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

**Electronic Meeting, 10– 19 October 2022**

**Agenda item:** 6.8.3.4

**Source:** Moderator (Ericsson)

**Title:** Email discussion summary for [104-bis-e][213] FR2\_multiRx\_RRM\_part3

**Document for:** Information

# Introduction

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

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

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

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

Contact information

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| **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)

# Topic #1: TCI state switching in multi-rx chain DL reception

*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** |
| R4-2215362 | Intel Corporation | Proposal 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.  Proposal 2: For dual TCI state switch, the legacy Rel-15/16 TCI state switch delay requirement can be reused. |
| R4-2215465 | Xiaomi | Observation 1: The Rel-15/Rel-16/Rel-17 based TCI state activation/deactivation have different MAC CE.  Proposal 1: Dual TCI state switching delay requirement shall base on Rel-15/16 framework.  Proposal 2: For scenario 1, 3, 7 as one MAC CE is used before and one MAC CE is used after the TCI state switching, the legacy MAC CE based delay requirement apply.  Proposal 3: For scenario 8, the legacy TCI state switching delay requirement will be used for each TCI state switching.  Proposal 4: The MAC CE processing time will need to be further considered in certain scenario as the 2nd MAC CE comes within the 1st MAC CE processing time.  Proposal 5: If one of the target TCI state of the group of Dual-TCI state is unknown, then it should be considered as unknown. |
| R4-2215762 | MediaTek Inc. | Proposal 1: In R18 multi-Rx, to define the TCI state requirement based on R15/R16 TCI framework.  Proposal 2: For known and unknown condition of TCI state in R18 multi-Rx, the legacy R15/R16 requirement can be reused.  Observation 1: For legacy TCI state switch delay requirement in TS 38.133, the transient time for panel power ON/OFF is not considered.  Proposal 3: Reuse Rel-15/16 TCI state switch delay unless RF session achieves a new conclusion on panels ON/OFF switch time.  Proposal 4: For dual TCI state switch, the legacy TCI state switch delay requirement can be reused. |
| R4-2215806 | LG Electronics Inc. | Proposal 1: Independent TCI state switching delay requirements for multi-Rx chain could be based on Rel-15/Rel-16 TCI state switching delay requirements.  Proposal 2: Further study UE behaviour in case one of the TCI states is unknown for dual TCI state switching. |
| R4-2215815 | OPPO | Observation 1: The RRM impact of inside-panel TCI state switching and cross-panel TCI state switching due to different UE implementation needs to be studied.  Observation 2: For the case of cross-panel TCI state switching, additional panel/RF chain switching time needs to be evaluated.  Proposal 1: Dual TCI state switching delay requirements shall base on Rel-15/16 TCI framework.  Proposal 2: For dual TCI state switching delay requirements, the followings can be discussed:  - the scenarios of different trigger events, e.g., 1 or 2 MAC-CE, 1 or 2 DCI  - whether to update the definition of known/unknown TCI state  - whether TCI association to different PCI is allowed |
| R4-2215870 | vivo | Proposal 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.  Proposal 2: Dual TCI state switching delay requirements shall be based on Rel-15/16 TCI framework in this WI.  Proposal 3: When defining Dual TCI state switching delay requirements, following cases shall be considered.  • PDCCH non-SFN: Two MAC CE with one for each TCI state  • PDCCH SFN: single MAC CE for two TCI states  • PDSCH single DCI: single DCI for two TCI states  • PDSCH multiple DCI: Two DCI with one for each TCI state  Proposal 4: The legacy known/unknown condition can be reused for each TCI state of the dual TCI states.  Proposal 5: For MAC-CE based dual TCI states switch, requirements for both known and unknown conditions are specified.  Proposal 6: For DCI based dual TCI states switch, requirements are only specified for known condition, i.e., each of the dual TCI states are known.  Proposal 7: For dual TCI states switch, delay requirements are specified for each TCI state and legacy TCI state switch delay requirements are reused.  Proposal 8: Legacy TCI states switch delay requirements are enhanced for UE with multi-Rx chain. |
| R4-2216277 | Huawei, HiSilicon | Observation 1: Rel-17 unified TCI is not jointly considered with dual TCI, which is listed as an objective in Rel-18 MIMO.  Proposal 1: Define dual TCI state switching delay requirements base on Rel-15/16 TCI framework.  Proposal 2: Define dual TCI state switching requirements for following cases:  • PDCCH non-SFN: Two MAC CE with one for each TCI state  • PDCCH SFN: single MAC CE for two TCI states  • PDSCH single DCI: single DCI for two TCI states  • PDSCH multiple DCI: Two DCI with one for each TCI state  Proposal 3:  The definition of dual TCI state switch shall be clarified considering following cases:  1. Single TCI to dual TCI  2. Dual TCI to single TCI  3. Dual TCI with changes of both QCL Type D RSs  4. Dual TCI with change of only one of QCL type D RS.  Observation 2: For dual TCI switching requirements, the conditions shall be considered that the two TCIs with different QCL type D RS shall be the ones that UE can simultaneously receive.  Observation 3: The requirements shall apply provided that two directions with different QCL typeD are received by different UE panels.  Proposal 4: Following conditions shall be considered for the known conditions:  • The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.  • The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion. |
| R4-2216477 | ZTE Corporation | Proposal 1: Referring to dual TCI state switching, we can have two assumptions：  2) Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.  2）Without the limitation of not cross pool switching allowed, the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e. each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.  Proposal 2: Under the 1st assumption, basically UE can perform dual parallel TCI state switching simultaneously. Under the 2nd assumption, the following three different cases should be considered:  Case 1: Dual known TCI state switching  Case 2: One known TCI state switching + one unknown TCI state switching  Case 3: Dual unknown TCI state switching  And it seems that dual parallel TCI state switching is only possible for Case 1. |
| R4-2216581 | Nokia, Nokia Shanghai Bell | Proposal 1: For definition of TCI state switching delay for dual TCIs, RAN4 to consider at least the scenarios below, without precluding other scenarios in future discussions:  - Single-DCI, multi-TRP scenario  - Multi-DCI, multi-TRP scenario  Proposal 2: Multi-Rx UEs are assumed to support at least 2 active TCI states in Rel-18.  Proposal 3: The dual TCI state switch requirements are applicable when the corresponding TCI states are in the same, or in different panels.  Observation 1: Strict timing synchronization between Rx chains is challenging in case of distributed TRPs (non-ideal backhaul).  Observation 2: In multi-Rx chain, time and frequency can be tracked independently per Rx chain.  Proposal 4: In the case of dual TCIs, consider independent frequency/time tracking per Rx chain.  Proposal 5: Each TCI switching per RX chain is assumed to be independent in aspect of TCI switching delay.  Proposal 6: RAN4 to consider legacy Rel-15/Rel-16 TCI switching delay requirements as baseline to Rel-18 UE requirements with multi-RX chains in multi DCI and multi TRP scenarios.  Observation 3: TCI state switch delay depends on TL1-RSPR\_Measurement\_Period\_SSB and TL1-RSRP\_Measurement\_Period\_CSI-RS  Proposal 7: Enhancements on L1 RSRP delays should be reflected on TCI state switch delay.  Observation 4: UE is expected to track all the active TCI states independent of the panel being used. It is already assumed that that there is no need of any additional delay for cross panel TCI state switching.  Proposal 8: RAN4 not to define additional TCI state switching delay for cross panel TCI state switching.  Observation 5: The use of multiple Rx chains is not necessarily helping on the conditions for a target TCI state to be known or unknown.  Proposal 9: Reuse existing conditions for known/ unknown TCI state for multi Rx chain capable UEs. |
| R4-2216827 | Ericsson | Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:  o the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.  Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:  o A new active TCI state is added,  o An active TCI state is removed,  o An active TCI state is switched/replaced.  Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.  Proposal 4: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:  o addition of an active TCI state to the set of active TCI states for simultaneous reception,  o removal of an active TCI state from the set of active TCI states for simultaneous reception,  o switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception.  Proposal 5: RAN4 to discuss whether there is an issue when the number of active TCI states is at any time larger than the UE capability for simultaneous reception. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Sub-topic 1-1: Requirements and Scenarios

*Sub-topic description:*

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

**Issue 1-1-1: Requirements to be defined**

* Proposals
  + Proposal 1: TCI state switching requirements
    - DL TCI state switch requirements
      * Note: It is my understanding that WI is only for DL reception.
  + Proposal 2: TCI state list update requirements
    - Addition/removal/update of TCI states in the list
* Recommended WF
  + Agree on the proposal 1 and 2.

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| **Company** | **Comments** |
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**Issue 1-1-2: Scenarios to be considered w.r.t Intra-cell/Inter-cell multi-TRP.**

* Proposals
  + Scenario 1: Intra-cell multi-TRP. That means same PCI is assumed for two TRP and two TCI states are from same PCI
  + Scenario 2: Inter-cell multi-TRP. That means PCI is different for two TRP and TCI states may be from different PCI.
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
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**Issue 1-1-3: Scenarios to be considered w.r.t single DCI/multi-DCI.**

* Proposals
  + Scenario 1: Single-DCI, multi-TRP scenario
  + Scenario 2: Multi-DCI, multi-TRP scenario
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
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### Sub-topic 1-2: TCI state switching requirements

*Sub-topic description*

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

**Issue 1-2-1: Assumptions for dual TCI state switching**

**Issue 1-2-1-1: Dual TCI state switching requirements shall be based on**

* Proposals
  + Option 1: Rel-15/Rel-16 TCI framework
  + Option 2: unified TCI framework
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-2-1-2: Can the TCI switch is assumed to be independent on each RX chain?**

* Proposals
  + Option 1: Yes. For each RX chain, the TCI state switch is assumed to be independent.
  + Option 2: No. Both the TCI states should be switched together.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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If the TCI activation is assumed to be independent on each RX chain, each TCI state can be switched independent and at a time single or two TCI state can be switched. If one TCI state is switched at a time, existing requirements may be applicable. When two TCI states are switched at the same time, new requirements may need to be specified.

**Issue 1-2-2: Switch command for dual TCI state switch**

**Issue 1-2-2-1: When two TCI states are switched simultaneously, assumption on the switch commands**

* Proposals
  + Option 1 (Vivo, Huawei): requirements are defined for following modes of switching
    - Two DCI one for each TCI state (PDSCH multiple DCI)
    - Two MAC CE one for each TCI state (PDCCH non-SFN)
    - One DCI for two TCI states (PDSCH single DCI)
    - One MAC CE for two TCI states (PDCCH SFN)
* Recommended WF
  + My understanding is above modes are supported from RAN1 perspective and suggest to agree on option 1.

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| **Company** | **Comments** |
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**Issue 1-2-2-2: TCI state switch scenarios to be considered**

* Proposal 1 (Xiaomi):
  + 1, Single TCI state to Dual TCI state within one MAC CE
  + 2, Single TCI state to Dual TCI state with two MAC CE
  + 3, Dual TCI state within one MAC CE to Single TCI state
  + 4, Dual TCI state with two MAC CE to Single TCI state
  + 5, Dual TCI state with one MAC CE to Dual TCI state with two MAC CE
  + 6, Dual TCI state with two MAC CE to Dual TCI state with one MAC CE
  + 7, Dual TCI state with one MAC CE to Dual TCI state with one MAC CE
  + 8, Dual TCI state with two MAC CE to Dual TCI state with two MAC CE
* Proposal 2 (Huawei): The definition of dual TCI state switch shall be clarified considering following cases:
  + Single TCI to dual TCI
  + Dual TCI to single TCI
  + Dual TCI with changes of both QCL Type D RSs
  + Dual TCI with change of only one of QCL type D RS.
* Recommended WF
  + Both proposals look similar. Can they be merged into proposal 1? Further discussion needed.

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| **Company** | **Comments** |
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**Issue 1-2-2-3: If the proposal 1 to issue 1-2-2-2 is acceptable, can the following proposal be acceptable.**

* + Proposal 1 (Xiaomi): For scenario 1, 3, 7 as one MAC CE is used before and one MAC CE is used after the TCI state switching, the legacy MAC CE based delay requirement apply
  + Proposal 2 (Xiaomi): For scenario 8, the legacy TCI state switching delay requirement will be used for each TCI state switching.
  + Proposal 3 (Xiaomi): The MAC CE processing time will need to be further considered in certain scenario as the 2nd MAC CE comes within the 1st MAC CE processing time
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-2-3: Known condition**

**Issue 1-2-3-1: When two TCI states are switched simultaneously, known condition for the TCI states is:**

* Proposals
  + Option 1 (Xiaomi): Assumed known if both TCI states are known. If anyone of the TCI state is unknown, both the TCI states considered unknown.
  + Option 2: Dual TCI states are independent, and each of the TCI state can be known or unknown.
  + Option 3 (MTK, Nokia): the legacy R15/R16 definition can be reused
  + Option 4 (OPPO): Further study whether to update the definition of known/unknown
  + Option 5 (Huawei): Following conditions shall be considered for the known conditions:
    - The UE has sent at least one L1-RSRP report for the target TCI states before the TCI state switch command where the associated QCL type D RSs are reported within one group configured by groupBasedBeamReporting-r17.
    - The associated QCL type D RSs in target TCI states satisfy the conditions that the RSs are received from different panels, where the conditions shall follow RF conclusion.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-2-4: Delay requirements:**

**Issue 1-2-4-1: Requirements are specified for following cases only. Do you agree with below proposals?**

* Proposals
* Proposal 1 (Vivo): For DCI based switching, only known TCI state switching requirement are defined
* Proposal 2 (Vivo): For MAC-CE based dual TCI states switch, requirements for both known and unknown conditions are specified.
* Recommended WF
  + Discussion is needed.

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| **Company** | **Comments** |
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**Issue 1-2-4-1: Does the cross-panel switch time needs to be defined.**

* Proposals
  + Option 1 (MTK): Reuse Rel-15/16 TCI state switch delay unless RF session achieves a new conclusion on panels ON/OFF switch time. I.e., transient time is not considered for cross panel switch.
  + Option 2 (Nokia): RAN4 not to define additional TCI state switching delay for cross panel TCI state switching
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-2-4-2: TCI state switch delay requirements**

* Proposals
  + Option 1 (Vivo): for known TCI state, reuse legacy requirements. For unknown state, legacy TCI states switch delay requirements are enhanced for UE with multi-Rx chain
  + Option 2 (Intel): For dual TCI state switch, the legacy Rel-15/16 TCI state switch delay requirement can be reused
  + Option 3(MTK): Legacy TCI states switch delay requirements are reused for UE with multi-Rx chain
  + Option 4 (Nokia): Enhancements on L1 RSRP delays should be reflected on TCI state switch delay
  + Option 5 (LGE): Further study UE behavior in case one of the TCI states is unknown for dual TCI state switching
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-2-5: Time frequency tracking requirements**

* Proposals
  + Option 1: UE with multi-Rx chain should track timing/frequency independently for each TCI state when dual TCI states are activated.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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### Sub-topic 1-3: TCI state list update requirements

*Sub-topic description*

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

**Issue 1-3-1: TCI state pools**

* Proposals
  + Option 1: Independent candidate TCI state pool for each Rx chain/panel. Then the TCI state switching is only allowed within one candidate TCI state pool, cross-pool switching is not allowed.
  + Option 2: Cross pool switching is allowed, i.e., the target TCI state can be in any pool, same of different with the pool of current TCI state, i.e., each TCI state switching can be within panel/Rx chain or cross panels/Rx chains.

Clarification required from the proponent. Is the TCI state pool referred here same as active TCI state list?

* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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**Issue 1-3-2: Active TCI state list update requirements**

* Proposals
  + Proposal 1: RAN4 to discuss the active TCI states requirements for any change to the set of active TCI states used for simultaneous reception, i.e., requirements for:
    - addition of an active TCI state to the set of active TCI states for simultaneous reception,
    - removal of an active TCI state from the set of active TCI states for simultaneous reception,
    - switching/replacement of an active TCI state in the set of active TCI states for simultaneous reception.
* Recommended WF
  + Companies are requested provide their views on the above proposal.

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| **Company** | **Comments** |
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**Issue 1-3-3: Other proposals**

* Proposals
  + Proposal 1: The new RRM requirements (e.g., measurement or beam management requirements) defined for simultaneous measurements and procedures on two chains need to apply, provided:
    - the corresponding active TCI states are configured and used for simultaneous reception during the entire measurement or evaluation period.
  + Proposal 2: RAN4 to define the necessary UE behaviour and measurement requirements for simultaneous reception when the set of active TCI states changes during the measurement or evaluation period, e.g., when:
    - A new active TCI state is added,
    - An active TCI state is removed,
    - An active TCI state is switched/replaced.
  + Proposal 3: RAN4 to discuss and decide on how to differentiate in the specification the set of active TCI states which can be used for simultaneous reception from other active TCI states which cannot be used for simultaneous reception.
* Recommended WF
  + Discussion needed

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| **Company** | **Comments** |
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## Companies views’ collection for 1st round

### Open issues

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

# Recommendations for TDocs

## 1st round

**New tdocs**

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

**Existing tdocs**

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

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

## 2nd round

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