**3GPP TSG-RAN WG4 Meeting # 97e R4-2016637**

**Electronic Meeting, 2 – 13 Nov., 2020**

**Agenda item: 12.3.1, 12.3.2.1.1, 12.3.2.1.4, 12.3.2.1.5, 12.3.2.2.3**

**Source:** Moderator (Nokia)

**Title: Draft** Email discussion summary for [97e][135] NR\_RF\_FR2\_req\_enh2\_Part\_1

**Document for:** Information

# Introduction

REL16 FR2 maintenance stream.

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

* 1st round: None
* 2nd round: TBA

# Topic #1:General and work plan (AI 12.3.1)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014513 | Nokia, Nokia Shanghai Bell | TR skeleton for Rel-17 FR2 UE RF WI |
| R4-2014514 | Nokia, Nokia Shanghai Bell | Work plan for New WID on NR RF Enhancements for FR2 |

## Open issues summary and views’ collection for 1st round

### CRs/TPs comments collection

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| --- | --- | --- |
| **CR/TP number** | **Type/Source** | **Comments collection** |
| R4-2014513 | Draft TR skeleton  Rapporteur | TR skeleton for Rel-17 FR2 UE RF WI |
| Company A: |
| Company B: |
| … |
| R4-2014514 | Approval  Rapporteur | Work plan for New WID on NR RF Enhancements for FR2 |
| Company A: |
| Company B: |
| … |
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## Summary for 1st round

### Open issues

*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: Applicability of CBM/IBM for different CA

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014724 | Samsung | Discussion on Rel-17 FR2 inter-band CA  Discussion.  Note this contribution has content to three AI and proposals are discussed accordingly.  Observation 1: for a particular CA configuration, the same CBM/IBM attributes apply for both DL CA and UL CA as long as UL CA is supported  Observation 2: CBM is not applicable for CA configurations between different freq. groups, but only applicable within same freq. group.  Observation 3: IBM is not only applicable for CA configurations between different freq. groups, but also applicable within same freq. group.  **Proposal 1:  IBM is applicable for all CA configurations while CBM is only applicable for CA configurations with same freq. group. UE can report either IBM or CBM depending on UE capability for CA configurations with same freq. group.**  **Proposal 3:  For forward compatibility, the “frequency group” term shall not be defined in specification.** |
| R4-2014912 | Apple Inc. | More on FR2 Inter-band DL CA  Approval  **Proposal 1: RAN4 to develop the remaining inter-band DL CA requirements based on the band group categorization as shown in Table 2.1-2.**   |  |  | | --- | --- | | **Group 1** | **Group 2** | | n257, n258, n261 | n259, n260, n262 |   **Observation 1**: For a typical FR2 PC3 radio architecture design, inter-band CA combinations composed by bands within Group 1 or within Group 2 can only be supported by CBM.  **Observation 2**: For a typical FR2 PC3 radio architecture design, inter-band CA combinations composed by one band from Group 1 and one band from Group 2 can be supported by IBM.  **Observation 3**: It is feasible to support IBM for inter-band CA within the same band group which however is at the expenses of increasing mmW module size, cost, and power consumption during CA operation.  **Observation 4**: Repurposing the existing transceiver path not designed for the intended band group to support IBM would cause substantial performance degradation for SCell despite no area and cost penalty.  **Observation 5**: CBM for inter-band CA from different band groups can be subjected to more than 10 dB performance loss for SCell. |
| R4-2015327 | vivo | Discussion on FR2 inter-band DL CA enhancements  Discussion  **Observation 1:** Co-located deployment is more reasonable for CBM.  **Observation 2:** Non-co-located deployment has more problem on implementation while the feasibility is still unclear.  **Proposal 1:** **For IBM/CBM, the priority is to discuss the performance under co-located deployment, and more study is needed on whether non-co-located deployment is feasible.**  **Observation 3:** The performance of CBM depends on both the frequency separation between CCs, and the specific band (combination).  **Proposal 2: Study the feasibility that only part of the spectrum of the band pair can be used for inter-band CA with CBM. It is preferred to allow this as option 2.**  **Proposal 3: Based on previous observations and proposals, study and introduce per-band combination parameter F**s,inter **in the specification as a reference of applicability for IBM/CBM. A draft could be as following table:**  **Table 2 Distinction of IBM/CBM using F**s,inter   |  |  |  | | --- | --- | --- | | Band A-Band B | Fs,inter≤[TBD] | CBM&IBM (chosen by UE) | | Fs,inter＞[TBD] | IBM |   **Observation 4:** As a range for which CBM is applicable, intra-band CA can also use this Fs,inter as a reference for CBM applicability.  **Proposal 4:** **How to determine the value of Fs,inter to distinguish between IBM and CBM needs more discussion** |
| R4-2014293 | Qualcomm Incorporated | Inter-band DL CA CBM band pairs for FR2 Rel-17  Approval  **Observation 2:** CBM capability means UE is not able to follow beam management reference symbols independently for the bands defined as part of CBM band pair  **Observation 3:** IBM capability for UE means that UE is able to follow beam management reference symbols independently for each band part of declared inter-band CA configuration and UE is able to follow beam management reference symbols from an other band |
| R4-2014515 | Nokia, Nokia Shanghai Bell | FR2 interband CA CBM vs IBM  Discussion |
| R4-2014586 | Intel Corporation | CBM IBM Applicability for Inter-Band DL CA  Approval  **Proposal 1**: **CBM/IBM applicability should be based on UE capability.**  **Proposal 2: Consider IBM as baseline architecture for L+H inter-band DL CA.**  **Proposal 3: Consider CBM with capability of frequency separation as baseline architecture for L+L and H+H inter-band DL CA.** |
| R4-2015348 | OPPO | Discussion on Rel-17 FR2 inter-band DL CA  Approval  **Observation 1:** Issues like IBM/CBM capabilities, collocated/non-collocated scenarios, common coverage requirements, beam squint evaluation, etc. were difficult to reach consensus which makes slow progress in Rel-16.  **Observation 2:** Clearly defined scope will benefit of the discussion in Rel-17.  **Proposal 1: It is proposed to take IBM for inter freq group and CBM for same freq group as 1st priority in Rel-17.**  **Proposal 2: It is proposed to take CBM for inter freq group and IBM for same freq group as 2nd priority, and the discussion will based on the clear demands from industry.**  **Observation 3**: Whether IBM or CBM will be used for certain band combination depends on UE implementation.  **Proposal 3: is proposed to clearly define whether IBM or CBM requirements are defined for certain band combination and it depends on UE to decide which beam management type will be implemented.** |
| R4-2016344 | Ericsson, Sony | Views on applicability of CBM/IBM for different CA configurations  Approval  **Observation 1:** a CBM UE is assumed to support the co-located deployment scenarios. An IBM UE is assumed to support both co-located and non-co-located deployment scenarios.  **Observation 2:** the MRTD for a collocated scenario cannot be less than 3 us. A UE indicating CBM requirements for a band combination can expect the MRTD for a collocated scenario.  **Proposal 1: the network shall be able to configure a UE with a supported band combination according to its advertised capabilities, including the BM capability (that must be indicated for each supported band combination) in accordance with standard capability indication.**  **Proposal 2: a band combination should not be conditioned on the support of a particular BM capability; if requirements for a particular BM are not specified for a band combination, then this is noted in the specification.** |
| R4-2016523 | Huawei, HiSilicon | On Rel-17 inter band DL CA\_FR2  Approval  **Observation1**: 3us MRTD is not applicable for inter-band CA CBM under common RF chain assumption if performance loss is not expected.  **Proposal 1: Accept demodulation performance degradation for L+L/H+H band combinations with CBM type, and make clarification into RAN4 spec.**  **Proposal 2: Separation class extends to be indicated per band combination per receiving chain** **for L+L and H+H CA combinations.**  **Proposal 3: Clarify in RAN4 spec that CBM type can support non-collocated deployment with possible demodulation performance degradation.**  **Proposal 4: Introduce RF requirements for L+L/H+H band combinations with IBM type into TS 38.101-2.**  **Proposal 5: For L+L/H+H band combinations with IBM type, max PSD difference follows the definition for L+H IBM type in Rel-16.** |

## Open issues summary and views’ collection for 1st round

**Issue 2-1:** **CBM is only applicable for CA configurations with same freq. group (R4-2014724).**

* Proposals:
  + Option 1: Yes CBM can only support CA configurations within same frequency group
  + Option 2: No there is not restrictions which CA configurations CBM UE can support
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Issue 2-1: CBM is only applicable for CA configurations with same freq. group (R4-2014724).  Option 1 with additional restriction on 1) collocated scenario. 2) limited MRTD |
| Qualcomm | Option 1: Yes CBM can only support CA configurations within same frequency group. CBM UEs across different frequency groups are expected to have significantly compromised RF performance |
| MediaTek | We think “Option 1” is more practical. |
| Samsung | We support Option 1, i.e. Yes, CBM can only support CA configurations within same frequency group. Performance loss for CBM UE across different frequency group is too severe. |
| OPPO | Option 2, but CBM can be considered 1st priority for same freq goup, and 2nd priority for different freq group. |
| Apple | Option 1 |
| Ericsson | Option 2. There should be no restriction on what the UE can advertise in its BM capability per BC. It is up to the network to configure the UE with CA according the capability advertised for the supported BC. In a collocated case the network could still configure a CBM-capable UE with DL SCell(s) in the inter-band case (the network can provide similar beam information for the two bands).  It may be that minimum requirements for CBM are only ensured under specific conditions. The RAN4 core requirements cannot cover all cases in the field. If the performance is degraded in the field due to limited UE capability for a particular BC (would be noticed by the gNB), the network could reconfigure the UE connection. |
| vivo | Prefer option 3. Before we confirm this applicability restriction, it could still consider to do some more general evaluation, e.g. on:  (1) How to evaluate whether CBM can work?  (2) Can DL and UL use different BM type? (e.g. CBM for DL but IBM for UL)  Considering CBM has advantages on cost and overhead, it may be beneficial to expand the applicability of CBM if possible. At least we can evaluate n260-n261 first. That is part of the concerns for proposed Fs,inter which is mentioned in Issue 2-5. |
| Sony | Option 2: We think there is no need to restrict the CBM UE from the specification aspect, and band combinations should be flexibly configured with any beam management types regardless of whether the CCs are in the same frequency group or a different frequency group.  From the feasibility aspect, we have also discussed that allowing CBM UEs can facilitate inter-band CA deployment at least under co-located scenarios in our paper in [R4-2015874](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_97_e/Docs/R4-2015874.zip" \t "_blank). |
| Nokia | Option 1 |
| Xiaomi | Option 1. We also believe the co-located scenario is needed for CBM. |
| Huawei | We prefer to leave it as Option 2 currently. For different Band group, it could be deployed co-located, although 2 RF chain is highly required for L band and H band respectively, but it doesn’t mean the 2RF chain cannot use the common codebook. We admit that if H band used codebook of L band measurement result, it may lead to beam squint, but it also save the RS overhead. It may be useful for some network configuration. We would like to see other companies’ view. |

**Issue 2-2: IBM is applicable for all CA configurations (R4-2014724).**

* Proposals:
  + Option 1: Yes by default IBM is applicable for all CA configurations
  + Option 2: No IBM is not by default applicable for all CA configurations
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. But depending on the same frequency group or different frequency groups two CA bands are associated with, the requirements may be different. |
| Qualcomm | Option 1: Yes by default IBM is applicable for all CA configurations. |
| MediaTek | We think “Option 2” is more practical. |
| Samsung | Option 1: Yes, by default IBM is applicable for all CA configurations.  A clarification is that “by default” here does not mean IBM is the default UE capability, but the IBM applicability is by default. UE always needs to report its beam management capability. |
| OPPO | Option 3, IBM can be considered 1st priority for inter freq group, but 2nd priority for intra freq group. |
| Apple | Option 1: Yes. But IBM may not always be available for UE to support CA within the same band group. |
| Ericsson: | Option 1. Requirements for IBM should apply for all DL inter-band CA configurations. |
| vivo | Prefer option 2. IBM is more flexible to support different CA configuration and BS deployment, but it may be not necessary for every CA configuration, e.g. same frequency group with co-located deployment. We should evaluate the benefits of IBM under this scenario. |
| Sony | Option 1: As we have mentioned in Issue 2-1, the BM type should not be restricted by the band combinations. In addition, allowing IBM UEs for all the band combinations can give the network deployment great flexibility and should be allowed by the 3GPP specification. |
| Nokia | Option 1 |
| Xiaomi | Option 1. But we think the IBM for same frequency group has high cost but the performance gain is not shown yet. |
| Huawei | Option 1. IBM can be the default type for all CA configuration considering it can support all scenarios without performance degradation, and MRTD can be large. |

**Issue 2-3: The “frequency group” term shall not be defined in specification (R4-2014724).**

* Proposals:
  + Option 1: “frequency group” term shall not be defined
  + Option 2: “frequency group” term is defined
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| MediaTek | We think define frequency group for discussion stage would be helpful to converge discussion. However, whether to define frequency group in TS or not can be for further discussed. |
| Samsung | Option 1: “frequency group” term shall not be defined.  For convenience of discussion, frequency group concept is used, but it is better not to specify this term in specification for the sake of forward compatibility. CBM and IBM attributes can be specified based on CA band combinations. |
| OPPO | Option 1, requirements are defined based on band combinations which is clear enough, rather than defined based on freq group combinations. |
| Apple | The frequency group or band group can be an informal definition of band categorization to facilitate the FR2 inter-band CA requirements development. It does not have to be captured in the technical specifications. The purpose can be similar to the definition of LTE inter-band CA classes A1, A2, A3, and A4 in early inter-band CA requirements development. |
| Ericsson | Option 1. |
| Vivo | Prefer option 1. Based on CA band combinations is already sufficient.  The group itself may also not that stable, e.g. if new band introduced into the gap between “groups” then would these groups merge? |
| Sony | Option 1. The concept of frequency group used in the Rel-16 discussion may be ambiguous since it is only based on the bands defined until the Rel-16, and it could create issues when there are more bands to be defined in FR2. |
| Nokia | Option 1: “frequency group” term does not necessarily need to be defined in TS. |
| Xiaomi | Option 1: Agree that base on each combination is quite enough. |

**Issue 2-4: Clearly state in specification whether IBM and/or CBM requirements are defined for certain band combination (R4-2015348).**

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

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| **Company** | **Comments** |
| Intel | Option 2. It is up to UE’s capability signalling. UE may claim IBM and/or CBM for each band combination. |
| Qualcomm | Option 3: (Other). Standard only needs to specify band combinations that can be supported by CBM UEs. Any band combination can be supported by IBM UEs |
| MediaTek | Not sure if our understanding on this issue statement is correct. However, we think the particular requirement shall clarify it is for CBM or IBM of each band combination. |
| Samsung | This issue is correlated with issue 2-1 and issue 2-2.  If conclusion is that CBM is only applicable for the same band group, then Option 1 (Yes) is okay and Option 3 proposed by Qualcomm is also one feasible way. |
| OPPO | Option 1, yes. RAN4 requirement itself shall be clear whether IBM or CBM or both requirements are defined to guide UE design. This is from requirement perspective, not UE capability. |
| Apple | Option 3: Depending on the conclusion of the study phase of CBM and IBM, if either CBM or IBM is concluded as infeasible for certain band combinations, it is reasonable to clearly state in the spec that only the requirements of feasible BM apply to these band combinations. If both CBM and IBM are concluded as feasible for certain band combinations, IBM/CBM is up to UE’s capability. It is more important to state clearly whether the requirements are defined based on collocation or non-collocation, same AoA or different AoA. |
| Ericsson | Option 3. The applicability of IBM/CBM minimum requirement for BC would be conditioned on specific preconditions like for all core requirements. This does not necessarily mean that the UE is not functional if these conditions are not met. A UE indicating a BM capability for a BC, e.g. CBM, should be able to expect certain operational conditions (e.g. relevant for a collocated case, this could merit further discussions). |
| Vivo | Not quite clear about the question. The definition of IBM/CBM should be a capability defined for certain band combination. This is also related to if a “default” IBM capability is assumed for all. |
| Sony | Option 3: Further discussion might be needed. However, it is important that UE should be allowed to claim its capability (CBM/IBM) for any band combination. |
| Nokia | If term “frequency group” is not defined in specification, then applicability of CBM and/or IBM needs to be stated per band combination. For those combinations where both CBM and IBM would be feasible it is up to UE capability. |
| Xiaomi | Option 1. As long as when we define the requirements, it is considering the CBM/IBM difference, then they should be captured clearly in the TS. |
| Huawei | Option 2. It is up to UE’s capability signalling, which is indicated per band combination. |

**Issue 2-5: Study and introduce per-band combination parameter Fs,inter in the specification as a reference of applicability for IBM/CBM (R4-2015327)**

* Proposals:
  + Option 1: YesFs,inter parameter is studied further
  + Option 2: No Fs,inter parameter is not studied further
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. Considering the frequency span of inter-band CA in 28GHz and 39GHz can be as large as 5~6GHz, such parameter is needed. |
| Qualcomm | Option 3: Fs,inter may make sense as part of a broader enhancement including allowing the UE to declare per RF chain capability. This type of enhancement is motivated by the need to allow the UE and network to work together in optimizing UE’s limited resources to network needs. |
| MediaTek | We think use “Fs,inter” to discuss in discussion stage would be helpful. However, whether introduce “Fs,inter” in specification shall be for further discussion. |
| Samsung | This issue is correlated with Issue 2-3. Fs.inter is more general criteria than “frequency group” term to judge the applicability of CBM. Generally we think CBM applicability shall be based on detailed CA combination than “frequency group”. If a general rule should be set up to define CBM/IBM applicability, then Fs.inter is worth further study (Option 1).  Considering the Fs.inter value may vary with carrier frequency, a relative parameter as a ratio (e.g. Fs.inter/fcenter) could also be considered.  Agree with MediaTek that it does not mean the parameter will be definitely introduced into specification, but pending on further discussion. |
| OPPO | Option 2, understood the intention but this will make the requirement definition quite complex. To make simplicity certain BM types can be assumed for intra/inter freq group. |
| Apple | Option 2: No Fs,inter parameter is not studied further. We prefer not to have two requirements for a CA configuration, one is defined based on CBM capability, the other is defined based on IBM capability using Fs,inter as a dividing boarder. It may also complicate the network scheduling for a CA configuration. |
| vivo | Option 1. The reason we propose this parameter is to hope that IBM and CBM can have a unified evaluation criteria.  It should be noted that although proposed to do more study, this parameter is not necessarily have to be included in the spec just as some previous comments mentioned. |
| Sony | Option 2: To our understanding, this Fs,inter stands a similar meaning to the band group. As we have discussed, we think the BM type should not be restricted, and it is not preferred to be studied as a reference of applicability for IBM/CBM.  However, we are okay to discuss how the Fs would affect the requirement itself but not applicability. |
| Nokia | From NW operation point of view introduction of “Fs,inter” parameter is not attractive |
| Xiaomi | Option 2. Agree that the frequency separation can be used for discussion but it is not preferred for introducing this for requirements. |
| Huawei | We need further evaluate. |

**Issue 2-6: Separation class extends to be indicated per band combination per receiving chain for L+L and H+H CA combinations (R4-2016523).**

* Proposals:
  + Option 1:  New UE capability for separation class is only introduced per band combination
  + Option 2：New UE capability for separation class is introduced per band combination per receiving chain
  + Option 3:  separation class is not indicated per band combination per receiving chain, no new UE capability is introduced
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. Considering CBM limitation on large frequency span support, such parameter is needed. |
| Qualcomm | Option 2 , our preference is to investigate this in greater detail, to determine if there is a net benefit. Applicability for CBM and IBM handling should be discussed further. |
| Samsung | Not sure the detailed meaning of “per receiving chain”. Would like to see the necessity to define frequency separation class for inter-band CA. is it only for CBM within same frequency group? |
| OPPO | Further study is needed whether new capability is needed per chain based. |
| Apple | Option 3 Minimum requirements shall be defined based on the widest frequency separation for each CA configuration within the same band group. There is no need to further define frequency separation class. |
| Ericsson | Option 3: this discussion seems to be related to the MRTD for inter-band CA, not BM capability. |
| vivo | Prefer option 2, but more study is needed. |
| Sony | Option 3 is preferred to reduce the complexity of UE capabilities. |
| Nokia | Option 3 |
| Huawei | Option 1 currently. Whether option 2 is needed, we prefer to wait for completion of separation class revision discussion in Rel-15 and Rel-16. |

## 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** |
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### 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 #3: UE requirements for CA configurations CA\_n258A-n260A and CA\_n257A-n259A based on IBM (AI 12.3.2.1.4)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014589 | Intel Corporation | UE requirements for CA\_258A-n260A and CA\_257A-n259A based on IBM  Approval  **Proposal: Apply the same requirements defined for CA\_n260A-n261A to CA\_n258A-n260A and CA\_n257A-n259A.** |
| R4-2014966 | NTT DOCOMO INC. | DL Inter-band CA\_n257-n259  Approval  **Observation 1:** For difference of MBR between CA\_n257-n259 and CA\_n260-n261, there is 0.2 dB difference on dMBP,n between n257 and n261 in 28GHz bands. Other factors have no difference.  **Observation 2:** Required relaxation value due to common spherical coverage for n258+n260 and n260+n261 is expected to be the same value although the frequency ranges of n258 and n261 are different.  **Observation 3:** Relaxation due to beam squint loss seems not needed for IBM UE.  **Proposal 1: For ΔRIB,P,n and ΔRIB,S,n, apply the same relaxation values with n260+n261 to n257+n259.**  **Proposal 2: Release independent from Rel-16 shall apply to DL inter-band CA of n257-n259.** |
| R4-2015875 | Sony, Ericsson | Views on Rel-17 inter-band DL CA in FR2  Approval  **Observation 1:** 2.5 dB relaxation on each band is sufficient for the common spherical coverage of band combination CA\_n258A-n260A and CA\_n257A-n259A to reach the 50% spatial coverage.  **Observation 2:** A significant EIS difference can occur because the PSD level of the untested band is fixed at EIS spherical overage requirement level.  **Observation 3:** Additional performance relaxation is needed to fulfill the EIS spherical coverage requirement for inter-band CA operation.  **Proposal 1: Introduce 2.5 dB + 1dB = 3.5 dB relaxation on the spherical coverage requirement for the band combination CA\_n258A-n260A and CA\_n257A-n259A based on IBM.** |

**Issue 3-1: Apply the same requirements defined for CA\_n260A-n261A to CA\_n258A-n260A**

* Proposals:
  + Option 1: Yes same requirements apply
  + Option 2: No same requirements do not apply
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. Due to the similar frequency gap sizes in these CA configurations, the same IBM requirements can be applied. |
| Qualcomm | Option 3 : FFS. We also need to discuss how to address requirements and relaxations for other power classes. |
| MediaTek | Maybe it’s too early to say whether apply same requirements or not, because RAN4 even has not completely defined “CA\_n260A-n261A” yet. |
| Apple | Option 3: Further analyses are needed before we can conclude whether the same requirement for CA\_n260A-n261A can be applied to CA\_n258-n260A. |
| Ericsson | Option 1. |
| Vivo | Option 3: FFS.  The situation is still different. If we consider lower edge of lowest band and upper edge of highest band, the difference between n260A-n261A and n258A-n260A may be larger. |
| Sony | Option 1 |
| Nokia | Eventually requirements may be same but perhaps more discussion is needed |
| Xiaomi | Option 1. |
| Huawei | Option 1. |

**Issue 3-2: Apply the same requirements defined for CA\_n260A-n261A to CA\_n257A-n259A**

* Proposals:
  + Option 1: Yes same requirements apply
  + Option 2: No same requirements do not apply
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. Due to the similar frequency gap sizes in these CA configurations, the same IBM requirements can be applied. |
| Qualcomm | Option 3 : FFS. We also need to discuss how to address requirements and relaxations for other power classes. |
| MediaTek | Maybe it’s too early to say whether apply same requirements or not, because RAN4 even has not completely defined “CA\_n260A-n261A” yet. |
| Apple | Option 3: Further analyses are needed before we can conclude whether the same requirement for CA\_n260A-n261A can be applied to CA\_n258-n260A. |
| Ericsson | Option 1 |
| vivo | Option 3: FFS.  The reason is same to previous one. |
| Sony | Option 1 |
| Nokia | Eventually requirements may be same but perhaps more discussion is needed |
| Xiaomi | Option 1. |
| Huawei | Option 1. |

**Issue 3-3: DL CA configurations CA\_n258A-n260A and CA\_n257A-n259A are release independent from REL-16**

* Proposals
  + Option 1: from Rel-16
  + Option 2: from Rel-17
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 : from Rel-16 |
| MediaTek | We prefer “Option-2”. |
| Apple | Option 1 |
| Ericsson | Option 1. |
| Sony | Option 1 |
| Nokia | Option 1 |
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## Open issues summary and views’ collection for 1st round

## 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** |
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### 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 #4: UE requirements for CA configurations within the same frequency group based on CBM (AI 12.3.2.1.5)

## Companies’ contributions summary

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| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2014588 | Intel Corporation | UE requirements for CA configurations within the same frequency group based on CBM  Discussion  **Observation 1:** CBM is more applicable to collocated gNB deployment scenario.  **Observation 2:** There is no beam squint degradation at beam peak under perfect phase calibration.  **Proposal**: **RAN4 should study the impact of beam squint effect on beam peak (REFSENS and peak EIRP) based on practical phase calibrations for CBM together with spherical coverage.** |
| R4-2014724 | Samsung | Discussion on Rel-17 FR2 inter-band CA  Discussion.  **Proposal 2:  For CBM band pairs, no spherical coverage requirement will be defined.** |
| R4-2014912 | Apple Inc. | More on FR2 Inter-band DL CA  Approval  **Proposal 2**: **For FR2 inter-band CA within the same band group, the UE RF requirements are only defined based on cell collocation and intra-band CA MRTD requirement.** |
| R4-2014293 | Qualcomm Incorporated | Inter-band DL CA CBM band pairs for FR2 Rel-17  Approval  **Observation 1:** RAN4 firstly needs to understand how to define requirements for the CBM band pair and then decide how to capture them in the TS.  **Observation 4:** RAN4 may withhold defining spherical coverage requirements for CBM band pair  **Proposal:** **Define at least peak EIS requirement for CBM band pair for inter-band DL CA** |

**Issue 4-1:** For FR2 inter-band CA CBM band pairs, no spherical coverage requirement will be defined.

* Proposals:
  + Option 1: spherical coverage requirement is not defined for FR2 inter-band CA CBM band pairs
  + Option 2: spherical coverage requirement is defined for FR2 inter-band CA CBM band pairs
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 : spherical coverage requirement is not defined for FR2 inter-band CA CBM band pairs |
| Samsung | Option 1 : spherical coverage requirement is not defined for FR2 inter-band CA CBM band pairs |
| OPPO | Ok with Option 1. |
| Apple | Option 1 |
| vivo | Option 1, current spherical coverage may be enough for CBM under same frequency group |
| Nokia | Option 1 |
| Xiaomi | Option 1 |
| Huawei | Option 2. Inter-band CA CBM is not like intra-band DL CA. it is important to verify whether CBM type UE can reach the same spherical coverage requirement on both bands, with the condition that RS be only configured for one band. |

**Issue 4-2:** For FR2 inter-band CA define at least peak EIS requirement for CBM band pair for inter-band DL CA

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

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| **Company** | **Comments** |
| Intel | Option 1 |
| Qualcomm | Option 1 : Yes |
| Samsung | Option 1 : Yes |
| OPPO | Ok with option 1, to verify the CBM function. |
| Apple | Option 1 |
| Ericsson | Option 1 |
| vivo | Option 3: FFS. the applicability of CBM is still not clear. |
| Sony | option 1 |
| Nokia | Option 1 |
| Xiaomi | Option 1 |
| Huawei | Option 1, spherical coverage requirement is also defined. |

**Issue 4-3:** For FR2 inter-band CA within the same band group, the UE RF requirements are only defined based on cell collocation

* Proposals:
  + Option 1: Yes UE requirements only assume cell collocation for FR2 inter-band CA within the same band group
  + Option 2: No UE requirements assume both cell collocation and non-collocation for FR2 inter-band CA within the same band group
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 1. |
| Qualcomm | Option 3. Instead of subjective deployment scenario discussion, we would do well to focus on the actual requirements (for example: PSD difference for REFSENS to reflect non-co-located or co-located scenario) |
| MediaTek | We think “Option 1” is made sense, while we consider the capability of CBM UE. |
| Samsung | That depends on CBM or IBM. For CBM UE, agree with MediaTek that Option 1 is reasonable. |
| OPPO | Option 1, this is the scenario that the intra band group requirements defined but it is not necessary to explicitly restrict the deployments in spec. Instead some side conditions (PSD/MRTD) can be used as some band combinations in FR1. |
| Apple | Option 1 which also implies limited PSD difference and same AoA |
| Ericsson | Option 3. |
| vivo | Option 1. non-collocation may have poor performance with CBM |
| Sony | Option 3, further study is needed. |
| Nokia | We cannot rule out non-collocation deployments. In practice CBM performance would be poorer than IBM in non-collation deployment but it would be up to network to decide if it configures CA for CBM UE in non-collation scenario. |
| Xiaomi | Option 1. As we have already shown the understanding in topic#2. |
| Huawei | Option 2, even with collocated deployment assumption, with 3us MRTD, we still see substantial performance loss in SCell. |

## Open issues summary and views’ collection for 1st round

## 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** |
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### 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 #5: UE requirements for CA configuration CA\_n257A-n259A based on IBM (AI 12.3.2.2.3)

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2016086 | NTT DOCOMO INC. | UL inter-band CA for different band group based on IBE  Approval  **Proposal 1: For maximum TRP for FR2 UL inter-band CA, the sum of TRP from LB and HB shall not exceed maximum TRP associated with each power class, e.g., 23dBm for power class 2/3/4.**  **Proposal 2: For maximum peak EIRP for FR2 UL inter-band CA, it should be guaranteed that the sum of peak EIRP from LB and HB in any direction does not exceed the allowable level, e.g., 43dBm for PC 2/3/4.**  **Proposal 3: For FR2 UL inter-band CA, UE should meet minimum peak EIRP of LB and HB individually, and should meet common spherical coverage EIRP.**  **Proposal 4: UE should meet emission requirements of LB and HB under UL inter-band CA operation, respectively.** |

**Issue 5-1:** **For maximum TRP for FR2 UL inter-band CA,** **the sum of TRP from LB and HB shall not exceed maximum TRP associated with each power class, e.g., 23dBm for power class 2/3/4.**

* Proposals:
  + Option 1: Yes the sum of TRP from LB and HB shall not exceed maximum TRP associated with each power class
  + Option 2: No there will not be such limitation
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 3. Need further study. |
| Qualcomm | Option 3: 23dBm is for intra-frequency coex and sidelobe rejection and therefore max TRP should be per band. For Japan we can consider Pmax restriction. |
| MediaTek | Our view is between “Option1” and “Option3”. We think legacy power class definition is “total power concept”, so it would be made sense to leverage the concept to FR2. However, further study is fine. |
| Samsung | Slightly prefer Option 1 but Option 3 is also acceptable. |
| OPPO | Option 3, restricting sum of TRP according to the power class in inter-band CA potentially will cause UE output power back off. The impact to the inter-band CA requirements need further study. Besides, for inter-band CA the output power are at different freq, need to understand better on the impact to Max TRP regulation which is probably based on per-band. |
| Apple | Option 3: FFS |
| vivo | Option 3, max TRP is for reducing interference, so per band may be better. |
| Xiaomi | We slightly agree with Option 1 as TRP is the total radiated power by definition. However, we also agree that further study can be carried out at this early stage. |
| Huawei | It depends on regulation requirement. Different regions seem have different requirement on TRP. RAN4 may need further discussion how to handle with the condition. |

**Issue 5-2: For maximum peak EIRP for FR2 UL inter-band CA, it should be guaranteed that the sum of peak EIRP from LB and HB in any direction does not exceed the allowable level, e.g., 43dBm for PC 2/3/4.**

* Proposals:
  + Option 1: Yes it should be guaranteed that the sum of peak EIRP from LB and HB in any direction does not exceed the allowable level
  + Option 2: No there will not be such limitation
  + Option 3: Other
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 3: Need further study |
| Qualcomm | Option 1: Yes it should be guaranteed that the sum of peak EIRP from LB and HB in any direction does not exceed the allowable level |
| MediaTek | Our view is between “Option1” and “Option3”. We think legacy power class definition is “total power concept”, so it would be made sense to leverage the concept to FR2. However, further study is fine. |
| Samsung | Slightly prefer Option 1 but Option 3 is also acceptable. |
| OPPO | Option 3, restricting sum of peak EIRP according to the power class in inter-band CA potentially will cause UE output power back off. The impact to the inter-band CA requirements need further study. Besides, for inter-band CA the output power are at different freq, need to understand better on the impact to peak EIRP regulation which is probably based on per-band. |
| Apple | Option 3: It depends on how regulatory requirement is defined. Should EIRP be measured within certain frequency window or no frequency limit? |
| Vivo | Option 3, need more study.  Max EIRP is derived from complying regulator, but it is related to the beam direction.. |
| Xiaomi | Option 3. Further study is needed as summation is not a good choice when considering EIRP directions. |
| Huawei | From regulation requirement perspective, peak EIRP is required per UE per Frequency range. |

**Issue 5-3: For FR2 UL inter-band CA, UE should meet minimum peak EIRP of LB and HB individually, and should meet common spherical coverage EIRP.**

* Proposals:
  + Option 1: Yes UE should meet minimum peak EIRP of LB and HB individually, and should meet common spherical coverage EIRP
  + Option 2: Needs more discussion
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 2: Need more discussion. Supporting peak EIRP and spherical coverage on both LB and HB simultaneously needs to double Tx power consumption comparing with single CC or intra-band UL. RAN4 needs to decide if this is practical for some UE power class, for example, PC3.  Intel2: Thank MediaTek reminder. add company name in the company column. |
| Qualcomm | Option 2: Yes UE should meet minimum peak EIRP of LB and HB individually for interband CA operation, and should meet common spherical coverage EIRP. (values FFS) Also depends on CBM/IBM, power sharing, etc |
| MediaTek | Similar view as max TRP and max Peak EIRP, if “total power concept” is also applied to FR2, the UE shall have different min peak EIRP requirement than non-CA case.  Beside, the reminder of first comment (Intel?) on Tx power consumption is made sense for us. |
| OPPO | Option 2, the minimum peak EIRP needs further clarification since in CBM there might be some relaxation; and whether to define common spherical coverage for CBM is still under discussion. |
| Apple | Option 2: It depends on whether relaxation is allowed or not when both ULs are transmitting simultaneously. |
| vivo | Option 2. Applying min peak EIRP per band is ok for ensuring minimum performance, but the spherical coverage should study further. |
| Xiaomi | Option 2. Same as peak EIRP. |
| Huawei | Option 2. UL CA needs to configure out what is CBM or IBM. UL CC BC is based on which DL RS on which CC? we still see much issues need study. |

**Issue 5-4: UE should meet emission requirements of LB and HB under UL inter-band CA operation, respectively.**

* Proposals:
  + Option 1: UE meets emission requirements of LB and HB under UL inter-band CA operation, respectively i.e. both LB and HB meet own applicable requirements
  + Option 2: Needs more discussion
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Intel | Option 2 |
| Qualcomm | Option 2: We believe regulatory facing general emissions requirements are per UE (SEM, general spurious, OBW) |
| MediaTek | Option 2 |
| OPPO | Option 2. Emission might needs to be summed from two bands since they are overlapped in freq domain. |
| Apple | Option 2: It depends on whether relaxation is allowed or not when both ULs are transmitting simultaneously. |
| vivo | Option 2. |
| Xiaomi | Option 2. |
| Huawei | Option 1. But some exception may be defined, it needs further discussion. |

## Open issues summary and views’ collection for 1st round

## 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** |
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### 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”* |