**3GPP TSG-RAN WG4 Meeting # 102-e R4-2206325**

**Electronic Meeting, 21 Feb – 3 Mar, 2022**

**Agenda item:** 10.4.1, 10.4.2

**Source:** Moderator (Nokia)

**Title:** Email discussion summary for [102-e][125] NR\_RF\_FR2\_enh2\_Part\_1

**Document for:** Information

# Introduction

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

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

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

# Topic #1: General AI 10.4.1

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2204787**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204787.zip) | TR 38.851 v0.4.0 | Nokia, Nokia Shanghai Bell |  |

## Open issues summary

### Sub-topic 1-1: Updated version of TR

**Issue 1-1-1: Is updated TR agreeable**

* Proposals
  + Option 1: Yes
  + Option 2: No
* Recommended WF
  + Yes

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| **Company** | **Comments** |
| Nokia | Option 1: Yes |
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## 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** | **CR/TP name** | **Comments collection** |
| [**R4-2204787**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204787.zip) | TR 38.851 v0.4.0 | Company A |
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## Summary for 1st round

### Open issues

*None*

### 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** | **CR/TP name** | **CRs/TPs Status update recommendation** |
| [**R4-2204787**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204787.zip) | TR 38.851 v0.4.0 | Approve the TR update |

## Discussion on 2nd round (if applicable)

Not needed.

# Topic #2: CA configurations within the same frequency group based on CBM AI 10.4.2.1.1

## Companies’ contributions summary

|  |  |  |  |
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| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
|  |  |  |  |
| [**R4-2204361**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204361.zip) | Sensitivity requirements for inter-band DL CA with CBM | NTT DOCOMO, INC. | **Proposal 1:** REFSENS requirements does not limit the UE implementation.  **Proposal 2:** REFSENS requirements is specified based on normalized equal PSD.  **Proposal 3:** REFSENS requirements does not limit the NW scenario and PSD imbalance.  **Proposal 4:** The requirements on each CC do not have to be met simultaneously at single direction.  **Proposal 5:** For CBM CA within same frequency group, [2.5dB] should be set as the base value for the relaxation of REFSENS requirements.  **Proposal 6:** For REFSENS requirements for CA within same frequency group, Fs\_Inter capability is introduced for performance functional separation.  **Proposal 7:** IBM requirement is reused as REFSENS requirements for CBM CA between different frequency groups.  **Proposal 8:** For CBM CA between different frequency groups, [3.5dB] should be set as the base value for the relaxation of REFSENS requirements. |
| [**R4-2204789**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204789.zip) | Addition of downlink CA feature for CBM UEs and one band combination for IBM UEs | Nokia, Qualcomm | CAT B CR for Addition of downlink CA feature for CBM UEs and one band combination for IBM UEs |
| [**R4-2204035**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204035.zip) | UE requirements for CBM for the same frequency group | Sony, Ericsson | **Observation 1: about 3.5 dB total relaxation for EIS spherical coverage is derived for band combination of n258+n261.**  **Proposal 1: Define the minimum requirement based on the largest frequency separation between two CCs**  **Proposal 2: The PSD condition in CBM UE within the same frequency group shall ensure the devices can simultaneously meet sensitivity requirements on both CCs.**  **Proposal 3: RAN4 shall define the requirement of CBM UEs within the same frequency group based on an example band in Rel-17, e.g., n258+261, and the relaxation due to the EIS spherical coverage is 3.5 dB in this case.** |
| [**R4-2204143**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204143.zip) | Discussion on CBM based inter-band DL CA within same frequency group | LG Electronics | **Proposal 1: Introduce LL combo n258+n261 UE requirements with Fs\_inter for CBM, and without Fs\_inter for IBM.**  **Proposal 2: Agree CR introducing LL combo n258+n261 with Fs\_inter and CR introducing LH combos CA\_n257-n259, CA\_n258-n260 and CA\_n260-n261 as a package.**   * **Reference sensitivity relaxation :**    + **Table 2.7 for IBM**   + **Table 2.8 for CBM** * **EIS** **spherical coverage requirement relaxation**    + **Table 2.9 for IBM**   + **Table 2.10 for CBM** * **Table 2.2 for Frequency separation class(Fs\_inter) for inter-band CA with CBM**   **Proposal 3: Add ‘Fs\_inter’ in feature list of NR\_RF\_FR2\_req\_enh2.** |
| [**R4-2204229**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204229.zip) | Fs\_inter and view on FR2 inter-band DL CA within same frequency group based on CBM | MediaTek Beijing Inc. | **Proposal1 : Define “Option2: Fs\_Inter capability is introduced. No additional EIS relaxation specific for frequency separation factor is acceptable”**  **Proposal 2: LS to RAN2 to raise the request on “Fs\_inter”.** |
| [**R4-2204927**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204927.zip) | R17 FR2 CBM inter-band DL CA | OPPO | ***Observation 1: When NW configure CCs within this Fs\_inter capability, UE performance is guaranteed by requirements and testing.***  ***Observation 2: When NW configure CCs that is larger than this Fs\_inter capability, UE behaviors could be different and it is up to implementation.***  ***Proposal 1: Fs\_inter capability is optionally reported by UE, and should be considered by NW, but to keep both NW scheduling and UE implementation flexibility, it is proposed to agree that once configured CCs exceed this capability then UE behavior is considered to be undefined.***  ***Observation 3: The smallest value of Fs\_inter should at least cover one band in FR2, and the largest value of Fs\_inter should be the largest distance between 28GHz and 39GHz.***  ***Proposal 2: Define Fs\_inter capability as per band combination capability and the value range is from 4GHz to 16GHz with 1GHz as step, i.e. {4GHz, 5GHz, 6GHz, … 16GHz}.***  ***Observation 4: The “normalized equal PSD” approach actually tighten REFSENS requirements rather than relaxation of CA requirements.***  ***Observation 5: Simultaneous sensitivity with different beam direction of each band is more aligned with UE real performance of REFSENS.***  ***Observation 6: No testability issue is expected for simultaneous sensitivity with different beam direction of each band approach.***  ***Proposal 3: Use simultaneous sensitivity with different beam direction of each band approach to define the peak EIS requirements for inter-band DL CA CBM.***  ***Proposal 4: 2.5dB peak EIS relaxation is needed for inter-band DL CA with CBM based on the simultaneous sensitivity of different beam direction approach.***  ***Proposal 5: 4dB spherical coverage relaxation is needed for inter-band DL CA with CBM based on the simultaneous sensitivity of different beam direction approach.***  ***Observation 7: It was agreed that “****Configuration and side condition of reference signal of the Band\_with\_BMRS is as single-band beam correspondence operation****”, and also agreed that “****Different BMRS types, i.e., configuration of CSI-RS or SSB, have no impact on DL requirements****”, therefore, only one of the BMRS configurations is enough for the CBM testing.***  ***Proposal 6: Only one of BMRS configuration is tested for inter-band DL CBM.***  ***Proposal 7:*** ***Choose one of the reference signal setting below as the side condition, and propose to use SSB+CSI RS as the BMRS, and use DMRS at the other band as the QCL-D target reference signal.*** |
| [**R4-2204940**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204940.zip) | Discussion on requirement of n258-n261 | vivo | **Observation 1:** The Fs, inter is only needed for single-chain UE.  **Observation 2:** The purpose of introducing the example band combination is record our effort on CBM discussion, to avoid unnecessary argument in the future.  **Observation 3:** Additional 0.5 dB relaxation for common spherical coverage is required due to the beam mapping accuracy.  **Observation 4:** The beam mapping accuracy will not impact the peak EIS if the requirement is not need to be met in the same direction simultaneously.  **Proposal 1:** Introduce Fs, inter as a functional capability with no relaxation.  **Proposal 2:** Combine Fs, inter and “simultaneous sensitivity” as a package:   * UE report Fs, inter 🡪test with “simultaneous sensitivity”🡪ΔRIB,S,n =0, ΔRIB,P,n = 0 * UE don’t report Fs, inter 🡪 test with IBM PSD condition 🡪ΔRIB,S,n =X, ΔRIB,P,n = Y   X and Y is derived from the worst case of the specific band combination.  **Proposal 3:** Introduce requirement of n258-n261 as an example band combination in TR and with note as follows:  Note: the ΔRIB,S,n and ΔRIB,P,n can be revised with sufficient technical justification when the band combination is request by operator.  **Proposal 4:** For CBM, the peak EIS does not necessary to be met in the same direction simultaneously.  **Proposal 5:** The CBM requirement for n258-n261 can be:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **NR CA band combinations** | **BM type** | **NR band** | **ΔRIB,P,n (dB)** | **ΔRIB,S,n (dB)** | | CA\_n258-n261 | CBM | n258 | 3.5 | 5.5 | | n261 | 3.5 | 5.5 |   **Proposal 6:** The IBM requirement for n258-n261 can be:   |  |  |  |  |  | | --- | --- | --- | --- | --- | | **NR CA band combinations** | **BM type** | **NR band** | **ΔRIB,P,n (dB)** | **ΔRIB,S,n (dB)** | | CA\_n258-n261 | IBM | n258 | 3.0 | 3.0 | | n261 | 3.0 | 3.0 |   **Proposal 7:** The REFSENSE and spherical coverage will only be tested with worst case of BMRS side condition, i.e., the BMRS is only located in the untested band, to reduce the test complexity. |
| [**R4-2205122**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205122.zip) | Discussion on inter-band DL CA with CBM | Xiaomi | **Proposal 1: Treat inter-band DL CA for CBM with single chain as intra-band CA.**  **Proposal 2: Send LS to RAN2 ask whether inter-band DL CA for CBM with single chain can reuse the capability of *intraBandFreqSeparationDL* for intra-band NC CA.**  **Proposal 3: the requirements of inter-band DL CA with CBM within same frequency group and between different frequency groups can be defined based on multiple chains.**  **Proposal 4: Wait for the operator demands before defining requirements for specific band combinations within same frequency group.**  **Proposal 5: If an example band combination, i.e., CA\_n258-n261, is required strongly, the requirements for both CBM and IBM should be introduced.**  **Proposal 6: For CBM inter-band DL CA between different frequency groups, the REFSENS and EIS spherical coverage requirements could meet the existing IBM inter-CA requirements with additional 0.5dB relaxation.** |
| [**R4-2205598**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205598.zip) | On RF requirements for FR2 Inter-band DL CA with CBM | Huawei, HiSilicon | ***Proposal 1: It is proposed to differentiate PSD based on different UE architectures, i.e. 6dB PSD difference for UE implemented with single RF chain, and requirements including PSD difference similar to IBM for inter-band CA with CBM for different frequency group.***  ***Proposal 2: It is proposed to define larger delta\_RIBs for CBM compared that for IBM for same band combination, and it should be considered case by case for different band combinations.***  ***Proposal 3: If no consensus reached for the BMRS conditions, leave it to RAN5 as a measurement issue.***  ***Proposal 4: Introduce Fs\_Inter capability for inter-band CA with CBM. The capability should be included in Rel-17 feature list.*** |
| [**R4-2206055**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206055.zip) | On delta(RIB) for n258+n261 DL inter-CA | Qualcomm Incorporated | **Proposal 1: For DL CA for n258+n261, delta(RIB\_spherical) is [3.5] dB for IBM.**  **Proposal 2: For DL CA for n258+n261, delta(RIB\_spherical) is [4.5] dB for CBM receivers with low DL PSD difference.**  **Proposal 3: For DL CA for n258+n261, delta(RIB\_peak) is [2.0] dB for IBM, and [2.5] dB for CBM.** |
| [**R4-2204612**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204612.zip) | Introduction of requirements for DL inter-band CA for CBM-capable UEs | Ericsson, Sony | CAT B CR : Introduction of requirements for DL inter-band CA for CBM-capable UEs |

## Open issues summary

### Sub-topic 2-1: REFSENS

Issue 2-1-1: EIS spherical coverage

* Proposals *(Can support more than one)*
  + Option 1: REFSENS requirements is specified based on normalized equal PSD. The requirements on each CC do not have to be met simultaneously at single direction. R4-2204361, R4-2204575
  + Option 2: It is proposed to differentiate PSD based on different UE architectures, i.e. 6dB PSD difference for UE implemented with single RF chain, and requirements including PSD difference similar to IBM for inter-band CA with CBM for different frequency group.
  + Option 3: specify sensitivity verification rule for inter-band CA supporting ‘both’ beam management capability as following:
  + Peak EIS should be verified with both IBM and CBM
  + if the measured EIS spherical coverage of CBM has already satisfied the requirements of IBM, then the IBM EIS spherical coverage verification is not necessary
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: Support  Option 2: Do not support yet. 6dB seems arbitrary, would proponent provide more detail on choice of 6, but not 4 or 8? Furthermore, this type of limit is not easily scalable to other power classes which have very different beam directivities, and therefore different allowances for delta.  Option 3: Prefer to establish the core requirements first, and then decide test skipping. In general test skipping is justified only if the functionality to be verified is somehow verified with some other requirement. We are not sure this justification exists to skip spherical. Moreover, to get peak EIS, spherical data has to be collected anyway, before beam peak search begins. |
| Samsung | Option 1: support  Option 2: do not support. Sensitivity is special than other RX test cases. A fixed PSD difference could be configured for other RX test cases. But for sensitivity test, PSD difference is determined by measurement result which is varying for different test. Note that for IBM the PSD difference is not an exact fixed value either.  Option 3: support. It is reasonable to verify with the more challenging beam management type when UE supporting both. Peak EIS can be verified with both IBM and CBM where peak direction could be obtained from CBM spherical coverage measurement. If the IBM and CBM requirements could not be met with CBM side conditions, anyway both IBM and CBM test cases will be done separately. |
| Xiaomi | Option 1 |
| vivo | We can only support portion of each option  For option 1, we support that the requirement on each CC do not have to be met simultaneously at single direction, but for multi-chain UE, the normalized equal PSD does not match the actual working status.  For option 2, we support that to differentiate PSD based on different UE architectures, but the fixed PSD difference, i.e., 6 dB, is hard to maintain for all direction in the test.  Considering the Fs, inter is only needed for single-chain, we prefer combine the Fs,inter and PSD condition as a package as a compromise.   * UE report Fs, inter 🡪test with “simultaneous sensitivity”🡪ΔRIB,S,n =0, ΔRIB,P,n = 0 * UE don’t report Fs, inter 🡪 test with IBM PSD condition 🡪ΔRIB,S,n =X, ΔRIB,P,n = Y   X and Y is derived from the worst case of the specific band combination.  The worst case here means the largest frequency span for the specific band combination.  For option 3, we agree with Qualcomm, the core requirement should be defined first |
| MediaTek | **Option1:** Support  **Option2:** Not support.  **Option3:** It would be better to further discuss it while CBM core requirement is much clearer/stable. We understand test reduction is important, and positive on the discussion intention. |
| OPPO | For Option 1, it needs further clarification, the “*normalized equal PSD*” and “*requirements on each CC do not have to be met simultaneously at single direction*” looks contradicting with each other. In last meeting it seems the “*normalized equal PSD*” requires UE to meet REFSENS simultaneous in the same direction, and it is tightening UE requirements rather than relaxation for CA.  We are ok with the second half, i.e. “*requirements on each CC do not have to be met simultaneously at single direction*” which is aligned with our proposal (not be included in the listed options above) and not ok with the “*normalized equal PSD*” which is tightening requirements.  Our suggestion is using simultaneous sensitivity with different beam direction of each band approach to define the peak EIS requirements for inter-band DL CA CBM.  For Option 2, not support, there is no UE capability to differentiate single chain or multi chain.  For Option 3, is the EIS spherical coverage of CBM is equal or tighter than IBM? If not then this is not justified. |
| ZTE | Option 1 is fine. |
| Ericsson | **Option 1:** support for UEs only indicating CBM capability for a BC. The “normalized PSD” requires clarification. In the proposed CR in R4-2204612 we propose the following:  For CBM-only capability for a BC, measure with “equal PSD”  -- Measured carrier: measure the CCDF as per the existing EIS test procedure  -- Other carrier: sweep the second until 95% is achieved for each test point of the measured carrier, shall be lower than the spherical coverage EIS.  **Option 2**: not supported. The requirement should be differentiated between  -- IBM + both, the UE meets the requirement with different input level PSD, the BS can use either CBM or IBM beam management RS at least for collocated. IBM support beneficial for non-colocation (then the different PSD also makes sense)  -- CBM-only (i.e. does not support IBM), it is assumed this needs ‘equal PSD’ to meet the requirement. This can be used at least for colocation (but no limitation)  **Option 3**: this is up to RAN5, core requirements should be specified for all BM such that the gNB can configure the UE according to its supported BM and rely on that the UE is functional. |
| Sony | Option 1 is fine for us. Meanwhile, Option 3 is dealing with test reduction. We don’t object to it but think it can be discussed separately after we stabilize the core requirement. |
| DOCOMO | We support option 1.  We also support to combine the Fs\_inter capability and PSD condition as a package. In this case, option 1 is applied if UE report Fs\_inter, and option 2 (IBM reuse) is applied if UE do not report Fs\_inter.  For option 3, the core requirement should be defined first. |
| Huawei | Support Option 2. The method by vivo can be considered. Fs can be utilized to indicate the applicable requirements for CBM. If UE only specifying the requirements based on option 1, how it is workable for the real deployment scenario?  Option 3 can be further considered after requirements are stable, and the test related issue can also be left to RAN5, not see the need it has to be decided by RAN4. |
| Nokia | Option 1. |
| Apple | Option 1 could be a useful starting point. We should define the term "normalized equal PSD." Is the criterion here that the PSD of each carrier should correspond to the REFSENS / EIS spherical coverage levels from single-carrier requirements? |

Issue 2-1-2: EIS spherical coverage relaxation

* Proposals
  + Option 1: For CBM CA within same frequency group, [2.5dB] should be set as the base value for the relaxation of REFSENS requirements. R4-2204361
  + Option 2: About 3.5 dB total relaxation for EIS spherical coverage is derived for band combination of n258+n261. R4-2204035
  + Option 3: [2.5] with Note 1 : ‘Fs\_inter’ is the maximum frequency separation between lower edge of lowest CC and upper edge of highest CC in FR2-1 inter-band DL CA based on CBM which UE can support with corresponding ΔRIB,S,n. If the configured frequency separation is larger than ‘Fs\_inter’, additional relaxation is allowed. R4-2204143
  + Option 4: 4dB spherical coverage relaxation is needed for inter-band DL CA within same frequency group with CBM based on the simultaneous sensitivity of different beam direction approach. R4-2204927
  + Option 5: The CBM requirement for n258-n261 can be 5.5 dB R4-2204940
  + Option 6: UE report Fs, inter, test with “simultaneous sensitivity” ΔRIB,S,n =0 and UE don’t report Fs, inter test with IBM PSD condition ΔRIB,S,n =X. X is derived from the worst case of the specific band combination.
  + Option 7: For CBM inter-band DL CA between different frequency groups, the REFSENS and EIS spherical coverage requirements could meet the existing IBM inter-CA requirements with additional 0.5dB relaxation.
  + Option 8: For DL CA for n258+n261, delta(RIB\_spherical) is [4.5] dB for CBM receivers with low DL PSD difference, R4-2206055.
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | This relaxation value(s) depends on whether Fs\_inter is agreed as a functional limitation, and what ‘stops’ are defined for Fs\_inter. We need to revisit after FS\_inter discussion has found convergence. |
| Samsung | Options cover both same frequency group and different frequency group.  For a dedicate band combination, its CBM relaxation value should be larger than the IBM relaxation value of that band combo, no matter for same frequency group or different frequency group. If IBM is not specified yet, CBM can only be specified together with or after IBM. |
| Xiaomi | Support Option 2/4/5/7/8  In previous discussions, we prefer to wait for the operator demands before defining requirements for specific band combinations within same frequency group. As comments from ZTE in sub-topic 2-4, CA\_n258-n261 has been requested in the inter-band xUL/DL NR CA/DC basket WID (R4-2118205). For a specific band comb, CBM relaxation value should be larger than the IBM relaxation value, no matter for same frequency group or different frequency group Therefore, as proponent of Option7, the proposal can apply to L+L CA\_n258-n261. |
| vivo | We support Option 5 and option 6, our analysis is as follows:   |  |  |  |  | | --- | --- | --- | --- | | **NR CA band combinations** | **NR band** | **Influential factors** | **ΔRIB,S,n (dB)**  **(multi-chain)** | | n258-n261 | n258 | Beam squint | 0 | | Beam mapping accuracy | 0.5 | | common spherical coverage | 1.5 | | Multi-chain degradation | 1.5 | | PSD imbalance | 1.0 | | MBR | 0.7 | | summary | **5.2** | |  | n261 | Same as n258 |  | |
| MediaTek | We share similar view with Qualcomm about *it depends on Fs\_inter discussion*. Moreover, we'd like to recap WID objective “*(on hold until there is* ***operator request*** *or CBM requirements are finalized for one band combination)*” |
| LG Electronics | Support Option3. For value, it is open. However, note1 for ‘Fs\_inter’ is necessary. |
| OPPO | Option 4. |
| ZTE | Similar view with QC, should discuss Fs\_inter first. |
| Ericsson | Option 2. The relaxation should apply for the largest frequency separation of a supported BC. It should be noted that a 3.5 dB relaxation of the minimum requirement already implies a reduction of the DL coverage by a 1/3 under free-space conditions, roughly speaking. |
| Sony | Agree with QC. Without introducing Fs\_inter, we think 3.5 dB relaxation is sufficient for REFSENS and spherical coverage and it has already considered the largest frequency separation for n258+n261.  If Fs\_inter would be introduced in the end, then we believe an even tighter requirement should be placed since the UE is not going to support the largest frequency separation in this case. |
| DOCOMO | The PSD condition and Fs\_inter capability should be agreed first in order to properly consider the necessary factors for relaxation. |
| Huawei | Option 6. Further discussion on the relaxation with option 4, 5, 7. |
| Apple | Our preference is to capture a table of EIS spherical coverage degradations based on frequency separation of the component carriers. We don't believe the capability FS\_inter\_CBM is necessary, but the relaxation to spherical coverage should be dependent on frequency separation, as was clearly shown in the beam squint analysis by many companies. We should also follow the previously utilized framework of defining ΔRIB,S,n (as has already been done for IBM based combinations in the spec).  In summary, a possible starting point for the example band combination within the same frequency group is as follows:  For CA\_n258-n261 with configured total DL spectrum ≤ 800 MHz, ΔRIB,S,n = 3.5 dB  For CA\_n258-n261 with configured total DL spectrum > 800 and ≤ 1400 MHz, ΔRIB,S,n = 4.0 dB  For CA\_n258-n261 with configured total DL spectrum > 1400 and ≤ 2400 MHz, ΔRIB,S,n = 5.0 dB  For CA\_n258-n261 with configured total DL spectrum > 2400 MHz, ΔRIB,S,n = [5.5] dB  NOTE: for different frequency groups the degradation is anticipated to be larger |

Issue 2-1-3: peak EIS

* Proposals
  + Option 1: Use simultaneous sensitivity with different beam direction of each band approach to define the peak EIS requirements for inter-band DL CA CBM. R4-2204927
  + Option 2: It is proposed to differentiate PSD based on different UE architectures, i.e. 6dB PSD difference for UE implemented with single RF chain, and requirements including PSD difference similar to IBM for inter-band CA with CBM for different frequency group.
  + Option 3: REFSENS requirements is specified based on normalized equal PSD. The requirements on each CC do not have to be met simultaneously at single direction. R4-2204361, R4-2204575
* Recommended WF
  + TBD

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: support  Option 2: Do not support.  On differentiating PSD: This seems reasonable based on different architecture assumptions for different band combinations.  On 6 dB: 6dB seems arbitrary, would proponent provide more detail on choice of 6, but not 4 or 8? This proposal also would be less problematic if we assume single chain architecture as reference for CBM. Furthermore, this type of limit is not easily scalable to other power classes which have very different beam directivities.  Option 3: support the idea based on understanding that this option is similar to option 1. The spec wording needs to be explicit. |
| Samsung | Option 1: support  Option 2: do not support. Sensitivity is special than other RX test cases. A fixed PSD difference could be configured for other RX test cases. But for sensitivity test, PSD difference is determined by measurement result which is varying for different test. Note that for IBM the PSD difference is not an exact fixed value either.  Option 3: support. In our understanding Option 3 and Option 1 indicates the same thing, spec wording can be refined based on the two options. |
| Xiaomi | Option 1 and Option 3 support. |
| vivo | Similar view in issue 2-2-1 |
| MediaTek | **About Option1 & 3:**  It seems that companies may use different definitions on “*simultaneous sensitivity*” and “*normalized equal PSD*”. Conceptually, we support apply similar PSD for the two bands within the same frequency group, and don’t prefer to introduce additional limitation on beam directions of the two bands. While we check the 2 corresponding tdocs, it seems that both Option 1 and 3 propose this concept. Maybe let’s further optimize the statement together.  **About Option2:** Not support |
| OPPO | Option 1.  For the Option 3 the it needs further clarification, the “*normalized equal PSD*” and “*requirements on each CC do not have to be met simultaneously at single direction*” looks contradicting with each other. In last meeting it seems the “*normalized equal PSD*” requires UE to meet REFSENS simultaneous in the same direction, and it is tightening UE requirements rather than relaxation for CA.  We are ok with the second half, i.e. “*requirements on each CC do not have to be met simultaneously at single direction*” which is aligned with our proposal and not ok with the “*normalized equal PSD*” if it means meet REFSENS in the same direction which is tightening requirements. |
| ZTE | Option 1 and option 3 are similar, both are ok to us. Or maybe further optimize the statement together, as stated by MTK. |
| Ericsson | **Option 1:** support for UEs only indicating CBM capability for a BC. The “normalized PSD” requires clarification. In the proposed CR in R4-2204612 we propose the following for the peak EIS requirement:  For CBM-only for an inter-band BC, then  1. Measured carrier: peak REFSENS + relaxation  2. Other carrier: a starting point is peak REFSENS but the level may be increased up to the REFSENS for the spherical coverage EIS to achieve ‘equal PSD’ conditions  **Option 2**: not supported. The requirement should be differentiated between  -- IBM + both, the UE meets the requirement with different input level PSD, the BS can use either CBM or IBM beam management RS at least for collocated. IBM support beneficial for non-colocation (then the different PSD also makes sense)  -- CBM-only (i.e. does not support IBM), it is assumed this needs ‘equal PSD’ to meet the requirement. This can be used at least for colocation (but no limitation)  **Option 3**: the proposed test levels for Option 1 above can accommodate this by an allowance to modify the level of “the other carrier” (the peak RX beam that may not be completely aligned with that of the measured carrier) if not already covered by the peak REFSENS relaxation. |
| Sony | Option 1 is generally okay to our understanding. We think the different beam direction has been taken into account by adding the relaxation due to the beam squint effect. Therefore, the UE should be able to meet the REFSENS requirement at (at least) one point simultaneously with 3.5 dB relaxation as discussed in R4-2204940. Meanwhile, just for clarification, the peak direction of the beam on each CC can be of course at different direction |
| DOCOMO | We have same view as our comment on issue 2-1-1. |
| Huawei | Option 2. We need to admit that the PSD could be different for co-located and non-collocation scenarios, and for UE with different UE architectures, it has different ability to handle the different PSD differences. Fs\_inter can be considered together with the applicate requirements for CBM. Regarding 6dB difference, it is not an arbitrary value, it already used in the spec for the collocated scenario. |
| Nokia | Option 1 |
| Apple | Option 1 is fine |

Issue 2-1-4: peak EIS Relaxation

* Proposals
  + Option 1: 2.5dB peak EIS relaxation is needed for inter-band DL CA within same frequency group with CBM based on the simultaneous sensitivity of different beam direction approach. R4-2204927
  + Option 2: The CBM requirement for n258-n261 can be 3.5 dB R4-2204940
  + Option 3: UE report Fs, inter, test with “simultaneous sensitivity” ΔRIB,P,n =0 and UE don’t report Fs, inter test with IBM PSD condition ΔRIB,P,n =X. X is derived from the worst case of the specific band combination.
  + Option 4: For CBM inter-band DL CA between different frequency groups, the REFSENS and EIS spherical coverage requirements could meet the existing IBM inter-CA requirements with additional 0.5dB relaxation.
  + Option 5: For DL CA for n258+n261, delta(RIB\_peak) is [2.5] dB for CBM.
* Recommended WF
  + TBD

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1,3 and 5: support  Option 4: If proposal is intended for L+L, we support as a package with 1,3,5: IBM relaxation is 0.5 dB less than CBM relaxation. These values are consistent with our analysis also (06055).  Option 2: Thanks for the technical detail in 04940! In our analysis, we realized that for L+L, if the test condition reflects low PSD difference, we should not be taking the 1.0 dB desense for that mechanism (we have had to make this change in our proposals for this meeting). Also, why is multi-chain degradation a separate item from desense? With this accounting, we cannot explain the L+H budget for spherical coverage in Rel-16. |
| Samsung | Options cover both same frequency group and different frequency group.  For a dedicate band combination, its CBM relaxation value should be larger than the IBM relaxation value of that band combo, no matter for same frequency group or different frequency group. If IBM is not specified yet, CBM can only be specified together with or after IBM. |
| Xiaomi | support Option 2 and Option4  As proponent of Option4, the proposal can apply to L+L CA\_n258-n261. |
| vivo | We support option 2, option 3 and option 4. Our analysis is as follows:   |  |  |  |  | | --- | --- | --- | --- | | **NR CA band combinations** | **NR band** | **Influential factors** | **ΔRIB,P,n (dB)**  **(multi-chain)** | | n258-n261 | n258 | Beam squint | 0 | | Beam mapping accuracy | 0 | | common spherical coverage | 0 | | Multi-chain degradation | 1.5 | | PSD imbalance | 1.0 | | MBR | 0.7 | | summary | **3.2** | |  | n261 | Same as n258 |  |   We think the relaxation should not be smaller than IBM, so at least 3.5 dB is required.  To Qualcomm:  The multi-chain degradation here is referring to the degradation comes from hardware design, e.g., increase of insertion loss, impedance mismatch, etc. |
| MediaTek | **About Option1/2/5:**  We don’t prefer to define relaxation value for the band combination w/o operator demand, based on WID, i.e. “*(on hold until there is* ***operator request*** *or CBM requirements are finalized for one band combination)*”  **About Option3:**  We are positive on the framework. Look forward to learning companies’ view.  **About Option4:**  　This proposal seems for **different** frequency groups. |
| LG Electronics | Support Option 1 and Option5. In addition, as mentioned in issue 2-1-2, note1 for ‘Fs\_inter’ is necessary. |
| OPPO | Option 1 and 5. |
| Ericsson | Same relaxation as for the spherical coverage (3.5 dB) |
| Sony | Same comments as Issue 2-1-2. |
| DOCOMO | We have same view as our comment on issue 2-1-2. |
| Huawei | Option 2, 3, 4. |
| Apple | We recommend to simply reuse ΔRIB,P,n (3.5 dB) without additional degradation factors for REFSENS for CA configurations based on CBM within the same frequency group. If the PSD levels can be set to be equal in the side conditions, then we are open to further discuss the value, as Qualcomm suggests in their comments; perhaps we can capture the value square brackets for now. |

### Sub-topic 2-2: Fs\_inter

Issue 2-2-1: Fs\_inter

* Proposals *(Can support more than one)*
  + Option 1: Define the minimum requirement based on the largest frequency separation between two CCs. R4-2204035
  + Option 2: For REFSENS requirements for CA within same frequency group, Fs\_Inter capability is introduced for performance functional separation. R4-2204361, No additional EIS relaxation specific for frequency separation factor is acceptable R4-2204229, R4-2204940 .
  + Option 3: Fs\_inter capability is optionally reported by UE, and should be considered by NW, but to keep both NW scheduling and UE implementation flexibility, it is proposed to agree that once configured CCs exceed this capability then UE behavior is considered to be undefined.
  + Option 4: If Fs\_inter is to be introduced, it is proposed to refine previous agreement of Max input level, ACS and IBB verification rules as following:
    - if the measured Max input level, ACS and IBB has already satisfied the requirements with IBM, then the verification with CBM is not necessary
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1,2: Support only if the intent is to define requirements based on FS classes rather than by FS of configured CCs  Option 3: Support.  Option 4: Do not support yet. Agree that the requirements may need to be revisited. Prefer to address further test skipping tests until after requirements are identified. |
| Samsung | Option 1: support with the understanding that the largest frequency separation here means the largest Fs\_inter (if introduced) or the largest frequency separation between two bands.  Option 2: support. Per discussion of last meeting, if Fs\_Inter capability is introduced, no additional EIS relaxation specific for frequency separation factor is acceptable  Option 3: support if Fs\_inter is introduced  Option 4: support. Max input level verification rule has already been agreed. For ACS and IBB, it has low relationship with beam management. After Fs\_inter is introduced, CBM would possible only support a subset of frequency range. It is reasonable to verify with IBM whose frequency range always covers all the bands ranges. |
| Xiaomi | Support Option 2.  Option3 not support, if the Fs\_inter is defined due to functional limitation, once configured CCs exceed this capability, the configuration will fail. |
| vivo | We support option 2 and option 3. When the CC is scheduled outside of the single-chain capability (Fs, inter), the performance degradation will be sharp and it is hard and unreasonable to define the requirement based on such status.  Option 4 is also OK for us |
| MediaTek | **About Option 1&2:**  Although we only proposed Option2 originally, However, we think below compromise proposal can be considered:  *Issue 2-1-4: peak EIS Relaxation*   * + *Option 3: UE report Fs, inter, test with “simultaneous sensitivity” ΔRIB,P,n =0 and UE don’t report Fs, inter test with IBM PSD condition ΔRIB,P,n =X. X is derived from the worst case of the specific band combination.*   **About Option 3:**  We understand the intention, thanks for the proposal from comprehensive perspectives. However, we would like to learn what would be happened while “UE behavior is considered to be undefined.” We are not sure if the situation is better for network.  **About Option 4:**  　We are positive on this discussion intention but would like to have clear CBM requirement firstly. |
| LG Electronics | Support Option 1/2/3.  For option 3, if configured CCs exceed this capability, additional relaxation can be also considered. |
| OPPO | Support Option 3. When NW configure CCs within this Fs\_inter capability, UE performance is guaranteed by requirements and testing. When NW configure CCs that is larger than this Fs\_inter capability, UE behaviors could be different (performance issue or functional issue) and it is up to UE implementation. Therefore, what can be interpreted to cover all UE is that if NW configure CCs larger than this Fs\_inter then UE behavior is undefined means for some UE may fail (hard limitation in software), for others may still work under worse performance. This is a balance between UE and NW.  For Option 1, may need to clarify the meaning of “largest Fs”, is it total band combination Fs or referring to Fs\_inter?  For Option 2, as commented in above Option 3, the behavior is different for different UEs thus cannot consider Fs\_inter as just performance issue.  For Option 4, may need further check which requirement is tighter. |
| ZTE | For Option 3, we have similar question as MTK on the UE behavior. |
| Ericsson | Option 1: support.  We do not support introduction of an Fs\_inter in-capability: if the UE indicates support of a BC the gNB shall be able assign any carrier separation between carriers of the said BC. In case the UE does not support all carrier separations of a BC, it does not indicate support for the said BC. |
| Sony | Option 1 is preferred. A clarification, the frequency separation here means the largest frequency separation between the two bands. |
| DOCOMO | We have same view as LG Electronics. |
| Huawei | Support option 2. Additional proposal by MTK can also be considered. |
| Nokia | Option 1 is preferred option |
| Apple | As we commented in Issue 2-1-2, we don't see the need to define this capability. Rather, we simply need to define different relaxation levels for EIS spherical coverage based on the total aggregate configured bandwidth, in order to align with the beam squint analysis. We provided an exmaple of this in our comment to Issue 2-1-2. |

### Sub-topic 2-3: BMRS configuration

Issue 2-3-1:

* Proposals *(Can support more than one)*
  + Option 1: Use SSB+CSI RS as the BMRS and use DMRS at the other band as the QCL-D target reference signal.
  + Option 2: The REFSENSE and spherical coverage will only be tested with worst case of BMRS side condition, i.e., the BMRS is only located in the untested band, to reduce the test complexity.
  + Option 3: If no consensus reached for the BMRS conditions, leave it to RAN5 as a measurement issue.
  + Option 4: For CBM, all the reference signals in Band\_without\_BMRS shall traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS by certain manner and For CBM. Be more specific, DMRS in Band\_without\_BMRS traces TRS of Band\_without\_BMRS, and then traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS, R4-2204230.
* GTW agreement
  + All the reference signals in Band\_without\_BMRS shall traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS by certain manner.

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Agree only with option 3. No further agreements needed in RAN4. We however share our views to help establish common understanding:  Option 1: Do not agree. This option is incorrectly structured on many counts. For example: Why is BMRS limited to just one of the possibilities? DMRS is not a ‘mother’ RS.  Option 2: Do not agree. This type of agreement is inconsistent with the BMRS options available to the network or TE which were established by the UE when it declared its beam correspondence capabilities. UE’s choice of beam correspondence decides what BMRS applies.  Option 4: In our understanding the wording of this option seems correct. |
| Samsung | Option 1,3: support to use SSB+CSI RS as the BMRS, or leave it to RAN5  Option 2: support. Note that this downlink issue is not related with beam correspondence which is aiming for uplink performance.  Option 4: better to align with configuration in practical network deployment. |
| Xiaomi | Option3 |
| vivo | We support option 2, as our analysis on the requirement, several additional relaxations is derived from absent of BMRS, e.g., beam squint, beam mapping accuracy. It means the performance of the band without BMRS is worse than the band with BMRS, so we prefer to only verify the worst case to avoid test one band combination twice.  As for the BMRS type, either option 1 or option 4 seems ok for us. |
| MediaTek | **About Option4:** This latest proposal is triggered/inspired by many discussions in prior meetings and companies’ contributions, thanks for the professional inputs and discussion. As the proponent, we’d like to ask companies’ consideration for this proposal. We tried to explain it in tdoc ([*R4-2204230*](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204230.zip)**).** In short, after considering current RAN1 framework (below Fig1) for QCL-D method concept, we think this proposal is reasonable and feasible.    **About Option1:** We understand the idea, and Option4 is inspired by Option1 w/ further check RAN1 framework. Wish Option1 proponent could consider to support Option4.  **About Option2:** We are positive to discuss the test reduction. For example, if a UE claims to support 3 beam correspondence conditions (i.e. both CSI-RS and SSB; SSB-based; CSI-RS based), I believe we can find a suitable test reduction rule (ex: tested with worst case only) like what we did for single-band beam correspondence.  **About Option3:** We believe make core requirement package clearer and more solid is important, and RAN4 is a suitable WG for the discussion. Especially that RAN4 already has similar experience before, like beam correspondence, and RAN4 actually has clearer and clearer picture after these valuable discussions.  **To Samsung:** Could you be more specific? Because in our understanding, proposal 4 aligns with RAN1 framework and practical network deployment well. |
| OPPO | Support Option 1, and Option 4.  Option 4 is more detailed explanation of Option 1. |
| ZTE | Support leave it to RAN5, Option 3. |
| Ericsson | One CC QCL-D with the other CC. Not unlikely for a collocated case relevant for CBM. |
| Sony | The basic principle seems aligned through the options, where the one CC should be QCL-D with the other CC’s BMRS, maybe this can be agreed as a common ground and further discuss the QCL sources here, but we are also fine to leave it to RAN5. Option 2 is dealing with test reduction and can be discussed later once we have the core requirement in place. |
| Huawei | We prefer to leave the measurement issue to RAN5 as no progress in recent meetings. |
| Apple | As a fallback, Option 3 is always available if RAN4 cannot agree |

### Sub-topic 2-4: Band combination

Issue 2-4-1:

* Proposals
  + Option 1: Wait for the operator demands before defining requirements for specific band combinations within same frequency group. R4-2205122
  + Option 2: If an example band combination, i.e., CA\_n258-n261, is required strongly, the requirements for both CBM and IBM should be introduced. R4-2205122
  + Option 3: it is preferred not to explicitly introduce band combination, e.g. n258+n261into core specification without operator request, but to define CBM requirements in such manner that both same frequency group and different frequency group are applicable. R4-2204575
  + Option 4: Proposal 3: Introduce requirement of n258-n261 as an example band combination in TR and with note as follows: Note: the ΔRIB,S,n and ΔRIB,P,n can be revised with sufficient technical justification when the band combination is request by operator. R4-2204940
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | This discussion, along with FS\_inter description is important to resolve first, due to RAN2 implications.  Option 4 seems reasonable if L+L band combination not entered into core requirement. In that case FS\_inter would also be limited to TR. |
| ZTE | It seems all of the companies overlooked that the band combination of CA\_n258-n261 have already been included in the inter-band xUL/DL NR CA/DC basket WID (R4-2118205). However, the BCS channel bandwidth information for this combinations were missing by the proponent. So may be that is the reason why companies didn’t pay attention on it.  Here is the information:  11  There, we suggest to focus on the RF requirements, rather than the band combination itself. |
| Samsung | We support Option 3, i.e. to define CBM requirements in such manner that both same frequency group and different frequency group are applicable. It is similar as ZTE comments to focus on the RF requirements.  If CA\_n258-n261 is to be introduced in this WI, then we support option 2 (requirements for both CBM and IBM should be introduced) or Option 4 (capture into TR only until operator request for CBM).  Thanks for ZTE to point out CA\_n258-n261 in basket work item. Our understanding is that it is based on IBM in that basket WI since CBM is not available then. |
| Xiaomi | As ZTE comments the combination has been included in the basket WID, the requirements for both CBM and IBM should be introduced for it if it will be introduced in this WI. In additional, we support define CBM requirements in such manner that both same frequency group and different frequency group are applicable. |
| vivo | We support option 4. if companies have strong concern on introducing the n258-n261 in TS, we suggest introducing this example band combination into TR to record our almost 2 release efforts on CBM and avoid unnecessary argument in the future. As a further compromise, the note in option 4 weakens the effectiveness of requirement and leave adequate leeway if the band combination need to be transferred to the TS. |
| MediaTek | **Option1**: Support.  　To ZTE: Thanks for the information. We think this special band combination should not be proposed in bracket WI. Besides, there is no information about the demand is IBM or CBM.  **Option2:** Not support. It conflicts with WID “*(on hold until there is* ***operator request*** *or CBM requirements are finalized for one band combination)*”  **Option3:** Not support. Inter-band CA shall be defined based on band combination(s).  **Option4:** Not support. Even if we follow the method, we still wait for operator demand to define exact requirement in the end. |
| LG Electronics | Support to introduce the requirements for both CBM and IBM for band combination, CA\_n258-n261. |
| OPPO | Option 4 is ok. |
| ZTE | It is ture that no BM type are included when proponent request the band combination, so we can not judge it is for IBM or CBM at the stage of the requesting, it depends on UE capability. Which BM is supported should be specfied when the band combination is introduced in the specification. |
| Ericsson | **Option 2**: a possible option. In the CR in R4-2204612 we propose introduction of n258 + n261 for both CBM-only and IBM capable UEs. |
| Sony | No strong opinion on exact methodology (TR, TS or any other wayforwad), but support to finalize the requirement for n258-n261 as an example band combination in Rel-17. |
| DOCOMO | We prefer option 4.  We also support option 1 and option 2.  We do not support option 3. |
| Huawei | Support option 3. As mentioned by ZTE, if the combination is already in the basket WI, we don't need to spend too much time to argue the example band combination, and option 2 can be considered. |
| Nokia | At least IBM requirements can be defined for n258-n261 in REL17, preferably also CBM requirements but that seems to be difficult. |
| Apple | What would happen if RAN4 agrees the generic inter-band CA (same frequency group) requirements based on IBM but not based on CBM? Would IBM be the only applicable capability with which a UE could support this combination? |

### Sub-topic 2-5: in-gap exemption for ACS and IBB

Issue 2-5-1:

* Proposals
  + Option 1: for adjacent or overlapped band combinations, in-gap exemption for ACS and IBB apply for FR2 inter-band CA no matter IBM or CBM. R4-2204575
  + Option 2: Other
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 2: We do not wish to change the structure of IBM requirements even for L+L. The proposed change has impact on filtering decisions in the architecture.  For CBM for L+L and FS\_inter (i.e single chain), some clarifications would be useful to establish common understanding:   1. The interferer be anywhere in the super-set of the bands, but in-gap exception exists 2. FS\_inter would not restrict location of the interferer. |
| Samsung | Support option1. In case of overlapped band combinations, and the CCs are adjacent but from different bands, then ACS will fall into the normal CC. The same logic is also applicable for IBB. So we think exemption should be specified to avoid such special scenarios. The minimum in-gap condition for intra-band CA could be a reference and we are also open for other ideas. |
| vivo | Option 1. The in-gap exemption does not depend on the BM type. |
| OPPO | The in-gap requirement exemption was defined for intra-band NC CA. For inter-band CA, if similar concept is applied then probably for CBM UE is more suitable since one same chain is used.  Regarding Fs\_inter impact, it limits UE CC configurations, but not ACS/IBB testing. |
| ZTE | Option 1. The in-gap exemption does not depend on the BM type. |
| Ericsson | We propose to use a condition similar to that in FR1 for intra-band requirements (or non-contiguous), this can be applied also for inter-band configuration with overlapping bands, see R4-2204612. |
| Huawei | For IBM, in-gap exemption may not be necessary. |
| Apple | Is our understanding correct that Option 1 is intended to apply to UEs which support CBM inter-band CA based on a common Rx architecture? |

## 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** | **CR/TP name** | **Source** | **Comments collection** |
| [**R4-2204789**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204789.zip) | Addition of downlink CA feature for CBM UEs and one band combination for IBM UEs | Nokia, Qualcomm | LG Electronics : For ΔRIB,P,n & ΔRIB,S,n , need to define Tables for IBM and CBM separately. And, a note for ‘Fs\_inter’ needs to be considered in CBM table. |
| Apple: we should resolve the open issues before coming to this CR (especially the situation with FS\_inter). |
|  |
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| [**R4-2204612**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204612.zip) | Introduction of requirements for DL inter-band CA for CBM-capable UEs | Ericsson, Sony | LG Electronics : Fs\_inter needs to be introduced. And, we suggest two draft CRs(R4-2204789, R4-2204612) to be merged. |
| Ericsson; a correction for the cover page in yellow highlight:  Clause 7.3A.2.3: the input levels in the test case for peak EIS.  For IBM- or both for an inter-band BC, then   1. Measured carrier: peak REFSENS + relaxation 2. Other carrier: spherical coverage EIS + relaxation (about 10 dB higher than the measured carrier)   For CBM-only for an inter-band BC, then   1. Measured carrier: peak REFSENS + relaxation 2. Other carrier: a starting point is peak REFSENS but the level may be increased up to the REFSENS for the spherical coverage EIS to achieve ‘equal PSD’ conditions |
| Apple: we should resolve the open issues before coming to this CR (especially the situation with FS\_inter). |

## Summary for 1st round

### Open issues

*GTW outcome*

**Issue 2-1-1: EIS spherical coverage**

**Tentative Agreement:**

* For UE only supporting CBM for band combinations, the requirement with equal PSD on cells will be applied
* For UE supporting IBM, the requirement with the different input levels, i.e, [10]dB difference, will be applied.
  + The additional relaxation will be applied with respect to frequency separation.
* **Issue 2-2-1: Fs\_inter**

**Tentative Agreement:**

* For UE only supporting CBM for band combinations [within the same frequency group], the requirement with “equal” PSD on cells will be applied
  + Alternative 1: The additional relaxation will be applied with respect to frequency separation.
  + Alternative 1a: The additional relaxation will be applied with respect to frequency separation.
    - The signalling to indicate that the additional relaxation is needed.
  + Alternative 2: the requirement without relaxation is applied to scenario with the separation within Fs\_inter
    - Introduce the Fs\_inter capability.
  + Alternative 3: define the requirement without the relaxation only under condition of a certain separation (within the same frequency group)
    - Add note that beyond this separation no requirement is specified in Rel-17
* For UE supporting IBM or both IBM and CBM for band combinations, the [IBM] requirements [except for any sensitivity related requirements] different input PSD levels will be applied.
* **Sub-topic 2-3: BMRS configuration**

**Agreement:**

* All the reference signals in Band\_without\_BMRS shall traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS by certain manner.
* **Issue 3-1-1: Requirement setting for CBM between frequency groups**

**Tentative agreement**: Agree on Option 1 and Option 4.

* + Option 1: For CBM between different band groups is not feasible with single-chain architecture. The requirement definition for inter-band DL CA between different band groups should only be based on multi-chain architecture, R4-2203699 and R4-2204941 partly. And Sensitivity requirements for CBM UEs in an H+L combination shall be based on a multi-chain architecture. R4-2206056
  + Option 2: For UEs indicating IBM and ‘both’ capability for a BC across different frequency groups, then unequal PSD is used, while for UEs indicating CBM-only the input levels resembling an equal PSD are used, R4-2204036.
  + Option 3: CBM requirement shall NOT imply additional request on beam peak direction of each band compared to IBM; and CBM requirement shall NOT imply additional request on untested band EIS at specific AoA of tested band. R4-2204230
  + Option 4: Sensitivity requirements for CBM UEs in an H+L combination shall be based on a multi-chain architecture. R4-2206056
* FFS on Option 2
  + Need clarification on what the “unequal PSD” is
* **Sub-topic 2-5: in-gap exemption for ACS and IBB**

**Agreement:**

* Apply the in-gap exemption for the CBM requirements of ACS and IBB for inter-band CA within the same frequency group
  + Refer to R4-2114960
* For IBM requirements, the following changes in R4-2204789 are agreeable

### 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** | **CR/TP name** | **Source** | **CRs/TPs Status update recommendation** |
| [**R4-2204789**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204789.zip) | Addition of downlink CA feature for CBM UEs and one band combination for IBM UEs | Nokia, Qualcomm | Return to |
| [**R4-2204612**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204612.zip) | Introduction of requirements for DL inter-band CA for CBM-capable UEs | Ericsson, Sony | Return to |

## Discussion on 2nd round (if applicable)

Continue under DL CA WF email discussion initiated by Nokia.

Finally all comments from WFs will be transferred into this summary.

# Topic #3: CA configurations between different frequency groups based on CBM AI 10.4.2.1.2

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2203699**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203699.zip) | FR2 Sensitivity requirements for inter-band CBM | Apple | Proposal 1: For CBM between different band groups is not feasible with single-chain architecture. The requirement definition for inter-band DL CA between different band groups should only be based on multi-chain architecture.  Observation 1: The simulation results show the impact of the cross-array calibration of the beam for different band groups with only BMRS in one of the bands compared to cross-array calibration with BMRS in both bands.  Observation 2: Simulation results show that the delta between inter-band DL CA CBM and inter-band DL IBM is 5 dB.  Proposal 2: Additional relaxation ΔRIB,P,n (dB) and ΔRIB,S,n (dB) for inter-band DL CA CBM is required compared to inter-band DL CA IBM:   * ΔRIB,P,n (dB) for multi-chain CBM with different band groups = ΔRIB,P,n\_IBM (dB) + 5 dB * ΔRIB,S,n (dB) for multi-chain CBM with different band groups = ΔRIB,S,n\_IBM (dB) + 5 dB |
| **[R4-2204036](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204036.zip)** | Requirements for CBM UEs between different frequency group | Sony, Ericsson | **Observation 1: Both options of PSD condition can be feasible for testing the CBM UEs minimum requirement between different frequency groups. RAN4 can select one of them to define the minimum requirement for CBM UEs in different frequency groups.**  **Observation 2: CBM UEs can offer similar performance as IBM UEs in a co-located scenario across different frequency groups.**  **Proposal 1: consider adopting the same relaxation factor for REFSENS and EIS spherical coverage between CBM and IBM UEs for different frequency groups.**  **Proposal 2: for UEs indicating IBM and ‘both’ capability for a BC across different frequency groups, then unequal PSD is used, while for UEs indicating CBM-only the input levels resembling an equal PSD are used.** |
| [**R4-2204230**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204230.zip) | Reference signal, and relaxation value about FR2 inter-band DL CA between different frequency groups based on CBM | MediaTek Beijing Inc. | ***About 2.1 Reference signal***  ***Proposal1:*** *For CBM, all the reference signals in Band\_without\_BMRS shall traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS by certain manner.*  ***Observation:*** *“Traces its QCL type-D dependence” shows “no DL measurement” on the Band\_without\_BMRS as CBM’s definition.*  ***Proposal2:*** *For CBM, DMRS in Band\_without\_BMRS traces TRS of Band\_without\_BMRS, and then traces its QCL type-D dependence to SSB and/or CSI-RS in Band\_with\_BMRS*  ***About 2.2 Relaxation value and PSD condition***  ***Proposal3****: Define/clarify PSD condition firstly, before agreeing CBM relaxation value.*  ***Proposal4****: Relaxation value of CBM shall larger than IBM, no matter REFSENE or spherical EIS.*  ***Proposal5****: CBM requirement shall* ***NOT*** *imply additional request on beam peak direction of each band compared to IBM.*  ***Proposal6****: CBM requirement shall* ***NOT*** *imply additional request on untested band EIS at specific AoA of tested band.* |
| [**R4-2204575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204575.zip) | Discussion on requirements of FR2 inter-band DL CA | Samsung | **Observation 1: based on previous agreement, it does not prevent the CBM requirements work without having to explicitly introduce example band combination for same frequency group, e.g. n258+n261.**  **Proposal 1: it is preferred not to explicitly introduce band combination into core specification without operator request, but to define CBM requirements in such manner that both same frequency group and different frequency group are applicable.**  **Proposal 2: In case n258+n261 band combination is to be introduced as example band combination for same frequency group, specify IBM requirements together with CBM requirements for this band combination.**  **Proposal 3: for CBM sensitivity requirements (peak EIS and EIS spherical coverage), adopt normalized equal PSD (CC1 and CC2 achieve sensitivity status i.e. 95%TP simultaneously).**  **Proposal 4: the delta\_RIBs of CBM should be larger than that of IBM for the same band combination.**  **Proposal 5: for adjacent or overlapped band combinations, in-gap exemption for ACS and IBB apply for FR2 inter-band CA no matter IBM or CBM.**  **Proposal 6: specify sensitivity verification rule for inter-band CA supporting ‘both’ beam management capability as following:**   * + - * **Peak EIS should be verified with both IBM and CBM**       * **if the measured EIS spherical coverage of CBM has already satisfied the requirements of IBM, then the IBM EIS spherical coverage verification is not necessary**   **Proposal 7: If Fs\_inter is to be introduced, it is proposed to refine previous agreement of Max input level, ACS and IBB verification rules as following:**   * + - * **if the measured Max input level, ACS and IBB has already satisfied** |
| [**R4-2204941**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204941.zip) | Discussion on CBM between different frequency group | vivo | **Observation 1:** The impact of beam squint for different frequency groups may lead to a very large ΔRIB,S,n.  **Observation 2:** The wideband impedance matching is hard to achieve for band combination between different frequency groups.  **Proposal 1:** The requirement for CBM between different frequency group will defined based on multi-chain architecture, but the single-chain implementation is not precluded.  **Proposal 2:** The requirement for n260-n261 and n257-n259 can be:   |  |  |  |  | | --- | --- | --- | --- | | **NR CA band combinations** | **NR band** | **ΔRIB,P,n (dB)** | **ΔRIB,S,n (dB)** | | CA\_n260-n261 | n260 | 3.5 | 5.0 | | n261 | 3.5 | 5.0 | | CA\_n257-n259 | n257 | 3.5 | 5.0 | | n259 | 3.5 | 5.0 | |
| **[R4-2206056](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206056.zip)** | On delta(RIB) for DL inter-CA with CBM in n260+n261 | Qualcomm Incorporated | **Proposal 1: Sensitivity requirements for CBM UEs in an H+L combination shall be based on a multi-chain architecture.**  **Proposal 2: For DL CA for n260+n261 with PSD difference similar to that in the IBM requirement, delta(RIB\_spherical) for IBM is also applicable for CBM.**  **Proposal 3:** **For DL CA for n260+n261 with minimized PSD difference, delta(RIB\_spherical) for CBM is [1 dB] smaller than the corresponding value for IBM.**  **Proposal 4: For DL CA for n260+n261 with PSD difference similar to that in the IBM requirement, delta(RIB\_pk) for IBM is also applicable for CBM.**  **Proposal 5: For DL CA for n260+n261 with minimized PSD difference, delta(RIB\_pk) for CBM is [1 dB] smaller than the corresponding value for IBM.** |

## Open issues summary

### Sub-topic 3-1: Requirement setting for CBM between frequency groups

**Issue 3-1-1: Requirement setting for CBM between frequency groups**

* Proposals
  + Option 1: For CBM between different band groups is not feasible with single-chain architecture. The requirement definition for inter-band DL CA between different band groups should only be based on multi-chain architecture, R4-2203699 and R4-2204941 partly. And Sensitivity requirements for CBM UEs in an H+L combination shall be based on a multi-chain architecture. R4-2206056
  + Option 2: For UEs indicating IBM and ‘both’ capability for a BC across different frequency groups, then unequal PSD is used, while for UEs indicating CBM-only the input levels resembling an equal PSD are used, R4-2204036.
  + Option 3: CBM requirement shall NOT imply additional request on beam peak direction of each band compared to IBM; and CBM requirement shall NOT imply additional request on untested band EIS at specific AoA of tested band. R4-2204230
  + Option 4: Sensitivity requirements for CBM UEs in an H+L combination shall be based on a multi-chain architecture. R4-2206056

GTW Tentative agreement: Agree on Option 1 and Option 4.

* FFS on Option 2
  + Need clarification on what the “unequal PSD” is

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1,3,4: support.  Option 2: We do not support equal PSD test condition for L+H based on latest mod-proposed compromise. |
| Samsung | Option 1,2,4: it is true that CBM between different band groups is not feasible with single-chain architecture. But if we following previous agreement “RAN4 agrees to define CBM requirements in such manner that both single chain and multi chain architectures are possible”, then normalized equal PSD should also apply. If we reverting this previous agreement, there should be a way to indicate which band combos apply normalized equal PSD and which band combos not. Option 2 seems a smart way which solves the conflicts without reverting previous agreement.  Option 3: support. |
| Xiaomi | We prefer to apply the same test condition for CBM within the same frequency group or between different frequency groups.  And we also prefer to define CBM Sensitivity requirements for H+L combination based on multi-chain architecture.  So we support Option 1 and Option 4, and agree the clarification of Option 3. |
| vivo | We support option 1 option 3 and option 4. The single-chain UE will suffer huge degradation due to the beam squint impact and the large operating bandwidth, and UE may not get any performance gain form CA under such status. |
| MediaTek | **Option 1, 3, 4:** Support  **Option 2:** We understand the technical reasons, however, if option1/4 are agreeable, maybe the situation can be simpler. |
| OPPO | Suggest to align the requirement definition for CBM within same freq group and among different freq group, the limitation to UE is same though freq range is larger.  And for the single chain or multi chain, we don’t see the meaning to further discuss this since CBM requirements need to cover both and no UE capability to indicate which kind of architecture has implemented. |
| ZTE | We are wondering how to specfic the ‘multi-chain architecture’ in the speification to define the RF requirements, considering there were no signaling on the RF architecture.. As commented by samsung, previous agreement “RAN4 agrees to define CBM requirements in such manner that both single chain and multi chain architectures are possible” should be respected. |
| Ericsson | **Option 2.** Implemented in R4-2204612. The CBM-only case (that could be implemented by a single-chain architecture) most likely only relevant for the collocated case, hence the test case is resembling “equal PSD”. |
| Sony | We are fine to derive the requirement for different frequency group based on multi chain architecture. We also prefer normalized equal PSD condition for different frequency group (same as the same frequency group) but can accept the IBM type PSD condition as well. |
| DOCOMO | Support option 1/3/4, and not support option 2.  Adjusting the PSD condition helps to define the appropriate requirements and simplify the discussion on CBM DL CA. In our understanding, several ways to distinguish which requirements (PSD conditions) should be applied have already been provided. We currently recommend assuming multi-chain architecture in either of the following cases:  ・UE do not report Fs\_inter capability  ・For CA between different frequency groups (28G+39G)  Either way, equal PSD is not applied in the case of this issue. |
| Huawei | It seems that it is necessary to distinguish the CBM requirements based on different UE architectures, then what could be used to fulfil the purpose, FS\_inter, or indicating IBM and ‘both’ capability can be further discussed. |
| Apple | Option 1 |

**Issue 3-1-2: Relaxations**

* Proposals
  + Option 1: R4-2203699.
    - ΔRIB,P,n (dB) for multi-chain CBM with different band groups = ΔRIB,P,n\_IBM (dB) + 5 dB
    - ΔRIB,S,n (dB) for multi-chain CBM with different band groups = ΔRIB,S,n\_IBM (dB) + 5 dB
  + Option 2: consider adopting the same relaxation factor for REFSENS and EIS spherical coverage between CBM and IBM UEs for different frequency groups, R4-2204036.
  + Option 3: Relaxation value of CBM shall larger than IBM, no matter REFSENE or spherical EIS.
  + Option 4: The requirement for n260-n261 and n257-n259 can be 3.5 for ΔRIB,P,n 5 dB for ΔRIB,S,n., R4-2204941
  + Option 5: For DL CA for n260+n261 with PSD difference similar to that in the IBM requirement, delta(RIB\_spherical) for IBM is also applicable for CBM and For DL CA for n260+n261 with minimized PSD difference, delta(RIB\_spherical) for CBM is [1 dB] smaller than the corresponding value for IBM and For DL CA for n260+n261 with PSD difference similar to that in the IBM requirement, delta(RIB\_pk) for IBM is also applicable for CBM and For DL CA for n260+n261 with minimized PSD difference, delta(RIB\_pk) for CBM is [1 dB] smaller than the corresponding value for IBM. R4-2206056
* Recommended WF
  + Yes

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 2,5: Support  Option 1: Do not support. We do not follow the logic to equate the simulated throughput degradation and the necessary relaxation to support this feature.  Option 3: Can discuss if delta is small.  Option 4: In 04941, ‘multi-chain degradation’ (1.5 dB) is not necessary after desense from PSD imbalance has already been considered. With the accounting provided, we cannot achieve the 3.5 dB spherical coverage relaxation for IBM.  In general, we prefer to not define this feature if the relaxations are much worse than that of IBM. |
| Samsung | We support Option 3: Relaxation value of CBM shall larger than IBM, no matter REFSENE or spherical EIS. At least no more than IBM value if normalized equal PSD (minimized PSD difference) is adopted. In our view this delta could be small otherwise it is not useful in real network. |
| Xiaomi | Option 3 |
| vivo | We support option 3 and option 4, the CBM requirement should not be smaller than IBM.  To Qualcomm:  The budget for R16, in our understanding, is 1.5 dB (common spherical coverage) + 1 dB (PSD imbalance) + MBR, and we still leave some margin to cover other impact, e,g., increase of insertion loss, etc. |
| MediaTek | **Option1:** Thanks for the simulation analysis between IBM and CBM. It shows CBM do have worse performance than IBM based on same hardware capability.  **Option 2:** Not support. There is no BMRS for one of bands of CBM, why the performance could have no degradation.  **Option 3:** Support the general relationship.  **Option 4:** We are fine to further discuss the exact value, it at least like Option3 concept.  **Option 5:** Not support. Our view is closed to Option 3. |
| OPPO | Option 3 is ok. |
| Ericsson | Option 2: this would be verified with a single AoA (resembling a collocated case) for all BM types, but at “equal PSD” conditions for the CBM-only. |
| Sony | Option 2, same relaxation as IBM. The beam mapping error in our view is an implementation issue and can be tackled with properly designed precoding for CA operation, and thus it is possible to align the relaxation value of IBM and CBM.  In addition, we would like to remind that we should be careful on the relaxation of CA, where we shall ensure at least the channel throughput would not be worse than single CC operation under a given gNB-UE distance |
| DOCOMO | We support option 2 and option 5.  Also, we may accept to discuss about option 3 and option 4. However, as Qualcomm says, we prefer to not define this feature if the relaxations are much worse than that of IBM. |
| Huawei | Support option 3. |
| Apple | Option 1. The key aspect of the simulations we provide in our contribution is the consideration of cross-array calibration of beams.  To Qualcomm: We reviewed R4-2206056 and did not find an analysis of the beam mapping accuracy across the arrays of the two band groups. Factors such as manufacturing tolerances, suboptimal antenna element placement, and variation in trace lengths to each antenna element, contribute to this degradation, since the codebook mapping has to make uniform assumptions across a population of UEs. In effect, this is beam correspondence across band groups. We encourage a more thorough understanding of the integration challenges associated with such band combinations. |

## 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** | **CR/TP name** | **Comments collection** |
|  |  | Company A |
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## Summary for 1st round

### Open issues

*None*

### CRs/TPs

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

|  |  |  |
| --- | --- | --- |
| **CR/TP number** | **CR/TP name** | **CRs/TPs Status update recommendation** |
|  |  |  |

## Discussion on 2nd round (if applicable)

Continue under DL CA WF email discussion initiated by Nokia.Topic #4: Rx beam switch value AI 10.4.2.1.4

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2204790**](file:///C:\Users\vasenkap\Documents\Työt\RAN4\%23102e\Docs\R4-2204790.zip) | Discussion on UE Rx beam switch delay | Nokia, Nokia Shanghai Bell | Observation 1: UE Rx beam switch delay is the same for UE autonomous and network controlled Rx beam switch  **Proposal: Define a UE Rx beam switch delay of 60ns** |
| [**R4-2205598**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205598.zip) | On RF requirements for FR2 Inter-band DL CA with CBM | Huawei, HiSilicon | ***Proposal 5: Take 200ns as Rx beam switching value.*** |

## Open issues summary

### Sub-topic 4-1:

**Issue 4-1-1:**

* Proposals
  + Option 1: 60 ns
  + Option 2: 200n s
  + Option 3: Other
* Recommended WF
  + Yes

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 2  We cannot support option 1 because it would place a new requirement on some relatively mature UEs. Furthermore, the UE case is more challenging than a BS due to the following differences:   1. Power consumption strategies are much more aggressive in UEs to preserve battery life for the hand-held case. This reduces the flexibility to improve performance. 2. UE has wider dynamic range in both Rx and Tx. There are cases where the UE’s beam switch has wider scope of hardware configuration changes than just the phase shifter. These other changes take more time.   It is therefore not automatic that a UE can match the gNB’s performance. Moreover, if option 1 is motivated by the need to improve MRTD window for single-band receivers used for inter-CA, would this change also apply to intra-CA? |
| vivo | Option 2, 60 ns is too challenging for the phase shifter design. |
| OPPO | Option 2. |
| Huawei | Option 2. |
| Nokia | Option 1 was our proposal, any compromise value between 60 and 200 ns possible? |
| Apple | 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** | **CR/TP name** | **Comments collection** |
|  |  | Company A |
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## Summary for 1st round

* **Sub-topic 4-1: Rx beam switch value**

### **Agreement:** For CBM, Rx beam switch value is 200ns.Open issues

*None*

### 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** | **CR/TP name** | **CRs/TPs Status update recommendation** |
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## Discussion on 2nd round (if applicable)

Not needed.

# Topic #5: Inter-band UL CA for two bands AI 10.4.2.2.1 and CA configuration CA\_n257A-n259A based on IBM AI 10.4.2.2.2

## Companies’ contributions summary

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| --- | --- | --- | --- |
| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2203814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203814.zip) | Introduce FR2 n260 and n261 uplink CA | Verizon Denmark | … we proposed CA\_n260A-n261 uplink inter-band CA to be part of this work… |
| [**R4-2204037**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204037.zip) | UE UL CA requirements based on IBM | Sony, Ericsson | **Observation 1: MPE and power consumption and thermal issues can be handled with P-MPR.**  **Observation 2: 0.7 dB relaxation for each band is needed to ensure the PC5 device can reach a common spherical coverage at 85% for band combination n258+n259.**  **Observation 3: The PCMAX is defined at different reference plane than EIRP, which may create issues especially when the beams point towards different directions for UL inter band CA operation. For general inter-band UL CA the TRP could be used for governing the power prioritization of an inter-band combination and the total UE power.**  **Proposal 1: Specify spherical coverage per band with a relaxed requirement compared to single-CC considering MBR and common spherical coverage mismatching.**  **Proposal 2: Specify spherical coverage EIRP as per band with relaxed requirement compared to single-CC as ΔTIB,S,n = ΔRIB,S,n -1 dB.**  **Proposal 3: Specify minimum peak EIRP as per band with relaxed requirement compared to single-CC as ΔTIB,P,n = MBR.**  **Proposal 4: for UL inter-band CA power control in FR2, the existing behavior in 38.213 is assumed: the UE configures a PCMAX in an implementation-specific manner like for the intra-band case and relative power limits are used for controlling the power on the serving cells. PCMAX ≥ PCMAX,f,c for each configured serving cell *c* with PCMAX,f,c as specified in clause 6.2.4 with parameters MPR and A-MPR as specified per serving cell or modified as needed for the band combination (CA MPR).** |
| [**R4-2204576**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204576.zip) | Discussion on MOP relaxation of FR2 inter-band UL CA | Samsung | **Observation 1: MBR for single carrier operation does not fully reflect the transmission performance of CA concurrent operation**  **Proposal 1: relaxation due to CA concurrent operation should be considered besides MBR.**  **Observation 2: increased power consumption is practical implementation issue for FR2 power class 3 handheld UE which should be considered when specifying minimum requirements**  **Proposal 2: total power concept should be considered for FR2 power class 3 handheld UE when specifying the value of ΔTIB for inter-band UL CA.**  **Proposal 3: the MOP relaxation for inter-band UL CA should be comparable with that of intra-band CA, i.e. around 5dB.** |
| [**R4-2205123**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205123.zip) | Tx requirements for inter-band UL CA between different frequency groups based on IBM | Xiaomi | **Proposal 1: The relaxation for inter-band UL CA should be named as ΔTIB,P,n and ΔTIB,S,n for the min. peak EIRP and for the common EIRP spherical coverage to keep align with the relaxation name for inter-band DL CA.**  **Proposal 2: RAN4 should just define one set of common requirements for inter-band UL CA, how to implement inter-band UL CA should depend on the UE implementation.**  **Proposal 3: ΔTIB,P,n and ΔTIB,S,n for min peak EIRP and EIRP spherical coverage shall use the same value of ΔRIB,P,n and ΔRIB,S,n for the specific band combination as below table.**   |  |  |  |  | | --- | --- | --- | --- | | **NR CA band combinations** | **NR band** | **ΔTIB,P,n (dB)** | **ΔTIB,S,n (dB)** | | CA\_n257-n259 | n257 | 4.0 | 3.5 | |  | n259 | 4.0 | 3.5 | | CA\_n258-n260 | n258 | 3.5 | 3.5 | |  | n260 | 3.5 | 3.5 | | CA\_n260-n261 | n260 | 3.5 | 3.5 | |  | n261 | 3.5 | 3.5 | |
| [**R4-2205599**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205599.zip) | On RF requirements for FR2 inter-band UL CA | Huawei, HiSilicon | ∑ (min EIRPf,c-X/Y-Max(MPRf,c, MPRpa-pa))≤ P UMAX ≤ EIRP max + 3dB  P TMAX, ≤ TRP max  ***Proposal 1: Total power concept is considered either by the formula proposed above or by delta(TIB\_peak). TRP power for inter-band UL CA should not exceed the level for single band.***  ***Proposal 2: Before conclusion of SCell dropping solution for intra-band CA, no need to have further discussion on power control for FR2 UL inter-band CA case.*** |
| [**R4-2206057**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206057.zip) | Draft CR to 38.101-2 FR2+FR2 ULCA | Qualcomm, Nokia, Verizon, Docomo |  |

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| **T-doc number** | **T-doc name** | **Company** | **Proposals / Observations** |
| [**R4-2204228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204228.zip) | View on FR2 inter-band UL CA relaxation | MediaTek Beijing Inc. | ***Proposal1:*** *Total UE power concept factor shall be considered for relaxation value of FR2 inter-band UL CA.*  ***Observation:*** *Higher power class for higher total UE power can be further considered if there is demand.*  ***Proposal2:*** *Detailed factors and values for inter-band UL CA relaxation value calculation shall base on below table:*   |  |  |  | | --- | --- | --- | | # | Factor | X/Y relaxation | | #1 | MBR, insertion loss, and  common spherical coverage etc | ΔRIB,P,n – 1 dB  ∆RIB,S,n – 1 dB | | #2 | PA-PA interaction | 0 dB | | #3 | total UE (conductive) power | 3 dB | | #4 | Extra relaxation due to total power consumption concept | [0 to FFS] dB | |
| [**R4-2204928**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204928.zip) | R17 FR2 Inter-band UL CA requirements | OPPO | ***Observation 1: It is expected at least additional 1-2dB is needed to compensate the power consumption and thermal issues, while taking total power concept into account.***  ***Observation 2: It is not possible to use PMPR to solve thermal issues.***  ***Proposal 1: 2dB is considered in the peak EIRP and spherical coverage relaxation for the sake of thermal issues and control of total Tx power.***  ***Observation 3: 0.7dB relaxation is needed according to the multi-band relaxation.***  ***Proposal 2: Define 2.7dB relaxation (without considering the PA-PA interaction impacts) for min peak EIRP of each band in n257+n259 compared with single band requirements.***  ***Proposal 3: Define 4.7dB relaxation (without considering the PA-PA interaction impacts) for spherical coverage of each band in n257+n259 compared with single band requirements.*** |
| [**R4-2204942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204942.zip) | Discussion on iinter-band UL CA | vivo | **Observation 1:** The power sharing behavior, which is similar to FR1 CA, is hard to apply to FR2.  **Observation 2:** The device performance will be impacted by heat which lead to the transmitting power decrease.  **Observation 3:** The heat issue is not in the scope of P-MPR.  **Proposal 1:** 2 dB relaxation due to heat issue need to be included in CA relaxation.  **Proposal 2:** The △TIB for inter-band UL CA should be: △RIB – 1 dB + relaxation for total UE power.   |  |  |  |  | | --- | --- | --- | --- | | **NR CA band combination** | **NR band** | **ΔRIB,S,n (dB)** | **ΔRIB,P,n (dB)** | | n257-n259 | n257 | 4.5 | 4.5 | | n259 | 4.5 | 4.5 | | n260-n261 | n260 | 4.5 | 4.5 | | n261 | 4.5 | 4.5 | |
| [**R4-2205109**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205109.zip) | Discussion on relaxation value X&Y for CA\_n257A\_n259A | ZTE Corporation | **Observation 1: The X&Y relaxation for both min peak EIRP (ΔTIB,P,n)and EIRP spherical coverage(ΔTIB,S,n)should remove 1dB power imbalance margin.**  **Proposal 1: The relaxation for both min peak EIRP (ΔTIB,P,n)and EIRP spherical coverage(ΔTIB,S,n) i.e. X=Y=ΔRIB,P/S,n -1 dB.** |
| [**R4-2206054**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206054.zip) | delta(TIB) for FR2+FR2 ULCA | Qualcomm Incorporated | **Observation 1:** There are no globally applicable regulations that motivate a ‘total power concept’ relaxation.  **Observation 2:** A UE can self-limit UL power in the field using P-MPR, but the compliance verification condition for FR2 inter-band ULCA must be evaluated as possible motivation for peak EIRP relaxations.  **Observation 3:** In a compliance verification condition, FR2+FR2 inter-band ULCA is not uniquely challenging in terms of UE power consumption due to equivalence with FR2 intra-band DLCA operation.  **Observation 4:** There is neither regulation nor physical limitation that motivates further relaxation to delta(TIB\_peak) beyond the already agreed MBR component.  **Proposal 1: delta(TIB\_peak) = MBR**  **Proposal 2: For n257+n259 and n260+n261 PC3, delta(TIB\_spherical) = delta(TIB\_peak) + 2.0 dB**  **Proposal 3: For n257+n259 and n260+n261 PC5, delta(TIB\_spherical) = delta(TIB\_peak) + [0.5] dB**  **Observation 5:** The CA MPR proposal may require an additional meeting cycle to complete.  **Observation 6:** The single-band configured power requirement can serve as the template for an independent per-band configured power requirement for FR2+FR2 inter-band ULCA.  **Proposal 4: For FR2+FR2 inter-band ULCA, the configured power requirement shall be independent and per-FR2 band.** |

## Open issues summary

### Sub-topic 5-1:

**Issue 5-1: Band combo**

* Proposals
  + Option 1: UL CA\_n260-n261 is included in this WI in addition to CA\_n257-n259.
  + Option 2: Specify only CA\_n257-n259.
* Recommended WF
  + Option 1

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: Given operator interest, we prefer option 1. |
| Xiaomi | Option1, the UL CA\_n260-n261 should also be request in related basket WID. |
| vivo | We support option 1 |
| MediaTek | Option 1: Thanks for the operator makes demand very clear, i.e. “UL CA\_n260-n261 based on IBM.” |
| ZTE | In terms of the objectives of the NR\_RF\_FR2\_req\_enh2, only UL CA\_n257A-n259A was included..   * Inter-band UL CA [RAN4 RF/RRM]   + Specify requirements for inter-band UL CA for two bands between different frequency groups based on IBM.   + Define requirements for CA\_n257A-n259A based on IBM (Note this CA configuration will be moved to Basket WI in RAN#90 and more combinations may be added to Basket WI later).   + Both RF and RRM requirement aspects are in scope for UL interband CA.   If UL CA\_n260-n261 is included, the the procedure is a bit mess, the normal procedure for band combination should be operator request the combs before the meeting and be captured in revised WID, and then approved in the RAN plenery meeting. But we didn’t see the operators have such requests before the meeting. |
| LG Electronics | Support option 1.  We think, if CA\_n260-n261 is not completed in Rel-17, it can be treated in Rel-18 as Rel-17 leftover issue in FR2 RF enh. WI. And, we are open to discuss this under spectrum WI too. |
| Nokia | Support option 1. |
| Verizon | Support Option 1 |

**Issue 5-2: power class**

* Proposals
  + Option 1: PC3 is specified
  + Option 2: PC5 is specified.
  + Option 3: Both PC3 and PC5 are specified.
* Recommended WF
  + As there are concerns about total power for PC3, Moderator propose to exclude PC3 and focus on non-handheld device types such as PC1/PC2/PC4/PC5 and a possible new power class similar to PC3 but for non-handheld form factor like for laptops. The possible new power class is less affected by thermal/power/MPE issues and thus could maintain the PC3 EIRP/EIS requirement (without power concept but with CA relaxations).
  + Is it acceptable to specify PC1, PC2, PC4, PC5 and the new power class?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | We support the moderator’s WF proposal.  We think it is reasonable to limit this feature to UEs that can support it properly (‘less affected by thermal/power/MPE issues’) – otherwise requirements are diluted by hand-held UEs that may never support this feature anyway due to lack of use-case.  (Later clarification: A good point raised by companies is lack of requirements for DLCA for PC1/2/4/5. In our view, these UEs can support DLCA, but there is no verification testing for this feature. We are open to creating requirements for DLCA based on methodology used for PC3) |
| Samsung | We support the moderator’s recommended WF. One question is about the potential new power class. PC1/2/4/5 all already have single carrier requirements, for the potential new power class there is no single carrier requirements yet, it seems the work covers both single carrier requirements and CA requirements. For the potential new power class for non-handheld form factor like laptops, we think there should be no power supply limitation and form factor size limitation for this new power class, and only consider e.g. laptop in a whole as UE type, dongle type and embedded type may not be considered. |
| Xiaomi | We support the moderator’s WF proposal, but we have one concern, how about the DL CA for non-handheld UE? The requirements for FR2 inter-band DL CA for both IBM and CBM were discussing based on handheld UE. |
| DOCOMO | We don't support the moderator's WF proposal.  In our understanding, RAN4 has been discussing UL CA based on PC3 (Handheld) in the previous meetings. We cannot accept to exclude PC3 because we still think PC3 is one of use cases as a basic UE type and it is very difficult for us to decide to exclude possibility of PC3 deployment at this moment.  In addition, FR2 DL CA have been specified for PC3 only so far. If we introduce other PCs in UL CA, we need to introduce DL CA first.  It is true that there are concerns about total power with handheld device, so we agree to specify the requirements for handheld and non-handheld UE separately. We are open to discuss non-handheld UE requirements. However, we should continue to discuss PC3 as well, and we guess it would be better to focus on PC3 to complete this WI. |
| vivo | We are open for this issue. Our concern here is that the discussion before this meeting focus on the PC3, and the requirement of DL CA can be a reference for UL CA discussion, which can simplify the discussion. However, for other power class, we never discuss their CA requirement before. Even we can avoid the controversy on total UE power, we may need more analysis from beginning, e.g., simulation for common spherical coverage. |
| MediaTek | Thanks Moderator raise a fresh new thought. We are open for this brainstorming. We may also need to revisit current whole requirement framework. For example, current inter-band DL CA is based on PC3, and we don’t have inter-band DL CA for PC1/2/4/5 so far. If we go this proposal, the situation is like:   * Inter-band DL CA only: PC3 (so far) * Inter-band UL CA only: PC1/2/4/5/non-handheld ( & PC3 handheld is precluded)   Is my understanding correct? We also would like to understand operator’s view, because we still prefer to define corresponding requirement(s) for exact demand(s). |
| LG Electronics | Support the moderator’s WF. |
| OPPO | Up to now many efforts has been put on the inter band UL CA, and the analysis from companies mainly based on smartphone, we don’t understand the reason why now drop smartphone which is the most important UE type. If drop smartphone now, then need to understand better on when to specify them, is it planned to Rel-18? In our view, it can follow the normal path and strive to have some progress in Rel-17, in the end if cannot complete then postpone to Rel-18. |
| ZTE | Thanks for the moderator’s new thought. We have a question: is it possible to using different PC for UL CA and DL CA, i.e; DL CA (PC3) with UL CA(PC1/2/4/5)? if not, then PC1/2/4/5 DL CA requireents should be defined. |
| Sony | We agree with the moderator that focus on PC5/PC1 might be easier to go forward considering the deadlock situation for PC3. In addition, the inter band UL CA might be more meaningful for FWA/CPE devices than handheld UE at least in near term so it is fine to priorities the PC5 or PC1. |
| Huawei | We are ok to focus on the FWA/CPE firstly, but not all these power classes, PC5 or PC1 should have high priority. |
| SoftBank | Support Option 3. We appreciate to include the requirements for FWA/CPE devices in the spec, but we do not support to exclude PC3 at this time. And we have the same question of MediaTek and ZTE, is it possible to use the difference PC among DL and UL? |
| Nokia | We think that UL CA feature would be implemented first in CPE, FWA and Module for laptops or tablets, which should be prioritized in this WI. At least PC5 should be specified, then PC1 and possibly a laptop type UE should be considered. |
| Verizon | We support Option 3.  We agree UL CA feature would be implemented first in CPE, FWA and module for other devices. |
| Apple | We are fine with following the moderator proposal to first focus on non-handheld devices. |

**Issue 5-3: total power concept for PC3**

* Proposals
  + Option 1: not needed
  + Option 2: 1 dB
  + Option 3: 2 dB
  + Option 3: 3 dB or more
  + Option 4: TRP power for inter-band UL CA should not exceed the level for single band
  + Option 5: Others (please specify)
* Recommended WF
  + Moderator suggests focussing on non-hand-held power classes. Is it acceptable to skip PC3 issues 5-3, 5-5, 5-6, and 5-7?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Support moderator WF, ok to skip hand-held UE. There may be table-top PC3 UEs that can support this feature however, without the challenge of power consumption.  (Later clarification:). Option 1: There is no regulatory justification for ‘total power concept’. We have also shown (06054) that during compliance testing, the power consumption challenge for inter- ULCA is equivalent to DLCA testing, so compliance testing does not require ‘Total power concept’ either. |
| Samsung | Support moderator recommended WF. |
| Xiaomi | Support moderator WF.  If continue consider UL CA for PC3, support Option2 and Option 3, |
| DOCOMO | We do not support to skip PC3.  We prefer option 1, but we can accept the others if it is needed. |
| vivo | We support option 3, either 2 dB or 3 dB relaxation is OK for us. |
| MediaTek | We are fine to detailly discuss ***Issue 5-2: power class*** firstly. |
| LG Electronics | Support the moderator’s WF. |
| OPPO | Option 3 is used in our analysis. |
| ZTE | Similar with MTK, discuss issue 5-2 first. |
| Ericsson | Option 1. |
| Sony | Option 1 not needed is our preference, but we also support moderator’s proposal.  Regarding the heating issue, it is an implementation issue in our view and UE can use P-MPR in real life to mitigate it. For the possible issue in the test without P-MPR, we see it as a testability issue, and we should not compromise the minimum requirement due to such an issue. |
| Huawei | Prefer option 4, and option 3 can also be considered. |
| Nokia | We support skipping PC3.  If PC3 is not skipped, we support option 1. |
| Verizon | Option 1  Do not skip PC3 |
| Apple | We are fine with moderator proposal to focus on non-handheld devices first. If the discussion around PC3 continues, then we also not OK to proceed with the total power concept (Option 1). |

**Issue 5-4: total power concept for other than handheld device types (i.e., such as PC1/2/4/5 and a new PC)**

* Proposals
  + Option 1: not needed
  + Option 2: still needed
  + Option 3: Others (please specify)
* Recommended WF
  + Moderator suggests Option 1

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: We found no regulatory need, and no need during compliance testing based on power consumption [R4-2206054] (Tdoc # corrected as part of a later commenting round) |
| Samsung | For the potential new power class for non-handheld form factor like laptops, we think there should be no power supply limitation and form factor size limitation for this new power class, and only consider e.g. laptop in a whole as UE type, dongle type and embedded type may not be considered. otherwise there is also total power issue |
| Xiaomi | need consider PC by PC and case by case |
| vivo | In our understanding, the intention for total UE power is to expect FR2 UE behave to be similar to FR1 UE in CA case, i.e., the power level of each CC will drop proportionally with the increase in the number of CCs. From this perspective, this concept is also need for other power class.  However, this behavior is hard to apply to FR2 UE directly because the FR2 power class is not defined on conduct domain and only have lower limit. This behavior has two main benefits, one is to avoid SAR issue, and the other is to avoid too high power consumption.  For FR2 UE, the SAR (or MPE) issue can be addressed by P-MPR, so maybe we can only consider the relaxation for power consumption. If other PC not need to consider the power consumption issue, we prefer option 1. |
| MediaTek | Option 3: If we no need to worry practical UE feasibility (# still based on Issue 5-2 discussion), it makes thing simpler. Just a neutral open issue for discussion, we may still discuss do we wanna keep similar power class concept as LTE/FR1:   * If yes, we may still define -3 dB per band for original PC, but may create a new PC for the demand don’t wann -3 dB per band. For example:   + PC5 UL CA: -3 dB per band   + PC5**\_plus** UL CA: w/o -3 dB per band * If no, FR2 would have different definition from LTE/FR1. For example:   + PC5 & no support UL CA: single-band requirement   PC5 & support UL CA: still as single-band requirement (no -3dB), and the total power would be +3dB while UL CA active. |
| OPPO | Option 3. It should be clear which specific UE type is referring. The thermal and heating issue could be better for UEs that are larger and have power supply, but it needs to be analyzed case by case. |
| ZTE | Discuss issue 5-2 first. But if we need to choose one of the options, we prefer Option 1 since the total power concept is not appropriate for FR2. In addition, there are no additional regulatory restrictions. |
| Sony | Option 1 not needed. |
| Huawei | Even not for handheld UE, it should still need further study case by case. |
| Nokia | Support option 1 for all the power classes. |

**Issue 5-5: PC3 Peak EIRP relaxation relaxations** ΔTIB,P,n **for CA\_n257-n259**

* Proposals
  + Option 1: ΔTIB,P,n = MBR (Qualcomm, Sony)
  + Option 2: ΔTIB,P,n = ΔRIB,P,n -1 dB (ZTE)
  + Option 3: 2.7 dB (OPPO)
  + Option 4: 4.0 dB (Xiaomi)
  + Option 5: 4.5 dB (vivo)
  + Option 6: Around 5 dB (Samsung)
  + Option 7: ΔRIB,P,n – 1 + 3 + FFS dB (MediaTek)
* Recommended WF
  + Moderator suggests focussing on non-hand-held power classes. Is it acceptable to skip PC3 issues 5-3, 5-5, 5-6, and 5-7?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1  Many of these options may not be relevant for non-band-held.  As a general rule, we prefer to stay consistent with the spirit of the previous WF, i.e. align on physical mechanisms and analysis rather than use subjective arguments.  Moreover, given FR2 is UL limited, this feature becomes rapidly self-limiting with large relaxations in EIRP due to TRP reduction. Inter- ULCA would be an optional capability, so defining it in a way that does not guarantee significant network benefit means there would be inefficient use of network resources, which would impact better performing UEs also. |
| Samsung | Support moderator recommended WF. |
| Xiaomi | Support the moderator’s WF |
| DOCOMO | We do not support to skip PC3.  We prefer option 1, but we can accept the additional relaxation for total power concept if it is needed. Additional relaxation is based on the agreement of issue 5-3. |
| vivo | We support option 5 and option 6. 4.5 dB =ΔRIB,P,n -1 dB + 2 dB (relaxation for total UE power)  For option 7, in our understanding, if we introduce 3 dB relaxation for total UE power, the further relaxation on power consumption is not needed. |
| MediaTek | We are fine to detailly discuss ***Issue 5-2: power class*** firstly. |
| LG Electronics | Support the moderator’s WF. |
| OPPO | Option 2 in our analysis, also ok with Option 4/5/6 |
| ZTE | Discuss issue 5-2 first. But if we need to choose one of the options, we prefer Option 2 as we proposed. However, we are fine with Option 1 as well. |
| Sony | Option 1, but also fine with moderator suggestion |
| Huawei | Ok with the moderator WF. |
| Nokia | We support skipping PC3.  If PC3 is not skipped, we support option 1. |

**Issue 5-6: PC3 EIRP spherical coverage relaxation relaxations** ΔTIB,S,n **for CA\_n257-n259**

* Proposals:
  + Note: Please check the common spherical coverage relaxation in WF3 from the last meeting R4-2202343, where we discussed delta, ΔTIB,S,n - ΔTIB,P,n
  + Option 1: ΔTIB,S,n = ΔTIB,P,n + 2 dB (Qualcomm, OPPO)
  + Option 2: ΔTIB,S,n = ΔTIB,P,n - ΔRIB,P,n + ΔRIB,S,n (Sony, ZTE, Mediatek)
  + Option 3: ΔTIB,S,n = ΔTIB,P,n - 1 dB (Xiaomi)
  + Option 4: ΔTIB,S,n = ΔTIB,P,n (vivo)
* Recommended WF
  + Moderator suggests focussing on non-hand-held power classes. Is it acceptable to skip PC3 issues 5-3, 5-5, 5-6, and 5-7?
  + However, the proposed delta, ΔTIB,S,n - ΔTIB,P,n, is in the range [-1.0 … 2.0] dB.

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1: support  We prefer to stay consistent with the spirit of the previous WF, i.e. use a relaxation structure based on physical mechanisms. In option 2, because of the way delta(RIB\_p) and delta(RIB\_sph) are defined, there would be no relaxation for coverage misalignment in delta(TIB\_s). That would indirectly demand better single band spherical coverage of the UE than what will be carried over as the requirement for single band from Rel-16. |
| Samsung | Support moderator recommendation about focussing on non-hand-held power classes |
| Xiaomi | Support the moderator’s WF |
| DOCOMO | We do not support to skip PC3. We support option 1. |
| MediaTek | We are fine to detailly discuss ***Issue 5-2: power class*** firstly. |
| LG Electronics | Support the moderator’s WF. |
| OPPO | Option 1 in our analysis. |
| ZTE | Discuss issue 5-2 first. But if we need to choose one of the options, we prefer Option 2 as we proposed. |
| Sony | We think for UL spherical coverage relaxation, it should be **DL relaxation ΔRIB,S,n -1 dB,** which excludes the PSD imbalance impact which is only matters for DL. But we are fine to skip PC 3 as moderator suggested as well. |
| vivo | For n257-n259, ΔRIB,P,n is equal toΔRIB,S,n. so option 2 is same with option 4. We can accept either option. |
| Huawei | Ok with the moderator WF. |
| Nokia | We support skipping PC3.  If PC3 is not skipped, we support option 1. |

**Issue 5-7: PC3 relaxations** ΔTIB,P,n **and** ΔTIB,S,n **for CA\_n260-n261**

* Proposals
  + Option 1: the same as CA\_n257-n259 (Qualcomm, vivo)
  + Option 2: ΔTIB,S,n = ΔTIB,P,n = 3.5 dB (Xiaomi)
  + Option 2: others
* Recommended WF
  + Moderator suggests focussing on non-hand-held power classes. Is it acceptable to skip PC3 issues 5-3, 5-5, 5-6, and 5-7?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1 |
| Samsung | Support moderator recommended WF. |
| DOCOMO | We do not support to skip PC3. We support option 1. |
| vivo | Option 1 is preferred. |
| MediaTek | We are fine to detailly discuss ***Issue 5-2: power class*** firstly. |
| LG Electronics | Support the moderator’s WF. |
| OPPO | Option 1. |
| ZTE | We fully understand the operator's desire, but as stated in issue 5-1, it doesn't seem very procedural to do so. Maybe it's more appropriate to discuss this issue after we've decided to introduce CA n260-n261? |
| Sony | Option 1. |
| Huawei | Ok with the moderator WF. |
| Nokia | We support skipping PC3.  If PC3 is not skipped, we support option 1. |
| Verizon | Option 1  We also do not support to skip PC3 |

**Issue 5-8: Peak EIRP relaxations** ΔTIB,P,n **for CA\_n257-259 and CA\_n260-n261 for non-handheld power classes**

* Proposals
  + Option 1: ΔTIB,P,n = MBR (Qualcomm)
  + Option 2: others
* Recommended WF
  + Can each company provide the proposed min peak EIRP relaxations, ΔTIB,P,n, of non-handheld power classes for CA\_n257-259 and CA\_n260-n261 without assuming total power concept?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1 |
| Samsung | Option 2. Besides MBR, CA concurrent operation is also a relaxation factor. |
| vivo | Option 2, other degradation form hardware design also needs more analysis, e.g., insertion loss. |
| MediaTek | It’s better that we achieve consensus on ***Issue 5-2: power class*** firstly. Currently, we think Option1 is not agreeable. For us, Option1 means no degradation due to inter-band CA, because MBR is already existed even for non-CA operation. |
| LG Electronics | Option 2. Same view with Samsung. |
| OPPO | Option 2, FFS, up to now our analysis only focus on PC3 smartphone and need FFS for other UE types. |
| ZTE | Option 2. Similar with 5-7. |
| Sony | Option 1 |
| Huawei | Option 2. Some additional relaxation may still be needed. |
| Nokia | Option 1. |
|  |  |

**Issue 5-9: EIRP spherical coverage relaxation relaxations** ΔTIB,S,n **for CA\_n257-259 for non-handheld power classes**

* Proposals
  + Option 1: ΔTIB,S,n = ΔTIB,P,n + [0.5] dB (Qualcomm)
  + Option 2: Others (please specify)
* Recommended WF
  + Assuming ΔTIB,S,n = ΔTIB,P,n + Roverlap dB, can each company provide a budget for Roverlap of non-handheld power classes for CA\_n257-259 and CA\_n260-n261 without assuming total power concept?

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Agree with moderator WF.  Option1 would work for PC1 and PC5, but we are open to discussion, or to wait for other companies that may want to contribute. We have not analyzed PC2 and PC4, so we would like to scale back the scope of the proposal to just PC1/5. |
| vivo | Agree with moderator WF.  0.5 dB may not enough for all PC and this may also depend on the assumption of antenna array. |
| MediaTek | We are positive on the concept because of extra common coverage request for spherical coverage compared to peak. |
| LG Electronics | Support the moderator’s WF. Roverlap is open for non-handheld power classes(PC1/2/4/5). |
| OPPO | Option 2, FFS, up to now our analysis only focus on PC3 smartphone and need FFS for other UE types. |
| ZTE | We prefer to leave this issue FFS. For now, we should focus on the PC3 issue first. |
| Sony | Our simulations in [R4-2204037](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204037.zip) shows 0.7 dB relaxation for common spherical coverage for PC5, it is very similar to option 1 anyway, so we are also fine with option 1 as well. |
| Huawei | OK with the moderator WF, further discussion on the specific value. |
| Nokia | Option 1. Roverlap = [0.5] dB |

**Issue 5-10: CA MPR**

* Proposals
  + Option 1: The CA MPR proposal may require an additional meeting cycle to complete. (Qualcomm)
  + Option 2: Others (please specify)
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 1  We would like to request the group to consider extending by one meeting cycle for completion by June plenary.  (Later clarification:) We will leave it up to the rapporteur, but in our view this particular WI objective needs some more time – this could be accomplished as part of an exceptions list.  CA\_MPR being discussed here is as agreed in the WF – it applies independently of delta(TIB). It would be in 6.2A.2, not 6.2A.1 |
| vivo | OK with option 1. |
| MediaTek | Not sure the meaning from 3GPP process view. For example, does it mean exception list? or WI extension? or others? Could proponent clarify it? |
| OPPO | For clarification, is the CA MPR discussed here only for the power class definition (peak EIRP/Spherical) or it is for MPR section? |
| Huawei | If the requirements cannot be completed in Mar RAN, is it still be in Rel-17 scope? This should be some kind of RAN level discussion. |
| Nokia | We are fine with CA MPR proposal that Qualcomm made last meeting. If it is necessary to evaluate the MPR more, WI would need to be extended. |

**Issue 5-11: Power Control**

* Proposals
  + Option 1: **for UL inter-band CA power control in FR2, the existing behavior in 38.213 is assumed: the UE configures a PCMAX in an implementation-specific manner like for the intra-band case and relative power limits are used for controlling the power on the serving cells. PCMAX ≥ PCMAX,f,c for each configured serving cell *c* with PCMAX,f,c as specified in clause 6.2.4 with parameters MPR and A-MPR as specified per serving cell or modified as needed for the band combination (CA MPR). (Ericsson)**
  + Option 2: ***Before conclusion of SCell dropping solution for intra-band CA, no need to have further discussion on power control for FR2 UL inter-band CA case. (Huawei)***
  + Option 3: **For FR2+FR2 inter-band ULCA, the configured power requirement shall be independent and per-FR2 band. (Qualcomm)**
  + Option 4: Others (Please specify)
* Recommended WF
  + TBD

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |
| Qualcomm | Option 3: support  Option 1 presumes a power sharing across the bands, the regulatory motivation for which remains unidentified.  (Later clarification:) This WI covers ULCA with IBM, which is a multi-chain implementation. It is not known whether ULCA is even feasible at all for CBM with shared hardware. We therefore do not think single-band considerations should influence the decision here.  Further, option 1 will require a multi-band PUMAX EIRP inequality which is not feasible.  To oppo: If you recall, the discussion for NR-DC referred to the outcome of the inter-ULCA discussion. It needs to be resolved here first before we can resolve in [142]. |
| vivo | Option 4. For now, we only discuss the UL CA with IBM and we are not for sure whether the CBM will have some impact on the power control issue. We prefer not to make any decision for now. |
| MediaTek | There is a similar topic in “13.2.1 FR2 power control for NR-DC” of “[102-e][142] NR\_reply\_LS\_UE\_RF” discussion, if our understating correct.  In our understanding, while the UE is single-chain, the power control would be not independent for example.  Of course, our original motivation to propose “total power concept” is for min requirement discussion, not for real time power control behavior. |
| OPPO | If the issue is about SCC dropping, then Option 2.  If the issue is about independent power control or not, it is covered in thread [142] and no discussion is needed here, especially regarding Option 3. |
| Ericsson | Option 1 is power control according to the existing 38.213. It is based on that the UE prioritizes transmissions according to clause 7.5 of 38.213. We assume that the UE will scale/prioritize similarly to the intra-band UL CA case that is subject to the same rule.  Remark: for EN-DC (FR1 + FR2) the behavior is unspecified, priority all up to UE implementation. Not straightforward to handle in deployments. |
| Huawei | It seems the intention of the proposal is not clear to all companies, clarification is needed if that is only for SCell dropping issue. |
| Nokia | Option 1. |
| Apple | Option 3, assuming UL CA with IBM |

**Issue 5-12: Draft CR comment collection**

* Proposals
  + Use R4-2206057 as a baseline draft CR for FR2 UL CA feature
* Recommended WF
  + Companies are encouraged to provide comments, especially for issues not listed above, for further update of the draft.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Samsung | If it is agreed to skip PC3 and only focusing on non-handheld UE, corresponding revision is needed. |
| vivo | In R4-1902256, we have an agreement on beam correspondence for inter-band CA  *For inter-band CA in FR2, beam correspondence relationship is considered to be different across CCs within different bands.*  Maybe we should record the agreement in the spec together.  To Qualcomm:  This statement means that the BC capability can be different for each band, which is the opposite of description of intra-band CA. The meaning is aligned with IBM, but for CBM, this agreement seems not applicable. |
| LG Electronics | Same view with Samsung. |
| Qualcomm | For Vivo: would you clarify if the meaning of that statement is different from IBM? |

## 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.*

|  |  |  |
| --- | --- | --- |
| **CR/TP number** | **CR/TP name** | **Comments collection** |
|  |  | Company A |
|  |
|  |
|  |
|  |

## Summary for 1st round

GTW outcome

* **Issue 5-1: Band combo**
* **Agreement:** RAN4 recommends to include UL CA\_n260-n261 is included in this WI in addition to CA\_n257-n259.

**Issue 5-2: power class**

**Agreements:** Focus on the common requirements (i.e., MPR and power control) of PC1/2/3/4/5 and Delta\_TIB values of PC1/2/4/5, and afterwards discuss the PC3 specific requirements (i.e., Delta\_TIB values and total power issue).

* The power class cannot be supported without finalized the requirements including Delta\_TIB.
* **Issue 5-4: total power concept for other than handheld device types (i.e., such as PC1/2/4/5 and a new PC)**

**Agreement:** The total power concept is not applied for power classes such as PC1/2/5.

* FFS include new power class
* Further check the MPE regulation for FWA/CPE.

**Issue 5-11: Power Control**

**Agreement:** Focus on inter-band UL CA across the different frequency group for power control.

### Open issues

*None*

### CRs/TPs

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

|  |  |  |
| --- | --- | --- |
| **CR/TP number** | **CR/TP name** | **CRs/TPs Status update recommendation** |
|  |  |  |

## Discussion on 2nd round (if applicable)

Continue under DL CA WF email discussion initiated by Qualcomm.

Finally all comments from WFs will be transferred into this summary.

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF for FR2 DL CA | Nokia |  |
| WF for FR2 UL CA | Qualcomm Inc. |  |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| [**R4-2204787**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204787.zip) | TR 38.851 v0.4.0 | Nokia, Nokia Shanghai Bell | Approve |  |
| [**R4-2203700**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203700.zip) | Simultaneous Rx/Tx for DL inter-band CA | Apple | Moved to other thread |  |
| [**R4-2204361**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204361.zip) | Sensitivity requirements for inter-band DL CA with CBM | NTT DOCOMO, INC. | Noted |  |
| [**R4-2204789**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204789.zip) | Addition of downlink CA feature for CBM UEs and one band combination for IBM UEs | Nokia, Qualcomm | Return to |  |
| [**R4-2204035**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204035.zip) | UE requirements for CBM for the same frequency group | Sony, Ericsson | Noted |  |
| [**R4-2204143**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204143.zip) | Discussion on CBM based inter-band DL CA within same frequency group | LG Electronics | Noted |  |
| [**R4-2204229**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204229.zip) | Fs\_inter and view on FR2 inter-band DL CA within same frequency group based on CBM | MediaTek Beijing Inc. | Noted |  |
| [**R4-2204927**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204927.zip) | R17 FR2 CBM inter-band DL CA | OPPO | Noted |  |
| [**R4-2204940**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204940.zip) | Discussion on requirement of n258-n261 | vivo | Noted |  |
| [**R4-2205122**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205122.zip) | Discussion on inter-band DL CA with CBM | Xiaomi | Noted |  |
| [**R4-2205598**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205598.zip) | On RF requirements for FR2 Inter-band DL CA with CBM | Huawei, HiSilicon | Noted |  |
| [**R4-2206055**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206055.zip) | On delta(RIB) for n258+n261 DL inter-CA | Qualcomm Incorporated | Noted |  |
| [**R4-2203699**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203699.zip) | FR2 Sensitivity requirements for inter-band CBM | Apple | Noted |  |
| [**R4-2204036**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204036.zip) | Requirements for CBM UEs between different frequency group | Sony, Ericsson | Noted |  |
| [**R4-2204230**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204230.zip) | Reference signal, and relaxation value about FR2 inter-band DL CA between different frequency groups based on CBM | MediaTek Beijing Inc. | Noted |  |
| [**R4-2204575**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204575.zip) | Discussion on requirements of FR2 inter-band DL CA | Samsung | Noted |  |
| [**R4-2204612**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204612.zip) | Introduction of requirements for DL inter-band CA for CBM-capable UEs | Ericsson, Sony | Return to |  |
| [**R4-2204941**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204941.zip) | Discussion on CBM between different frequency group | vivo | Noted |  |
| [**R4-2206056**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206056.zip) | On delta(RIB) for DL inter-CA with CBM in n260+n261 | Qualcomm Incorporated | Noted |  |
| [**R4-2204790**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204790.zip) | Discussion on UE Rx beam switch delay | Nokia, Nokia Shanghai Bell | Noted |  |
| [**R4-2203814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2203814.zip) | Introduce FR2 n260 and n261 uplink CA | Verizon Denmark | Noted |  |
| [**R4-2204037**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204037.zip) | UE UL CA requirements based on IBM | Sony, Ericsson | Noted |  |
| [**R4-2204576**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204576.zip) | Discussion on MOP relaxation of FR2 inter-band UL CA | Samsung | Noted |  |
| [**R4-2205123**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205123.zip) | Tx requirements for inter-band UL CA between different frequency groups based on IBM | Xiaomi | Noted |  |
| [**R4-2205599**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205599.zip) | On RF requirements for FR2 inter-band UL CA | Huawei, HiSilicon | Noted |  |
| [**R4-2206057**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206057.zip) | Draft CR to 38.101-2 FR2+FR2 ULCA | Qualcomm, Nokia, Verizon, Docomo | Return to |  |
| [**R4-2204228**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204228.zip) | View on FR2 inter-band UL CA relaxation | MediaTek Beijing Inc. | Noted |  |
| [**R4-2204928**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204928.zip) | R17 FR2 Inter-band UL CA requirements | OPPO | Noted |  |
| [**R4-2204942**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2204942.zip) | Discussion on iinter-band UL CA | vivo | Noted |  |
| [**R4-2205109**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2205109.zip) | Discussion on relaxation value X&Y for CA\_n257A\_n259A | ZTE Corporation | Noted |  |
| [**R4-2206054**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_102-e/Docs/R4-2206054.zip) | delta(TIB) for FR2+FR2 ULCA | Qualcomm Incorporated | Noted |  |

Notes:

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

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-211xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-211xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-211xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents

# Annex

Contact information

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email address** |
|  |  |  |

Note:

1. Please add your contact information in above table once you make comments on this email thread.
2. If multiple delegates from the same company make comments on single email thread, please add you name as suffix after company name when make comments i.e. Company A (XX, XX)