feedback on the above question and any additional information that may help RAN1 determine the realistic assumptions on smartphone antenna gain.  RAN4 has discussed this topic in RAN4#104-e meeting.  The UE antenna gain varies depending on the operating frequency and UE design, where the antenna is placed. If previous generations of UEs had antenna gain much lower than 0 dBi, more recent generations have improved gain (at least for some of them).  Based on the information available on various websites (e.g., FCC certification database) and after further consideration, RAN4 thinks that a realistic UE antenna gain value would be in the range of [-3 ;-5] dBi. RAN4 would then recommend RAN1 then to take [-4] dBi as an assumption for their link budget evaluation. |
| R4-2212822 | vivo | **Observation 1**: -6 dBi antenna gain for ~2GHz centre frequency is a realistic value.  **Proposal 1: From passive antenna pattern perspective, -6 dBi is a realistic value of handheld UE antenna gain.**  **Observation 2**: The UE real radiated performance should also consider other aspects such as path loss from tuner switch and PCB transmission lines, the total path loss would be larger than 10dB.  **Proposal 2: If the target is to develop more realistic link budget analysis, in the reply LS it should be informed to RAN1 that radiated value of commercial smartphone should be used instead of pure passive antenna gain.** |
| R4-2213165 | Huawei, HiSilicon | Question: Whether the handheld UE antenna gain of -5 dBi is valid and if not, which realistic value of handheld UE antenna gain is appropriate?  Answer: Yes, the handheld UE antenna gain of -5 dBi is valid. |
| R4-2213701 | ZTE | **Question**: Whether the handheld UE antenna gain of **-5 dBi** is valid and if not, which realistic value of handheld UE antenna gain is appropriate?  Rely: this is reasonable assumption and antenna gain for normal smartphone should be around -5dB to -6dB. |

## Open issues summary

### Sub-topic 5-1: What antenna gain to provide in the reply LS?

* Proposals
  + Option 1: -5dBi
  + Option 2: -3 to -5 dBi
  + Option 3: -6 dBi
  + Option 4: -5dB to -6dB
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Based on our measurement results, we support Option 3.  Besides, this value is pure passive antenna performance without many factors being considered, it should be noted that the real radiated performance of smartphone will be much worse. |

### Sub-topic 5-2: Should RAN4 also provide additional info such as ” If the target is to develop more realistic link budget analysis, in the reply LS it should be informed to RAN1 that radiated value of commercial smartphone should be used instead of pure passive antenna gain.”?

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

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| --- | --- |
| **Company** | **Comments** |
| vivo | Option 1: Yes. Given the target of RAN1 is developing more realistic link budget analysis, but not traditional “rough” analysis of total path loss, it is valuable to share this information to RAN1.  As presented in RAN4-2212818 in FR1 TRP TRS WI for n41 measurements, 50-percentile radiated TRP performance of 69 PC2 smartphones for n41 is 14.7dBm, the antenna efficiency should be -11.3dB. If we assume typical 4dBi antenna directivity, then the “real” antenna gain should be -7.3dBi. This value has considered the impacts of tuner switch, PCB path loss and other aspects from different UE implementations.  In addition, if we consider most of commercial smartphones, e.g. 80-percentile, the value would be further worse. |

## Companies views’ collection for 1st round

### Open issues

Comments are collected in section “Open issues summary” above.

### 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** |
| R4-2210204/ R4-2210205/ R4-2210206 | Company A |
| Company B |
|  |
| R4-2209271/ R4-2209328/ R4-2209333 | 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** | *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)

*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** |
| R4-210xxxx | 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** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | 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** |
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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)