**3GPP TSG-RAN WG4 Meeting # 94-e-Bis R4-200XXXX**

**Electronic Meeting, 20 – 30 Apr., 2020**

**Agenda item:** 11.3.1, 11.3.3

**Source:** Moderator (Nokia)

**Title:** Email discussion summary for [98e][138] [98e][138] FR\_RF\_FR2\_req\_enh2\_Part\_1

**Document for:** Information

# Introduction

This email discussion if for Rel-17 NR RF requirement enhancements for frequency range 2 WI with following Ais

11.3.1 General and work plan

11.3.3 Feasibility study [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.1 Inter-band DL CA enhancements [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.1.1 Feasibility study for CA configurations within same frequency group based on IBM [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.1.2 Feasibility study for CA configurations between different frequency groups based on CBM [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.2 Inter-band UL CA [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.2.1 Feasibility study for CA configurations within same frequency group based on IBM and CBM [NR\_RF\_FR2\_req\_enh2-Core]

11.3.3.2.2 Feasibility study for CA configurations between different frequency groups based on CBM

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

1st round: TBA

2nd round: TBA

# Topic #1: General

## Companies’ contributions summary

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| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2100264**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100264.zip) | Release 17 FR2 bandwidth class | Verizon Denmark | **Proposal-1: Expand four (4) more additional 200MHz classes in the “Fallback group 2” and eight (8) more 100 MHz classes in the “Fallback group 3” in FR2 CA bandwidth classes in Table 5.3A.4-1 of 38.10-2 to meet 1.6 GHz aggregated channel bandwidth.**  **Proposal-2: Include this work in scope of Rel-17 FR2 enhancement Work Item and define the related requirements** |
| [**R4-2100693**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100693.zip) | Status overview and proposals on FR2 inter-band CA discussion | MediaTek Beijing Inc. | **Proposal1: For “feasibility study stage”, RAN4 shall converge inter-band DL CA discussion firstly, before start to do inter-band UL CA feasibility study.**  **Proposal2: For “UE requirement discussion stage”, RAN4 shall specify exact band combination demand firstly, before start to do UE requirement discussion.** |
| [**R4-2101727**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101727.zip) | On the inter-band UL CA study and change of scope too include improved BC | Ericsson, Sony | **Proposal 1: specify further enhanced SSB-based beam correspondence tests for initial access and connected mode operation within the Rel-17 WI on NR RF Enhancements for FR2, mandatory and without beam sweeping.**  **Proposal 2: remove the study part on inter-band UL CA not to increase TU for the Rel-17 WI on NR RF Enhancements for FR2.** |

## Open issues summary

### Sub-topic 1-1 New FR2 bandwidth classes

In U.S., there is a more than 1GHz contiguous FR2 spectrum available for NR operation. However, the defined aggregated bandwidth by either 4x200 or 8x100-megahertz in Rel-15/16 specs still retains partial spectrum utilization in the practical 5G commercial service, instead of entire spectrum.

**Issue 1-1-1: New FR2 bandwidth classes**

* Proposals
  + Option 1: Add 4 new CA BW classes to FBG2 and 8 new CE BW classes to FBG3
  + Option 2: Do not add new CA BW classes
  + Option 3: Add new CA BW classes but differently as in option 1.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 |
| LG Electronics | Support Option 1 |
| Apple | Option 3: Only add 4 new CA BW classes to FBG2, but not 8 new CA BW classes to FBG3. Also the naming convention of using next available alphabets for new CA BW classes may need to be reconsidered as they become less easy to comprehend and we may run out of alphabets soon. |
| OPPO | Ok with Option 1. |
| Nokia | Option 1 naming convention may need more discussion |
| DISH | Option 1 |

### Sub-topic 1-2: Procedures for work plan

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| **DL CA** | Different Frequency Group  (ex: 28+39) | Same Frequency Group  (ex: 28+28) |
| IBM | Type1: UE requirement discussion (# agenda 11.3.2.1.2)   * n261+n260 (done) * n257+n259 (ongoing) * n258+n260 (ongoing) | Type3: feasibility study (# agenda 11.3.3.1.1) |
| CBM | Type2: feasibility study (# agenda 11.3.3.1.2) | Type4: UE requirement discussion (# agenda 11.3.2.1.3) |

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| **UL CA** | Different Frequency Group  (ex: 28+39) | Same Frequency Group  (ex: 28+28) |
| IBM | Type1: UE requirement discussion (# agenda 11.3.2.2.1)   * n257+n259 (ongoing) | Type3: feasibility study (# agenda 11.3.3.2.1) |
| CBM | Type2: feasibility study  (# agenda 11.3.3.2.2) | Type4: feasibility study  (# agenda 11.3.3.2.1) |

**Issue 1-2-1: Feasibility stage UL CA work flow**

* Proposals
  + Option 1: For “feasibility study stage”, RAN4 shall converge inter-band DL CA discussion firstly, before start to do inter-band UL CA feasibility study. (NOTE: IBM requirements for CA\_n257A-n259A are excluded from this proposal)
  + Option 2: Proposal in option1 not necessary
* Recommended WF
  + TBA

**Issue 1-2-2: Requirement stage work flow**

* Proposals
  + Option 1: Agree for “UE requirement discussion stage”, RAN4 shall specify exact band combination demand firstly, before start to do UE requirement discussion.
  + Option 2: Current WID is sufficiently clear on this aspect
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | **Issue 1-2-1: Feasibility stage UL CA work flow**  We proposed Option1 from technical discussion perspective, because there are common part between DL CA and UL CA, it would be more efficient if we discuss them step-by-step.  **Issue 1-2-2: Requirement stage work flow**  We’d like to use this meeting as an example to explain our intention. RAN4#98-e reserves an agenda item 11.3.2.1.3 for discussion on “inter-band DL CA requirement of same frequency group and CBM”, however, if there is no clear band combination demand list, there would be many possible band combinations can be discussed, and may be not easy to be focused. |
| LG Electronics | Issue 1-2-1 : Support Option 2  Issue 1-2-2 : Support Option 1, |
| Apple | Issue 1-2-1: we are OK to prioritize inter-band DL CA during the feasibility study stage.  Issue 1-2-2: OK with option 1 based on operator request |
| Samsung | Issue 1-2-1: share same view with Apple to prioritize DL CA.  Issue 1-2-2: support option 1. Current discussion is quiet divergent without dedicated operator request |
| OPPO | Issue 1-2-1 : OK with Option 1  Issue 1-2-2 : ok with Option 1, |
| Nokia | Issue 1-2-1 : Ok with option 1, note that there is also a proposal to exchange UL CA feasibility part to SSB BC.  Issue 1-2-2 : WID says: Define UE requirements for inter-band CA within the same freq. group (e.g. 28GHz + 28GHz) for common beam management (CBM) based on requested band combinations. But we understand the issue and that exact band combination would be helpful hence we support Option 1 and hope to get feedback from operators for their deployments plans on this topic. |
| Huawei | Issue 1-2-1: share same view with Apple to prioritize DL CA.  Issue 1-2-2: Option 2. General requirement is always before specific RF requirement for Band combinations. |
| Sony | **Issue 1-2-1: Feasibility stage UL CA work flow**  Agree with option 1, RAN4 shall converge inter-band DL CA discussion firstly, before start to do inter-band UL CA feasibility study.  **Issue 1-2-2: Requirement stage work flow**  Agree with option 1 RAN4 shall specify exact band combination demand firstly, before start to do UE requirement discussion |
| Ericsson | **Issue 1-2-1**  Leave until the inter-band DL CA work flow has been confirmed. See also comment to Issue 1-3-2. |
| Verizon | **Issue 1-2-1**  Consider option 1, but should not eliminate proposals which are needed to exchange UL CA feasibility part as Nokia pointed out  **Issue 1-2-2 :**  Current WID is sufficiently clear |

### Sub-topic 1-3: Modification to the WID

Support of beam correspondence is fundamental for FR2 operation, but *not mandatory* for Rel-16 and requirements are not specified for initial access. The scope should be reduced to include only inter-band UL CA for two band with IBM capability, the study part should be postponed and replaced with the following:

* Enhancement of beam correspondence during initial access and connected mode [RAN4 RF]
  + SSB-based without UL beam sweeping
  + For initial access, verification of beam correspondence based on msg1 spherical coverage (at least)

**Issue 1-3-1: New objective of SSB-based beam correspondence tests for initial access**

* Proposals
  + Option 1: Modify the WID and include objective for further enhanced SSB-based beam correspondence tests for initial access and connected mode operation, mandatory and without beam sweeping.
  + Option 2: Do not add this new objective
  + Option 3: Other
* Recommended WF
  + TBA

**Issue 1-3-2: Removal of study part on inter-band UL CA objective**

* Proposals
  + Option 1: Modify the WID and remove the study parts on inter-band UL
    - Study and if feasible define UE requirements for CBM between different freq. groups (e.g. 28GHz + 37GHz).
    - Study and if feasible define UE requirements for CBM and/or IBM CA within the same freq. group (e.g. 28GHz + 28GHz), on hold until there is operator request.
  + Option 2: Do not remove these objectives
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | 1-3-1:  Option 1 deals with important functionality that is not treated in the standard today. We therefore prefer to enhance the BC definition with proposal in option 1. |
| MediaTek | **Issue 1-3-1:**  We support “Option 2: Do not add this new objective.” In our understanding, if UE really cannot support BC for initial access, the UE would fail existed general EIRP test. Hence, maybe we no need to add a new test item for initial access itself.  **Issue 1-3-2:**  We are open for WID scope reduction, because each subjective is actually a big topic. |
| LG Electronics | Issue 1-3-1 : Support Option 2  Issue 1-3-2 : Support Option 2 |
| Apple | Issue 1-3-1: Option 2 is preferred. There is no initial access requirements in 3GPP. The testability of option 1 should be justified before introducing this object to the WID  Issue 1-3-2: some clarifications on the option 1 are needed. We are OK if this means no inter-band UL related feasibility study is concluded and no corresponding requirements will be specified in R17. |
| Samsung | Issue 1-3-2: new items are proposed to expand the scope including intra-band CA enhancement in sub topic 1-1 with new bandwidth class and beam correspondence enhancement in issue 1-3-1. If either new item is added, then we are OK to go with Option 1 based on Apple’s clarification (conclude with no requirements) as long as there is no practical inter-band UL CA operator request. |
| OPPO | Issue 1-3-1 : Option 2  Issue 1-3-2 : Option 2 |
| Nokia | We support **Issue 1-3-1:** option 1 and **Issue 1-3-2:** option 1 as a package. |
| vivo | Issue 1-3-1 :  Option 2  Issue 1-3-2:  Option 2 |
| Huawei | Issue 1-3-1 :  Option 2  Issue 1-3-2:  Option 2 |
| Sony | **Issue 1-3-1: New objective of SSB-based beam correspondence tests for initial access**  Support option 1, Modify the WID and include objective for further enhanced SSB-based beam correspondence tests for initial access and connected mode operation, mandatory and without beam sweeping.  **Issue 1-3-2: Removal of study part on inter-band UL CA objective**  Support option 1. |
| Ericsson | Issue 1-3-1:  Option 1 (as proponent). The description of this sub-topic says it all.  Issue 1-3-2:  Option 1 (as proponent) and clarify that the requirements for inter-band UL CA for two bands are specified for inter-band UL CA between different frequency groups based on IBM. |
| Verizon | Issue 1-3-1:  Option 1  Issue 1-3-2:  Option 1 |

## Companies views’ collection for 1st round

### Open issues

### 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** | **Title** | **Company** | **Comments collection** |
|  |  |  | Company A |
| Company B |
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|  |  |  | 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:* |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

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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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #2: Feasibility study DL CA

## Companies’ contributions summary

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| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| **[R4-2100637](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100637.zip)** | Discussion on feasibility for inter-band CA configurations | LG Electronics | **IBM feasibility for DL CA between bands in the same frequency group**  **Proposal 1: For inter-band DL CA within same frequency group, either IBM or CBM is applicable.**  **Proposal 2: For IBM on inter-band DL CA within same frequency group, whether or not to reuse Rel-16 reference sensitivity relaxation and EIS spherical coverage relaxation should be investigated for corresponding band combination.**  **CBM for DL CA between bands in the same frequency group**  **Proposal 3: For CBM on inter-band DL CA within same frequency group, consider reference sensitivity relaxation similar to Rel-16 intra-band non-contiguous CA for corresponding band combination.**  **CBM feasibility for DL CA between bands in the same/different frequency group**  **Proposal 4: For CBM on inter-band DL CA, performance degradation due to Rx beam switch should be allowed if MRTD is defined that is larger than CP.**  **CBM/IBM vs *simultaneousRxTxInterBandCA***  **Proposal 7: For CBM UE on inter-band CA within same frequency group, simultaneous Rx/Tx capability does not apply.** |
| **[R4-2102714](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2102714.zip)** | Simulation and analysis of FR2 inter-band DL CA based on CBM/IBM | vivo | **Observation 1**: For co-located deployments, in the case of the same frequency group, IBM still has fairly significant gains in some cases compared to CBM, while generally the performance is similar for more cases.  **Observation 2+2a:** For co-located deployments, IBM and CBM will choose the same Rx beam in most cases, no matter same of different frequency group  **Observation 3:** For co-located deployments, in the case of the different frequency group, the degradation of CBM performance is significant.  **Observation 4:** For non-co-located deployments, even using wide beam cannot effectively alleviate the performance degradation of CBM.  **Proposal 1: For co-located deployments, use to restrict the frequency span between two CCs to ensure the minimum performance of CBM.**  **Proposal 2: RAN4 should clarify the acceptable performance degradation of CBM.**  **Proposal 3：For non-co-located deployment, only IBM can be used in FR2 inter-band CA.** |
| [**R4-2100893**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100893.zip) | Discussion on IBM inter-band CA within same frequency group | Samsung | Observation 1: IBM requires concurrent multi-beam antenna radiation pattern  Observation 2: a multi-band UE supporting IBM inter-band CA within same frequency group is more complicated than a multi-band UE supporting IBM inter-band CA across different frequency group.  **Proposal 1: RAN4 discuss dual polarization assumption of inter-band CA, and if IBM architecture with CC per polarization is considered.** |
| [**R4-2101375**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101375.zip) | The IBM UE capability for inter-band CA within the same frequency group | Xiaomi | **Proposal: for inter-band CA within the same frequency group, CBM type should be default applicability, and introduce a signaling to make UE inform network whether it supports IMB type.** |
| [**R4-2100240**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100240.zip) | On the feasibility of CBM for FR2 inter-band CA cross different frequency groups | Apple | Observation 1: Substantial performance degradation is expected for CBM with FR2 inter-band CA between different frequency groups from the aspects of frequency separation and beam squint.  Observation 2: When MRTD is more than CP length in CBM, one slot per Rx beam switching can be interrupted on all CCs where the symbol boundary misalignment from the reference CC is more than CP. If PDCCH is interrupted, the corresponding impacts can last multiple slots.  Observation 3: When non-collocated scenario is assumed, it is infeasible to assume MRTD is less than CP length due to both TAE and propagation delay differences. The performance degradation due to Rx switch and the corresponding interruption can be quite significant.  Observation 4: When MRTD>CP, parallel RRM measurement on FR2 CC becomes questionable since beam switch may happen during the symbol duration.  **Proposal 1: CBM should be limited to collocated scenarios, which include the FR2 inter-band CA within the same frequency group and between different frequency groups.**  **Proposal 2: No CBM based RF, RRM and demod requirements should be specified for FR2 inter-band CA between different frequency groups.** |
| **[R4-2101376](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101376.zip)** | The CBM UE capability for inter-band CA between different frequency groups | Xiaomi | **Proposal: for inter-band CA between different frequency group, IBM type should be default applicability, and introduce a signaling to make UE inform network whether it supports CMB type.** |

## Open issues summary

### Sub-topic 2-1: Beam management

**Issue 2-1-1: Beam management for CA within same frequency group**

* Proposals
  + Option 1: For inter-band DL CA within same frequency group, either IBM or CBM is applicable (R4-2100637)
  + Option 2: For inter-band CA within the same frequency group, CBM type should be default applicability, and introduce a signaling to make UE inform network whether it supports IBM type (R4-2101375)
  + Option 3: CBM type should be default applicability, but no new signalling is needed.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1.  IBM is considered a ‘full-featured’ inter-band solution, so it should be the natural default assumption for any FR2 inter-band CA band pair.  IBM is already agreed as being applicable to any band pair. |
| MediaTek | We are open for Option 2 & 3, after considering “complexity and difficulty of UE implementation and the implementation cost”, that is raised in R4-2101375 |
| LG Electronics | Support Option 1. In aspect of UE implementation, either IBM or CBM can be supported. |
| Apple | For inter-band CA within the same frequency group, CBM type should be default applicability. However, we don’t see how the signalling will be used at NW side. In this case, option 3 is preferable. |
| Samsung | We are okay with both option 1 and 3. The two options do not contradict to each other. Beam management type is mandatory to be reported already, no new signalling needed. |
| OPPO | Option 1 |
| Nokia | Option 1. There is no need to waste energy of discussing what is default BM. As Qualcomm pointed out it has been concluded that IBM UE can support any band combination and that is enough. What needs to be done is to define requirements for CBM for band combinations within same frequency group. We have the signalling in place to indicate the network whether UE is CBM or IBM. |
| vivo | Option1 or option2, our simulation result (R4-2102714) shows that even for same freq. group, the CBM performance degradation compared to IBM still may be large, especially for narrow beam. If we want set CBM as default applicability, it is a better choice to further restrict the span between different CCs, e.g, by Fs,inter, which can control the CBM performance degradation within an acceptable range. |
| Huawei | Option 1. We don’t need to discuss on default BM, signalling is already defined in Rel-16. We need to clearly define CBM/IBM in TS 38.101-2, it can be defined as:  Independent beam management (IBM): UE select a suitable DL beam for CCs across bands based on DL measurements on both Bands.  Common beam management (CBM): UE select a suitable DL beam for CCs across bands based on DL measurements only on one of the Bands. |
| Sony | Support option 1. For inter-band DL CA within the same frequency group, either IBM or CBM is applicable.  From the simulation and analysis provided by companies, it can be seen that the CBM can provide similar performance to IBM within the same frequency group, especially for the co-located deployment scenario. IBM UEs can work within the same frequency group as well. Though its implementation might be more complicated, we don’t see any reason to limit it from the standard perspective.  However, we don’t see a strong need to define any “default applicability”. Whether CBM or IBM is more feasible is related to the frequency bands separation and the deployment scenario. From the network aspect, it should be able to configure a UE with a supported band combination according to its advertised capabilities, including the BM capability. Suppose the advertised BM capability does not match the deployment scenario (e.g., CBM capability only for a collocation scenario). In that case, the network will simply not configure the UE with the band combination at hand.  Besides, As the default capability is based on the frequency group, it may create issues if more bands are introduced in FR2 since the frequency group concept is only based on the bands defined today. |
| Ericsson | Option 1. Any default signalling, if at all, should be specified in the RAN2 specifications. The network should not have to look in RAN4 tables to figure out the UE capability in case a field is absent. |
| Verizon | **Issue 2-1-1**  IBM should be a ‘full-featured’ inter-band solution for any band pair |

**Issue 2-1-2: Beam management for CA between the frequency groups**

* Proposals
  + Option 1: No CBM based RF, RRM and demod requirements should be specified for FR2 inter-band CA between different frequency groups (R4-2100240)
  + Option 2: For inter-band CA between different frequency group, IBM type should be default applicability, and introduce a signaling to make UE inform network whether it supports CMB type. R4-2101376
  + Option 3: IBM type should be default applicability, but no new signalling is needed.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2: FFS if CBM between different frequency groups is practical. |
| MediaTek | We are open for Option 2 & 3, after considering UE implementation feasibility. |
| LG Electronics | Support Option 2 |
| Apple | There is no much difference between option 1 and 3. We support option 1 since it is questionable on the feasibility to support CBM between frequency groups. |
| Samsung | We are okay with both option 1 and 3. It is not practical to specify CBM requirements between frequency groups with remarkable performance degradation expected. Beam management type is mandatory to be reported already, no new signalling needed. |
| OPPO | Option 2 |
| Nokia | Like we said in earlier issues no need to discuss default BM and there is no need for new signalling. What needs to be done is to discuss if CBM requirements would make sense for combinations between frequency groups and if they do then see if there is operator interest. And now I see that moderator did not list good option for us…hence option 3 is least bad. |
| vivo | Option 2 or Option3, the degradation of CBM with different freq. group is more severe, so IBM can be default configuration, but the CBM may be acceptable if the span between CCs is limited.  In our understanding, UEs that support IBM may also be able to implement CBM, so no new signalling may not be required. |
| Huawei | Both CBM and IBM are applicable for inter-band CA within the same freq group. No default BM is needed, UE just signal its capability.We need to clearly define CBM/IBM in TS 38.101-2, it can be defined as:  Independent beam management (IBM): UE select a suitable DL beam for CCs across bands based on DL measurements on both Bands.  Common beam management (CBM): UE select a suitable DL beam for CCs across bands based on DL measurements only on one of the Bands. |
| Sony | We don’t support any of the options at this moment.  First, we don’t think it is needed to have any “default applicability” as stated in issue 2-1-1.  In addition, we think it is too early to conclude that no CBM based requirement would be defined. Whether RRM requirements should be defined or not should be left to the RRM session. For RF requirements, we need to first converge on how RAN4 would further develop the requirement for inter-band CA before reaching such a conclusion (if the requirement should be detailed in each case of frequency groups vs deployment scenario or simply define a unified requirement agonistic for all cases). |
| Ericsson | None of these. See also response to Issue 2-1-1. |
| Verizon | Option 2 or 3  We shared Nokia comment above! |

### Sub-topic 2-2: Network deployment options

**Issue 2-2-1: Non-collocated/collocated deployments**

* Proposals
  + Option 1: For non-co-located deployment, only IBM can be used in FR2 inter-band CA (R4-2102714)
  + Option 2: CBM should be limited to collocated scenarios, which include the FR2 inter-band CA within the same frequency group and between different frequency groups (R4-2100240)
  + Option 3: There are no deployment restrictions (Non-collocated/collocated) for network to configure CA for IBM or CBM UEs
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 3 |
| MediaTek | We understand Option1&2’s judgement and intention. For typical cases, we think the two options are basically made sense. However, we’d like to raise below questions for more discussions to help companies to make decision:  (1) What’s the exact criteria between “non-co-located deployments” and “co-located deployment”? For example, in some scenarios, if the AoA of two BSs of non-co-located deployments are similar, the CBM UE would be still workable.  (2) Assume the CBM UE really cannot have good performance on specific scenario (ex: quite different AoA), is there extra benefit to let CBM UE access network? |
| LG Electronics | Support Option 1 & Option 2. |
| Apple | Option 1 and 2 are complimentary to each other. We support both. |
| Samsung | We prefer option 1 and 2, but can compromise to option 3 if there is no requirement specified and performance is not guaranteed for worse deployment scenarios for CBM UEs. |
| OPPO | Option 1 and 2 |
| Nokia | Option 3. Agree with MediaTek’s point that criteria for collocated and non-collocated deployment is not clear. CBM UEs may work also for non-collocated deployments therefore there is no need to restrict NW to be able to configure CA for CBM UE in case of non-collocated deployment. |
| vivo | Option1 or option2. The result of our simulation (R4-2102714) shows the CBM performance degradation is huge even using the wide Rx beam for non-colocated. |
| Huawei | Option 3.  We provide an example on how CBM support non-colllocated.  If we assume gNB antenna array size is 16\*16, 3dB beam width (HPBW) could be 6o, the angle between 2 DL beams of the non-collocated gNBs is 30o. When PC3 UE antenna array size is 2\*2, the 3dB beam width could be 50o, then this rough beam can cover 2 DL beams from gNBs. |
| Sony | Support option 3 There are no deployment restrictions (Non-collocated/collocated) for the network to configure CA for IBM or CBM UEs.  Networks can configure a UE with a supported band combination according to its advertised capabilities, including the BM capability. If the advertised BM capability does not match the deployment scenario (e.g., CBM capability only for a collocation scenario), the network simply will not configure the UE with the band combination at hand. Therefore, we don’t see any reason to confine the BM type in the specification. |
| Ericsson | Option 3. RAN4 requirements cannot restrict operator deployment scenarios. However, RF and RRM requirements for a beam management type can be associated with requirements for a deployment scenario (collocated/non-collocated) |
| Verizon | Option 3 |

### Sub-topic 2-3: CBM Requirements

**Issue 2-3-1: CBM UE and simultaneousRxTxInterBandCA**

* Proposals
  + Option 1: For CBM UE on inter-band CA within same frequency group, simultaneous Rx/Tx capability does not apply (R4-2100637)
  + Option 2: No restriction is needed on simultaneous Rx/Tx.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 |
| MediaTek | Support Option 1 |
| Xiaomi | Support Option 1, assume all band combs support non-simultaneous Rx/Tx capability, the UE need report the capability if it supports the simultaneous Rx/Tx capability. |
| LG Electronics | Support Option 1. Our understanding is that UL-DL configuration for each CC should be aligned for CBM UE on inter-band CA within same frequency group. |
| Apple | We support option 1 if it means that same UL-DL configurations are assumed for all CCs. |
| OPPO | Option 1 |
| Nokia | Option 1 |
| vivo | Option1. |
| Huawei | If CBM can support non-collocated deployment, obviously simultaneousRxTxInterBandCA is needed. So option 2. |
| Ericsson | We expect that the inter-band CA slot format will be subject to general rules and the timing requirements applicable for inter-band CA (the same restrictions as for intra-band CA expected unless otherwise stated). |
| Verizon | Optoin2 |

**Issue 2-3-2: CBM UE and REFSENS for CA within same frequency group**

* Proposals
  + Option 1: Define REFSENS relaxation for CBM UE which is a function of frequency span between the CCs. (R4-2100637, R4-2102714)
  + Option 2: Not needed.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 |
| MediaTek | Option 1 is made sense for us, frequency span shall be a component of REFSEEN relaxation discussion for CBM UE. |
| Xiaomi | Support Option 1 |
| LG Electronics | Support Option 1 |
| Apple | Option 1 |
| OPPO | Option 1 |
| Nokia | Option 1 |
| vivo | Option1，Even for same freq. group, the frequency span between two CCs is still too large. |
| Huawei | Option 1. |
| Sony | Basically fine with the Option 1, but need further study what relaxation factors should be considered here and exact values. |
| Ericsson | Option 1 makes sense, requirements are FFS. |
| Verizon | FFS |

### Sub-topic 2-4: Dual polarization antenna

**Issue 2-4-1:**

* Proposals
  + Option 1: RAN4 discuss dual polarization assumption of inter-band CA, and if IBM architecture with CC per polarization is considered.
  + Option 2: Up to UE implementation
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2:  UE is not restricted from optimized implementations like splitting band coverage by polarization. This however is a UE choice, rather than being viewed as a new mechanism to allow further relaxation from approx.. 3.5 dB delta(R\_IB) |
| MediaTek | Support Option2. For this specific proposed architecture, in our understanding, the performance under single-band operation would be 3 dB less. |
| LG Electronics | Support Option 2. However, if IBM architecture with CC per polarization can be included as UE implementation, related all RF requirements should be investigated. |
| Apple | Option 2 |
| Samsung | Thanks for all the comments, the intention we propose this proposal is to see the common understanding on IBM architecture with CC per polarization in RAN4. If it is allowed implementation, then it is almost not possible to pass the test with current requirement framework with single DL polarization from test equipment. Is that to say this implementation is not allowed? |
| OPPO | Option 2 |
| Nokia | Option 2 |
| vivo | Option2 |
| Huawei | For FR2, we think it should be OK for UE to support each Band with only 1 polarization assumption. However, currently the RF requirements are defined for 2 polarization, we may need RF requirement for UE only support 1 polarization on each Band. |
| Sony | Option 2: up to UE implementation. But we are also okay to further discuss it. |
| Ericsson | Option 2. For the specification of requirements, a reference architecture might have to be discussed. |
| Verizon | Fine with the Option 2, a concern is there would be no a standardized validate procedures in future. |

## Companies views’ collection for 1st round

### Open issues

### 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** | **Title** | **Company** | **Comments collection** |
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| 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:* |

*Suggestion on WF/LS assignment*

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### 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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Feasibility study UL CA

## Companies’ contributions summary

|  |  |  |  |
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| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2100637**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2100637.zip) | Discussion on feasibility for inter-band CA configurations | LG Electronics | **IBM/CBM feasibility for UL CA between bands in the same frequency group**  **Proposal 5: For inter-band UL CA within same frequency group, either IBM or CBM can be applicable.**  **CBM feasibility for UL CA between bands in the same/different frequency group**  **Proposal 6: For CBM on inter-band UL CA, RAN4 needs to study how to handle impact on performance due to Tx beam switching.** |
| [**R4-2102715**](file:///C:\Users\vasenkap\Documents\Työt\RAN4\%2398e\Docs\R4-2102715.zip) | Discussion on FR2 inter-band UL CA | vivo | **Observation 1**: From the need of UL CA to ensure similar coverage, it may be reasonable to apply max EIRP per UE.  **Observation 2**: Co-located and non-collocated deployment may be used for different rules (per-UE/per-band), but still there are some problems.  **Proposal 1: The max EIRP and P-MPR may be applied per UE under co-located deployment, and be applied per band under non-co-located deployment, however, some problems still remain**.  **Observation 3:** MPE measurement is quite depend on actual implementation of panels.  **Observation 4:** The concept of EIRP is based on one direction and more suitable for single beam scenario, and its application is ambiguous for simultaneous multi-beam transmission. This could be one of the underlying reasons for previous standardization difficulties.  **Proposal 2：It is encouraged to discuss if a new power metric for multi-beam scenario, e.g., “mEIRP”, could be helpful to counter EIRP's shortcomings.**  **Proposal 3: The max TRP and min peak EIRP can be applied per band to maintain the respective system performance.** |
| [**R4-2100619**](file:///C:\Users\vasenkap\Documents\Työt\RAN4\%2398e\Docs\R4-2100619.zip) | Definition of TRP and EIRP for FR2 ULCA | Qualcomm Incorporated | **Proposal 1: For non-overlapping bands it seems possible to specify TRP as per band, with max TRP of each band set to 23 dBm. The specification of TRP for overlapping bands needs to be discussed further.**  **Proposal 2: If there are regional requirements that require the TRP to be reduced then this can be done using an NS case or by limiting Pmax per band.**  **Proposal 3: For non-overlapping bands it seems possible to specify EIRP as per band, with max EIRP of each band set to 43 dBm. The specification of EIRP for overlapping bands needs to be discussed further.** |
| [**R4-2101374**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_98_e/Docs/R4-2101374.zip) | The MOP and Tx requirements for inter-band UL CA in FR2 | Xiaomi | **Observation 1:** The maximum output power can’t be defined per band basis or per UE basis purely. Some MOP requirements need define per band basis, others need define per UE basis.  **Observation 2:** When the gap between 2 UL is zero or smaller than the sum of OOB range of each band, the definition of SEM/ACLR/Spurious emission for contiguous or non-contiguous intra-band CA transmissions could be used as starting point for defining such requirements for inter-band UL CA in FR2.  **Observation 3:** If the gap between 2 UL is large enough, whether reuse the requirements of SEM/ACLR/Spurious emission defined for single CC operation for inter-band UL CA is up to MOP definition, i.e., whether power reduction is allowed for each band.  **Proposal 1:** **For inter-band UL CA in FR2, the power class should be follow current UE types.**  **Proposal 2: for inter-band UL CA in FR2, the maximum output power should be specified independency with UE BM types, the relaxation values could be introduced for different BM types.**  **Proposal 3: for inter-band UL CA in FR2, the maximum output power could be defined as Table 2.1-2:**  **Table 2.1-3 The MOP requirements for inter-band UL CA**   |  |  |  | | --- | --- | --- | | **MOP** | **Per band or per UE** | **requirements** | | **Min peak EIRP** | Per band | each band follow the requirement of single CC operation | | **Minimum EIRP spherical coverage** | Per band | each band follow the requirement of single CC operation | | **Max TRP** | Per band | each band follow the requirement of single CC operation | | **Max EIRP** | Per UE | aggregated max EIRP keep the same requirement with single CC operation |   **Proposal 3: For inter-band UL CA in FR2, the requirements of SEM/ACLR/Spurious emission need be defined considering the different gaps between 2 UL component carriers.** |

## Open issues summary

### Sub-topic 3-1: EIRP

**Issue 3-1-1: Max EIRP**

* Proposals
  + Option 1: The max EIRP is applied per UE under co-located deployment and per band under non-co-located deployment.
  + Option 2: For non-overlapping bands specify EIRP as per band, with max EIRP of each band set to 43 dBm, excluding PC1.
  + Option 3: Per UE and aggregated max EIRP keep the same requirement with single CC operation
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2: For non-overlapping bands specify EIRP as per band, with max EIRP of each band set to 43 dBm, excluding PC1.EIRP specification for overlapping bands needs to be discussed further |
| Xiaomi | We agree Max EIRP is applied per UE for non-overlapping bands. But we need also consider how to treat the overlapping bands, maybe it can be treated as intra-band CA, the requirements will be complex for inter-band CA. |
| LG Electronics | Support Option 3. For example, in case of n260+n261 (Each Max EIRP is specified with 43dBm in Rel-15/16), total max EIRP can be 46dBm. So, it needs to limit 43dBm. |
| Apple | Maximum EIRP would depend on regulatory requirements as whether total power or power spectral density counts. From this perspective, option 3 is preferable. |
| OPPO | Option 2, it relates to how regulation require this per freq or per UE. |
| Nokia | Option 2 |
| vivo | Option 1 or Option 3, the reason we propose option1 is that we want to notice that the definition of EIRP itself is closely related to the direction, so it is unreasonable to directly add the EIRP of different CCs regardless of the direction. Option 1 is a compromise solution based on this idea.  Option3 is more reasonable compared to option2. Regulatory requirements is per-UE based. However, we should clarify the definition of EIRP in scenarios where UE have multiple power radiation directions, since EIRP which is defined in a certain direction is currently based on the scenario of one Tx beam. |
| Huawei | We need more analysis on regulation requirement over the world. Currently we think option 3 is safe. |
| Verizon | Option 2 |

**Issue 3-1-2: Min peak EIRP**

* Proposals
  + Option 1: Min peak EIRP is applied per band
  + Option 2: Min peak EIRP is not applied per band
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 3: Min peak EIRP is applied per band for non-overlapping bands |
| MediaTek | Option3: Inter-band UL CA min peak EIRP requirement discussion shall apply “per UE” total power concept. UE total power consumption and thermal issue are critical for specific UE power class category.  This concept is actually leveraged from LTE/FR1. For example, for FR1 PC2 UE (26dBm), while non-CA operation, the single-band Tx power would be 26 dBm; but while inter-band UL CA operation, each band would have 23 dBm Tx, and then UE total power is still 26 dBm that align with PC2 26dBm definition.  Hence, for specific FR2 power class UE, we think no matter it is “single-band non-CA operation” or “inter-band UL CA operation”, the “total UE power” shall not exceed original power class Tx definition.  Of course, how we exactly apply “total UE power” concept to FR2 is still FFS. Because for LTE/FR1, it is simple conductive power; but for FR2, EIRP etc are used to define power class. |
| Xiaomi | We agreed min peak EIRP is applied per band for non-overlapping bands, But we need also consider how to treat the overlapping bands, maybe it can be treated as intra-band CA, the requirements will be complex for inter-band CA. |
| LG Electronics | Support Option 3. Need further discussion.  For example, in case of n260+n261(Each Min Peak EIRP is 20.6dBm and 22.4dBm in Rel-15/16). At first, we need to discuss whether an aggregated min peak EIRP is necessary or not for inter-band CA. If needed, what is the aggregated min peak EIRP? |
| OPPO | Option 1 at this moment, but the min peak EIRP actually is different from the single band value, some relaxation might be needed. |
| Nokia | Option 3: Min peak EIRP is applied per band for non-overlapping bands |
| vivo | Option1, min peak EIRP is to ensure the UL coverage for individual band. |
| Huawei | If max EIRP or TRP is based on per UE, how we define min peak EIRP per band? |
| Verizon | Option 3 |

**Issue 3-1-3: Min EIRP**

* Proposals
  + Option 1: Min peak EIRP is applied per band and each band follow the requirement of single CC operation
  + Option 2: Needs more discussion
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2: Needs more discussion |
| MediaTek | Support Option 2. We may achieve consensus on Issue 3-1-2 firstly. |
| Xiaomi | Option 2 |
| LG Electronics | Support Option 2. |
| OPPO | Option 2 |
| Nokia | Option 2 |
| vivo | Option2, as long as we try to use EIRP to define requirements, the same problems we described in Issue 3-1-1 will exist. |

### Sub-topic 3-2:TRP

**Issue 3-2-1: TRP**

* Proposals
  + Option 1: For non-overlapping bands specify TRP per band, with max TRP of each band set to 23 dBm, excluding PC1.
  + Option 2: specify TRP per band for all CA configurations
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1: For non-overlapping bands specify TRP per band, with max TRP of each band set to 23 dBm, excluding PC1. TRP specification for overlapping bands need to be discussed further |
| Xiaomi | We agree max TRP is applied per band for non-overlapping bands, But we need also consider how to treat the overlapping bands, maybe it can be treated as intra-band CA, the requirements will be complex for inter-band CA. |
| LG Electronics | Support Option 3. Need further discussion.  For example, in case of n260+n261(Each max TRP is 23dBm in Rel-15/16). At first, we need to discuss whether an aggregated max TRP is necessary or not for inter-band CA. |
| OPPO | Option 1. |
| Nokia | Option 1 |
| vivo | Option 1, one of the purposes of restricting max TRP is to avoid co-channel interference, per band is ok. |
| Huawei | Option 3. It is noting that max TRP is regulation requirement in some country. |
| Verizon | Option 1 |

### Sub-topic 3-3: Maximum output power and Power class

**Issue 3-3-1: MOP and Power class**

* Proposals
  + Option 1: For inter-band UL CA in FR2, the power class should be follow current UE types and is specified independently from UE BM types, the different relaxation values can be introduced for different BM types.
  + Option 2: Needs more discussion
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2: Needs more discussion |
| MediaTek | We are open for Option1 method. We anyway can kick-off relative discussion based on basic concept of Option1. |
| LG Electronics | Support Option 1. |
| Apple | Can be per-band based and OK to take option 1 as starting point. |
| OPPO | Option 1. |
| Nokia | Option 2 |
| vivo | Option 2, we should figure out the power class itself first, then consider the relationship between power class and BM type. |
| Huawei | Option 2 |

### Sub-topic 3-4: P-MPR

**Issue 3-4-1: P-MPR**

* Proposals
  + Option 1: The P-MPR is applied per UE under co-located deployment and per band under non-co-located deployment.
  + Option 2: P-MPR is not defined based on deployment scenario
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| LG Electronics | Need further discussion. |
| OPPO | Option 2. |
| vivo | Option 1 or Option 3, PMPR is applied to EIRP, this issue will become clear after we figure out the issue of EIRP. |
| Huawei | Option 2. |

## Companies views’ collection for 1st round

### Open issues

### 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 |
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| 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:* |

*Suggestion on WF/LS assignment*

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### 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)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation** |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |