**3GPP TSG-RAN WG4 Meeting # 95-e R4-2008313**

**Electronic Meeting, 25 May – 5 Jun., 2020**

**Agenda item:** 6.14.1.3, 6.14.1.5, 6.14.1.9

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion summary for [95e][123] NR\_RF\_FR2\_req\_enh\_Part\_3

**Document for:** Information

# Introduction

This document is intended to capture companies’ views on contributions in the following agenda items.

6.14.1.3 Intra-band non-cont DL CA for aggregated BW larger than 1400 MHz

6.14.1.5 Inter-band DL CA

6.14.1.9 Radiative degradation mechanisms for wide frequency separation (‘Beam squint’)

List of candidate targets for first round of discussion in agenda 6.14.1.3:

1. Final details of DL-only spectrum for e DL CA
2. Granularity of relaxation to REFSENS as a function of combined DL-only spectrum, also relaxation values

List of candidate targets for first round of discussion in agenda 6.14.1.5:

1. UE capability signalling (Independent vs common beam management)
   1. Is it beneficial?
   2. How to ensure networks can deliver intra-band MRTD for common BM
2. Quantifying spherical coverage
3. REFSENS/EIS requirements discussion, focusing on PSD during test

List of candidate targets for first round of discussion in agenda 6.14.1.9:

1. Simulation assumptions
2. Which parameters to quantify degradation?

# Topic #1: Intra-band non-cont DL CA

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2006567**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006567.zip) | On understanding of CC allocations in FR2 intra-band non-contiguous DL CA | Intel Corporation | Observation 1: UL spectrum is the frequency range within which UL CCs are confined. UL spectrum is the same with bidirectional spectrum.  Observation 2: UL CCs are strictly confined within UL spectrum, with additional UL frequency separatin class (UL Fs) restriction.  Observation 3: When UL Fs < DL Fs, DL only spectrum seems no longer needed.  **Proposal 1: RAN4 needs to clarify if a DL CC is allowed to be scheduled across the boundary of DL only spectrum and bidirectional spectrum for intra-band DL CA.** |
| [**R4-2006631**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006631.zip) | CR to 38.101-2 on REFSENS for intra-band non-contiguous CA for FR2 | Apple Inc. | |  |  | | --- | --- | | **Cumulative Aggregated Channel BW (MHz)** | **ΔRIB (dB)** | | ≤ 800 | 0.0page100image25314432 | | > 800 and ≤ 1400 | 0.5 | | > 1400 and ≤ 2400 | 1.0 | |
| [**R4-2008154**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008154.zip) | On intra-band NC DL CA\_FR2 | Huawei, HiSilicon | ***Proposal 1: one sided DL only spectrum should be more general which follow the definition in TS 38.331, the common part for both UL and DL can be unequal on the separation class indication.***  ***Proposal 2: frequency gap between DL-only spectrum and bidirectional spectrum should be allowed.***  ***Proposal 3: separation class signaling shall be enhanced with following 2 aspects:***   * ***1 bit to indicate whether there is DL-only spectrum limitation*** * ***If UE have DL-only limitation, need to Indicate the DL-only separation class supported by complementary receiving chain***   ***Proposal 4: RAN4 define separation class and DL-only separation class as below:***  **Frequency separation classes for non-contiguous intra-band operation**   |  |  | | --- | --- | | **Frequency separation class** | **Frequency separation (Fs)** | | I | Fs ≤ 800 MHz | | II | Fs ≤ 1200 MHz | | III | Fs ≤ 1400 MHz | | IV | Fs ≤ 1000 MHz | | V | Fs ≤ 1600 MHz | | VI | Fs ≤ 1800 MHz | | VII | Fs ≤ 2000 MHz | | VIII | Fs ≤ 2200 MHz | | IX | Fs ≤ 2400 MHz | | X | Fs ≤ 400 MHz | | XI | Fs ≤ 600 MHz | | NOTE 1: Fs values larger than 1400 MHz apply only to downlink frequency separation. | |   **Frequency separation classes for DL-only spectrum**   |  |  | | --- | --- | | Frequency separation class | Frequency separation (Fsd) | | I | Fsd ≤ 200 MHz | | II | Fsd ≤ 400 MHz | | III | Fsd ≤ 600 MHz | | IV | Fsd ≤ 800 MHz | | V | Fsd ≤ 1000 MHz | | VI | Fsd ≤ 1200 MHz | | VII | Fsd ≤ 1400 MHz | | VIII | Fsd ≤ 1600 MHz | | IX | Fsd ≤ 1800 MHz | | X | Fsd ≤ 2000 MHz | |

## Open issues summary

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

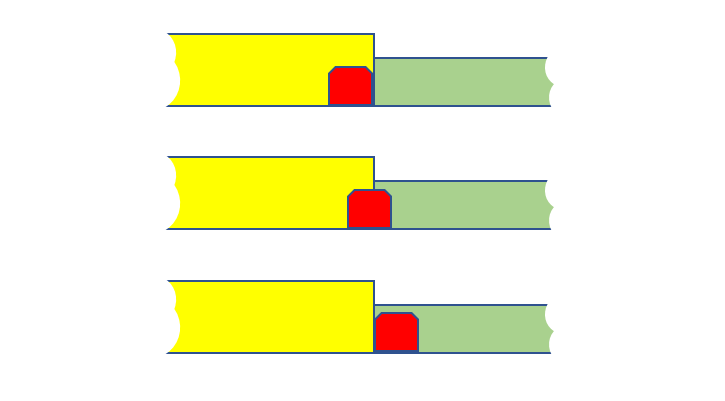
### Sub-topic 1-1

*Sub-topic description:* DL CC location restriction

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

**Issue 1-1: Should the network be restricted from scheduling a DL CC across the boundary of DL only spectrum and bidirectional spectrum for intra-band DL CA**

DL CC locations relative to boundary of bidirectional spectrum and DL-only spectrum



### Sub-topic 1-2

*Sub-topic description:* Gap in DL spectrum coverage

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

**Issue 1-2:**  Do we revert previous agreement (R4-1913042) that the UE’s combined DL spectrum capability shall be contiguous (no gaps).?

* Proposals
  + Option 1: yes
  + Option 2: (no change if no consensus)
* Recommended WF
  + This topic was discussed in the previous meeting with no consensus to change agreement to introduce gap. Assume unchanged outcome here (option #2) so we can proceed with the other details of this feature

### Sub-topic 1-3

*Sub-topic description*: Fsd=0 case

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

**Issue 1-3:** *:* How to treat case when UE has no DL-only spectrum

* Proposal (Y/N)
  + Fsd signalling is optional and can be used by UEs that need to signal non-zero Fsd
* Recommended WF
  + Adopt proposal

### Sub-topic 1-4

*Sub-topic description:* REFSENS relaxation (Moderator note: Proposal in R4-2006631 has been reframed to focus on relaxation for 2400 MHz combined DL spectrum)

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

**Issue 1-4:** REFSENS requirement relaxation for combined DL spectrum range (DL Fs+Fsd) that includes 2400 MHz is 1 dB

## Companies views’ collection for 1st round

### Open issues

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| 1-1: Should the network be restricted from scheduling a DL CC across the boundary of DL only spectrum and bidirectional spectrum for intra-band DL CA | Y/N | Intel: Prefer “Yes”  Nokia: Yes  MediaTek: Yes  OPPO: From scheduling flexibility it should be allowed to schedule DL CC across the boundary in case the DL only spectrum and bidirectional spectrum is continuous.  Huawei: Yes, DL CC cannot configured across the boundary if for UEs with DL-only spectrum limitation. So there is also configuration limitation for one-sided DL only UE which analyzed in my papers. |
| 1-2: Revert agreement (R4-1913042) of contiguous UE DL spectrum capability to include gaps? | Y/N | Intel: No  Samsung: No. it is a waste of spectrum to allow a gap.  Nokia: No  LGE : No  MediaTek: No. It needs another signaling parameter for the gap.  Huawei: Firstly, in R4-1913042, we don’t see any agreement on whether there is a gap between DL-only and bidirectional spectrum. So, the wording “revert” is ambiguous.  Secondly, even 2400MHz is the maximum separation class in the agreement, we can see the aggregated channel bandwidth=2400MHz configurations in the current g30 spec. allowing gap would be the explanation for such configurations.  Thirdly, from implementation perspective, we would like to clarify, what is the difference on complexity or cost or performance between allowing gap and not allowing gap? We don’t see any difference, then why we don’t allow?  To Samsung, what do you mean by waste of spectrum? The gap spectrum may not belong to the current licensee.  Qualcomm: No  Apple: We support to keep the agreement, making the change at this stage will harm the progress being made. |
| 1-3: Fsd = 0 case | Fsd signalling is optional and can be used by UEs that need to signal non-zero Fsd (Y/N) | Intel: Yes  Samsung: Yes  Nokia: Yes  LGE: Yes  MediaTek: Yes.  OPPO: ok with the proposal  Huawei: Yes. My paper discuss on this issue and the specific signaling design. It is not an enhancement, the signaling need to reflect this.  Apple: Ok to make Fsd signaling optional for Fsd = 0. |
| 1-4: REFSENS requirement relaxation for combined DL spectrum range (DL Fs+Fsd) that includes 2400 MHz is 1.0 dB | Y/N | MediaTek: We are okay with 1.0 dB relaxation for the frequency separation in the range between 1400 MHz and 2400 MHz.  OPPO: Yes  Huawei: 1) why relaxation is needed for DL-only UE with combined Fs+Fsd? The relaxation comes from common antenna, it already considers in single carrier requriment.  2) seems the relaxation should define for Fs only.  3) f  Apple: In R4-20066331, we have proposed 1 dB REFSENS relaxation between 1400 and 2400 MHz. |
| Co-located assumption of CCs in intra-band DL CA |  | **Verizon: Yes or NO!**  Although we agree the intra-band non-contiguous CA could be in collocated and under CBM discussion, it should not be only an assumption for the intra-band FR2 CA.  In fact, the FR2 spectrum is wide enough and applies different power classes applied. Thus, non-collocated intra-band CA could also be one of scenarios in operation for both indoor (PC3) and outdoor (PC1 and PC4) applications.  So far, not all of applications have been fully explored in applications along with the defined power classes. |
| CBM IBM for intra-band DL CA |  | **Verizon:**  Both CBM and IBM should be also applied to intra-band capability signalling framework. In our view, the non-collocated intra-band CA is also one of scenarios in operation for both indoor (PC3) and outdoor (PC1 and PC4) applications. |

### 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.*

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Company Comments** |
| [**R4-2006632**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006632.zip) | [draft] LS to RAN2 on DL-only separation class | Apple Inc. | Intel:  CR needs a revision to consider how to signal Fsd = 0.  1) If Fsd is optional signalling, need to indicate Fsd is optional clearly to RAN2  2) If Fsd is not optional signalling, need Fsd = 0 in the table.  In the table ‘Fs ≤’ is redundant, need to be removed.  Samsung:  Agree with Intel that consensus on Fsd=0 issue should be achieved in group firstly.  MediaTek:  Agree with Intel.  OPPO: For clarification, is the intention to introduce this signalling from Rel-15 by saying “The signalling shall be implemented in addition to the signalling of frequency separation (Fs) from Rel-15”?  Huawei: 1) no description on the UEs with no limitation on DL-only, for such UEs, Fsd does not need to define. 2) gap between Fs and Fsd should be allow, or companies have concern should provide the reason why gap is not allowed. |
| [**R4-2006634**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006634.zip) | CR to 38.101-2 on FR2 frequency separation class enhancement | Apple Inc., Nokia, Nokia Shanghai Bell, Qualcomm Incorporated | Intel:  If Fsd is not an optional signalling, need Fsd = 0 in the table.  In the tables ‘Fs ≤’ is redundant, need to be removed.  Samsung:  Agree with Intel that consensus on Fsd=0 issue should be achieved in group firstly.  MediaTek:  Agree with Intel.  OPPO: For the definition of DL only spectrum description “it extends on one-side of the bidirectional spectrum in contiguous manner” we prefer to use the refined wording in last meeting “no gap between bidirectional spectrum and DL only spectrum”.  For clarification, where is the restriction “The frequency separation class for DL-only spectrum (Fsd) can be equal but not larger than the frequency separation (DL Fs)” coming from?  Huawei: disagree on the CR, we have provide view in section 1.3.1. |
| [**R4-2006780**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006780.zip) | TP to TR38.831: FR2 UE architectures for DL Intra-band CA BW Enhancement | Qualcomm Incorporated | Intel: Add Fsd is optional. In the table ‘Fs ≤’ is redundant  Samsung:  About “Fs≤” issue, the similarity and difference between Fs/Fsd and CABW should be discussed. In our understanding, Fs/Fsd indicates the maximum span UE supports per band, so it should be equal to a value; CABW is the configured BW, so it could be ≤ a value.  MediaTek:  How about this?   |  |  | | --- | --- | | Frequency separation class | Max. DL only frequency separation (Fsd) | | I | 200 MHz | | II | 400 MHz | | III | 600 MHz | | IV | 800 MHz | | V | 1000 MHz | |
| [**R4-2008177**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008177.zip) | CR for 38.101-2 separation class for Rel-16 | Huawei, HiSilicon | Intel: We don’t think gap is needed. Otherwise, the total frequency span of DL can be greater than 2400MHz.  Samsung: agree with Intel. With upper limitation of 2400MHz, it is a waste of spectrum to allow a gap.  Nokia: gap should not be allowed between bi-directional and DL-only spectrum  MediaTek: Introducing a gap would need additional signalling parameter. Not sure if the intention is to allow wider than 2400MHz frequency separation. The scheduling for base station could become more complicated when having Fs + Fgap + Fsd.  Huawei: To Intel, why gap is not needed? If we take look on the current g30 spec on NC CA, the configuration already exceed 2400MHz.  To Nokia, appreciated if you can provide the reason. |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |  |
| --- | --- | --- |
| **Issue** | **Company Comments** | **Moderator Summary** |
| 1-1: Should the network be restricted from scheduling a DL CC across the boundary of DL only spectrum and bidirectional spectrum for intra-band DL CA | Yes:  Intel, Nokia, MediaTek, Huawei | *Recommendations for 2nd round:*  Further discussion towards establishing common understanding |
| No:  OPPO |
| 1-2: Revert agreement (R4-1913042) of contiguous UE DL spectrum capability to include gaps? | No:  Intel, Samsung, Nokia, LGE, MediaTek, Qualcomm, Apple | *Recommendations for 2nd round:*  This is the second meeting where the gap proposal has failed to pick up support towards consensus. Majority view is to abide by existing agreement which says ‘no gaps’ (excerpt below from R4-1913042):    Can we proceed with majority view? |
| Yes:  Huawei |
| 1-3: Fsd = 0 Case |  | *Tentative agreements:*  Fsd signalling is optional and can be used by UEs that need to signal non-zero Fsd  *Recommendations for 2nd round:*  Can capture in feature CR |
| 1-4: REFSENS requirement relaxation for combined DL spectrum range (DL Fs+Fsd) that includes 2400 MHz is 1.0 dB | Y:  MediaTek, OPPO, Apple | *Recommendations for 2nd round:*  Further discussion |
| N:  Huawei |

*Recommendations on WF/LS assignment*

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

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| [**R4-2006632**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006632.zip) | *to be revised* |
| [**R4-2006634**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006634.zip) | *to be revised. CR 8177 can be merged into this one depending on GTW session* |
| [**R4-2006780**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006780.zip) | *to be revised* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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

# 2 Topic #2: Inter-band CA

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2006320**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006320.zip) | Inter-band DL CA in FR2: CBM/IBM capability and associated spherical coverage EIS tests | Sony, Ericsson | Observation 1: To guarantee the UE inter-band CA performance under the co-located deployment senior, the common spherical coverage area is needed in the EIS test.  Observation 2: For the single AoA test setup, the common spherical coverage area is needed in the EIS test for both CBM and IBM to exam the UE performances under the co-located deployments.  Observation 3: The PSD difference is not related to UE capability on IBM/CBM but rather the frequency separation between the two CCs.  **Proposal 1: Introduce CBM/IBM for inter-band CA as a NR UE per-band combination capability for DL and UL. Support of IBM for a band combination implies support of CBM.**  **Proposal 2: The spherical coverage requirements for inter-band CA shall be defined in a way that it can guarantee the UE minimum performance under the desired deployment scenarios.**  **Proposal 3: Adopt the requirement on solid angles described by directions that simultaneously meet the inter-band CA spherical coverage for both bands, with the common area is 50 % for both IBM and CBM UEs with the single AoA test setup.**  **Proposal 4: For CBM inter-band CA spherical coverage, allowing X dB relaxation on the secondary CC, where X depends on the frequency separation between primary and secondary CCs.**  **Proposal 5: For IBM inter-band CA spherical coverage, allowing 2 dB relaxation on each band for the UE to meet the common spherical coverage requirement.**  **Proposal 6: Define the PSD imbalance as 0 dB for the CBM inter-band CA DL EIS.**  **Proposal 7: Define the PSD imbalance as 6.5 dB for the IBM inter-band CA DL EIS.** |
| [**R4-2006430**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006430.zip) | on EIS relaxation framework and PSD difference in FR2 inter-band CA | Samsung | Observation 1: EIS spherical coverage for inter-band CA is required to be based on common spherical coverage range while peak EIS is required per band without any limitation. Extra EIS relaxation factor for spherical coverage is necessary due to “common” coverage.  Observation 2: MBR factor shall not cover CA relaxation factor. MBR and CA relaxation are independent relaxation factors for inter-band CA  **Proposal 1: EIS relaxation framework for FR2 inter-band CA shall be as following for peak EIS and common spherical coverage respectively:**  ***Inter-band CA peak EIS = single-band EIS + multi-band relaxation + inter-band CA relaxation***  ***Inter-band CA spherical EIS = single-band EIS + multi-band relaxation + inter-band CA relaxation + “common” coverage relaxation***  Observation 3: feasible SNR range of testability shall be considered for PSD difference configuration. The feasible PSD difference upper bound = feasible SNR upper bound + 1dB.  Observation 4: there is SNR range testability issue for inter-band CA spherical coverage test, and a fixed PSD difference value is not feasible for inter-band CA spherical coverage test.  Observation 5: a fixed PSD difference value is also not feasible for inter-band CA peak EIS test during RX beam peak search since beam peak direction between bands may be different.  **Proposal 2: for RX beam peak search and EIS spherical coverage, it is proposed to start EIS searching from PSD difference=0dB at reference point and then achieve sensitivity status for both bands simultaneously, i.e., PSD difference=0dB at baseband regardless of PSD difference at reference point eventually.**  Observation 6: In case that RX beam peak direction is already known, a PSD difference equal to or higher than 6.5dB is feasible for inter-band CA REFSENS test |
| [**R4-2006565**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006565.zip) | Remaining issues on FR2 inter-band DL CA | Intel Corporation | **Proposal 1: Declaring CBM or IBM should be a per band pair capability for UE in inter-band DL CA**.  **Proposal 2: Intra-band non-contiguous CA requirements apply to CBM in inter-band DL CA.**  **Proposal 3: For IBM UEs, the PSD imbalance is 21.5dB for L+L (n/257/n258/n261) inter-band DL CA and the PSD imbalance is 20.5dB for H+H (n260/n259).**  **Proposal 4: For L+H inter-band DL CA, 30dB PSD imbalance should be specified.** |
| [**R4-2006591**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006591.zip) | FR2 Inter-band CA | Nokia, Nokia Shanghai Bell | *Observation 1: Lack of uplink resource does not limit to only CBM in downlink CA.*  *Observation 2: CBM should be considered as the baseline operation for inter-band DL CA for L+L.*  *Observation 3: IBM should be considered as the baseline operation for inter-band DL CA for L+H.*  ***Proposal 1: UE capability per band combination should be introduced to indicate CBM, IBM or both are supported.***  ***Proposal 2: Signaling shall be flexible enough to indicate which band pair is CBM, IBM or both for more than 3 bands.***  ***Proposal 3: The PSD difference for IBM shall be 6.5 dB or greater for IBM; it is for further to check if greater PSD difference is possible from testability point of view.***  ***Proposal 4: The PSD difference for CBM shall be 0 dB for L+L combo; non-zero PSD should be considered for L+H combo.***  *Observation 3: The common spherical coverage has been already agreed and shall be applied to both CBM and IBM; EIS spherical coverage is based on Rel-15 requirement except for additional relaxation for inter-band CA.*  ***Proposal 5: Inter-band DL CA relaxation factor shall include both conducted and radiated relaxation and shall not be applied in a single band operation.***  ***Proposal 6: The requirement specific to IBM shall be further discussed and developed in RRM/Demod.*** |
| [**R4-2006633**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006633.zip) | On common beam management assumptions and PSD difference in FR2 CA | Apple Inc. | **Proposal 1: RAN4 shall assume an equal PSD between CCs for intra-band CA.**  **Proposal 2: RAN4 shall define an equal PSD and co-located scenario for inter-band CA 28+28 GHz and 39+39 GHz.**  **Proposal 3: RAN4 shall define the PSD difference of 6.5 dB for inter-band CA 28 GHz + 39 GHz.**  **Proposal 4: RAN4 shall assume for inter-band CA 28+28 GHz a co-located scenario with CBM.**  On common beam management:  Observation 1: For FR2 intra-band CA, symbol level alignment within CP length is essential to guarantee the same downlink spatial domain transmission filter on one OFDM symbol.  Observation 2: FR2 SCell activation requirements for intra-band CA suggests that when common beam management is assumed, fine timing and spatial information from one CC can be directly re-used by the other CC. This again makes it important that symbol level alignment should be with CP length.  Observation 3: For CBM based FR2 intra-band CA, L1 and L3 measurements on one CC can be reused for all the other CC. That implies the same Tx and Rx beams used across all CCs per OFDM symbol.  **Proposal 5: Common beam management in FR2 inter-band CA is defined as that UE shall assume that the transmitted signals from the serving cells should have the same downlink spatial domain transmission filter on one OFDM symbol in all CCs.**  **Proposal 6: In case of common beam management, it is assumed that gNB for all CC are collocated and single Rx antenna array at UE is shared by all CC.** |
| [**R4-2006829**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006829.zip) | FR2 inter-band DL CA requirements | MediaTek Inc. | ***Proposal 1: IBM or CBM is per band pair capability declared by UE and shall not be strictly defined in the specifications.***  ***Proposal 2: The deployment scenario for intra-group band combinations shall be strictly limited to collocation and explicitly stated in the specifications.***  ***Proposal 3: The deployment scenario for inter-group band combinations can be either collocated or non-collocated.***  ***Observation 1****: The “Common Spherical Coverage” is only meaningful when the inter-band cell deployment is collocated, not because of CBM or IBM on UE.*  ***Proposal 4: It is unnecessary to introduce a stress test for both REFSENS and EIS spherical coverage with [6.5 – 30] dB PSD difference between the two DL carriers as such test has neither been introduced in LTE nor NR FR1 inter-band CA combinations.***  ***Proposal 5: The concerned “Common Spherical Coverage” requirements can be verified based on the proposed simultaneous REFSENS and EIS spherical coverage measurement procedure as described above*** |
| [**R4-2008051**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008051.zip) | Inter-band CA remaining open requirements | Qualcomm Incorporated | **Proposal 1: Define PSD difference for IBM band pair in such way that for peak EIS and spherical coverage test, the untested band is set to link condition with the power level corresponding to spherical coverage requirement for inter-band CA case.**  **Proposal 2: For IBM band pairs, keep the agreement on how to define spherical coverage requirement for inter-band CA with the spec language:**  **“*The inter-band CA spherical coverage requirement will be satisfied if the intersection set of spherical coverage areas exceeds the requirement. Intersection set of spherical coverage areas is defined as a fraction of area of full sphere measured around the UE where both bands meet their defined individual inter-band CA EIS spherical coverage requirement*.”**  **Proposal 3: For CBM band pairs, no spherical coverage requirement will be defined.**  **Proposal 4: For CBM band pairs, UE shall meet peak EIS requirement for both bands at the same time from same angle of arrival.**  **Proposal 5: Define new UE capability to distinguish IBM and CBM band pairs.** |
| [**R4-2008056**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008056.zip) | FR2 inter-band CA LB+HB | NTT DOCOMO INC. | Observation 1: Requested band combinations for FR2 inter-band CA is CA\_n257+n259.  **Proposal: Take Option A’ or Option B’ depending on PSD ability of IBM.**   * **Option A’: Define all LB + HB inter-band CA as IBM with at least 15dB PSD difference requirement.** * **Option B’: Introduce per band combination capability**   + **Define 25 dB PSD difference requirement for IBM.**   + **Define PSD difference requirement for CBM for at least LB +HB case as below:**     - **Set untested band power level equivalent to EIS spherical coverage criterion. PSD is equal to difference between REFSENS and EIS spherical coverage criterion**   **NOTE: Since it is expected that introducing capability make flexibility of UE implementation, PSD difference could be specified higher than option 1.** |
| [**R4-2008166**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008166.zip) | On inter band DL CA\_FR2 | Huawei, HiSilicon | ***Proposal 1: distinguishing between CBM and IBM with per band pair capability to declare IBM or CBM.***  *Observation 1:* *CBM UE may not requires for stringent MRTD(e.g. 0.26us) as for intra-band CA.*  *Observation 2: gNB only configure beam management RS to one CC for CBM UE, while can configure beam management RS to one CC or both CCs for IBM UE which is deployment dependent.*  ***Proposal 2: Further Extend the CBM and IBM UE definition:***   * ***Type 1: support MRTD=8us and independent beam management and max PSD difference≤ [30]dB*** * ***Type 2: MRTD=[TBD](depends on RRM session), common beam management and max PSD difference≤ [6]dB***   ***Proposal 3: Define UE capability for FR2 inter-band CA with type1 and type2 which is indicated per band combination.***  ***Proposal 4: RAN4 agrees to define different EIS spherical coverage requirement for different inter-band CA and indicate the RF requirement with single bit:***   * ***Bit 0: Spherical coverage for each band determinedly separately without common range definition*** * ***Bit 1: common EIS spherical coverage range between the two bands shall be 50% for power class 3***   ***Proposal 5: for inter-band CA, single polarization for each band is assumed to define the Rx requirement.***  ***Proposal 6: 3dB EIS requirement difference is required between single polarization and dual polarization architecture for each Band.***  ***Proposal 7: RAN4 defines 10% relaxation on spherical coverage requirement for inter-band 28GHz+39GHz CA, where spherical coverage means the common spherical coverage range between the 2 bands. Or 3dB relaxation on spherical coverage requirement for CDF 50% for inter-band 28GHz+39GHz CA.***  ***Proposal 8: 3dB per band is defined additionally for inter-band 28GHz+39GHz CA on min peak EIS.***  ***Proposal 9******: For type 2 UE, separation class extends to be indicated per band combination per receiving chain*** ***for L+L and H+H CA combinations.*** |

## Open issues summary

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

### Sub-topic 2-1

*Sub-topic description:* IBM/CBM capability

*Open issues and candidate options before e-meeting:* Based on contributions, there is majority support for introducing the new capability.

|  |  |
| --- | --- |
|  | Create IBM/CBM capability? |
| Yes | Huawei, MediaTek, Intel, Sony, Nokia, Ericsson, Qualcomm, LGE |
| No | Apple (?) |

Would company listed tentatively as ‘No’ consider aligning with majority view (create capability)?

**Issue 2-1-1: IBM/CBM Capability**

* Proposals
  + Support creation Y/N
* Recommended WF
  + Create capability and discuss attributes

**Issue 2-1-2: CBM attributes**

* Proposals (each is Y/N)
  + Intra-band non-contiguous CA requirements apply to CBM band pair in inter-band DL CA.
  + UE shall assume that the transmitted signals from the serving cells have the same downlink spatial domain transmission filter on one OFDM symbol in all CCs. gNB for all CCs are co-located.
  + MRTD=[TBD](depends on RRM session)

**Issue 2-1-3: IBM attributes**

* Proposals (each is Y/N)
  + Support of IBM for a band combination implies support of CBM (Note: there is already agreement in R4-2006736 that ‘Network assumes IBM UE supports both co-located and non-co-located deployments’)
  + support MRTD=8us

### Sub-topic 2-2

*Sub-topic description*: Spherical Coverage

*Open issues and candidate options before e-meeting:* One company (R4-2008166) has proposed introducing a new capability for UEs to declare if they support common coverage or not, in addition to IBM/CBM. This proposal received no support in the previous meeting in two round of discussion or the online session. The following classification assumes similar outcome in this meeting. The proposal is treated separately in **Issue 2-5-1**. Based on contributions the following pattern of majority support has emerged:

|  |  |  |
| --- | --- | --- |
| EIS Spherical Coverage | CBM | IBM |
| Adopt requirement on area of sphere (or equivalently, solid angle) where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply) | Sony, Ericsson, Nokia, MediaTek, Huawei (?). LGE | Sony, Ericsson, Nokia, MediaTek, Huawei (?), Qualcomm, LGE |
| No new requirements for inter-band CA spherical coverage | Qualcomm, Samsung |  |

**Issue 2-2-1: Spherical Coverage Metric for CBM band pairs**

* Proposals
  + Adopt requirement on area of sphere where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply)
  + No spherical coverage requirement for CBM band pair

**Issue 2-2-2: Spherical Coverage Metric for IBM band pairs**

* Proposals
  + Adopt requirement on area of sphere where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply)
* Recommended WF
  + ‘Yes’ to proposal above

### Sub-topic 2-3

*Sub-topic description:* PSD difference during requirements testing for CBM band pairs

*Open issues and candidate options before e-meeting:* Based on contributions, views on PSD difference are below. Majority view may be characterized as ‘to minimize PSD difference during compliance test’.

|  |  |  |
| --- | --- | --- |
| PSD difference during inter-band CA requirements testing | CBM band pairs | |
| L+L, H+H | L+H |
| 0 dB (@ baseband as clarified in R4-2006430) | Apple, Sony, Ericsson, Samsung, Nokia, Intel(1), LGE | Sony, Ericsson, Samsung, Intel (1) |
| <= 6.5 dB | Huawei, MediaTek, Intel(2) | Huawei, MediaTek, Intel(2), LGE |
| Set untested band to link condition.  (DL power level is set equivalent to EIS spherical coverage criterion) |  | NTTDocomo |
| Note 1: if it is agreed that Intra-band non-contiguous CA requirements apply to CBM in inter-band DL CA, see issue 2-1-2  Note 2: if Note 1 does not apply | | |

Would company proposing ‘Set untested band to link condition’ consider aligning with majority view ([0 – 6.5] dB)?

**Issue 2-3-1: inter-band CA PSD for CBM band pair**

* Recommended WF
  + Streamline majority view as ‘Minimize PSD difference in test condition’

### Sub-topic 2-4

*Sub-topic description:* PSD difference during requirements testing for IBM band pairs

*Open issues and candidate options before e-meeting:* Based on contributions, views on PSD difference are below. Moderator view is that some streamlining is possible and is presented as proposal

|  |  |  |
| --- | --- | --- |
| PSD difference during inter-band CA requirements testing | IBM band pairs | |
| L+L, H+H | L+H |
| 0 dB (@ baseband as clarified in R4-2006430) | Samsung | Samsung |
| <= 6.5 dB | Sony, Ericsson, MediaTek | Sony, Ericsson, MediaTek |
| >= 6.5 dB | Nokia | Nokia |
| [20 – 30] dB | Huawei, Intel, LGE | Huawei, Intel, LGE |
| Set untested band to link condition (DL power level is set equivalent to EIS spherical coverage criterion) | Qualcomm | Qualcomm |

**Issue 2-4-1: inter-band CA PSD for IBM band pair**

* Proposals
  + [0 – 6.5] dB
  + [20 – 30] dB
  + Set untested band to link condition (DL power level is set equivalent to EIS spherical coverage criterion)
* Recommended WF
  + There is large spread of PSDs in proposals, ranging from small ([0 – 6.5 dB]) to large (> 20dB). Proposal to ‘Set untested band to link condition’ represents a middle ground between the two. Can ‘Set untested band to link condition’ be adopted for PSD during test of IBM band pairs?

### Sub-topic 2-5

*Sub-topic description:* New capability in addition to IBM/CBM capability (see R4-2008166), to indicate whether UE can support common spherical coverage or not

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

**Issue 2-5-1: Inter CA spherical coverage capability**

* Proposals
  + New capability is required
  + Proposed capability can be absorbed into IBM/CBM capability

### Sub-topic 2-6

*Sub-topic description:* Relaxation framework

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

***Inter-band CA peak EIS = single-band EIS + multi-band relaxation + inter-band CA relaxation***

***Inter-band CA spherical EIS = single-band EIS + multi-band relaxation + inter-band CA relaxation + “common” coverage relaxation***

**Issue 2-6-1: Inter CA relaxation**

* Proposals (each is Y/N)
  + Applies only during inter-band operation due to simultaneous operation
  + Applies only during inter-band operation due to architecture change during inter-band operation (single pol vs dual pol)
  + Does not apply for single band operation
  + Includes radiated relaxation (beam squint effect)
  + This term is not necessary

**Issue 2-6-2: Common coverage relaxation for IBM band pairs**

* Proposals
  + Common coverage relaxation is common to all IBM band pairs
  + Create different classes of band pairs for common coverage relaxation: L+H, L+L, H+H

### Sub-topic 2-7

*Sub-topic description:*  Frequency separation class signalling for CBM band pairs

*Open issues and candidate options before e-meeting:* Should we adopt a different method of UE capability declaration to network for CBM band pairs vs IBM band pairs?

**Issue 2-7:** **Extend intra-band frequency separation class signalling to CBM inter-band band pairs**

* Proposals
  + For CBM band pairs, extend separation class signalling to ‘be indicated per band combination per receiving chain for L+L and H+H CA combinations’
  + CBM and IBM both use same inter-band capability signalling framework

## Companies views’ collection for 1st round

### Open issues

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| Issue 2-1-1: Introduce IBM/CBM Capability | Y/N | Intel: Yes.  We also think it may be good for UE to choose CBM or IBM for given band pair dynamically depending on its capability of handling frequency span from actual CC allocations in two bands (potentially the largest span can be around 6.25GHz in L+L and 6.5GHz in H+H, even larger in L+H, CBM may be difficult to capture the whole span). If all CCs are within certain frequency limit (UE’s capability), CBM can be used otherwise, IBM is used. Use CBM can potentially save power consumption by turning off the other beam/active antenna array.  Samsung: Yes  Nokia: Yes  LGE : Yes  MediaTek: Yes  OPPO: OK with introducing this capability.  SONY: Yes. It offers better flexibility for UE implementation, network beam management and cell deployment.  Huawei: Yes. But we should clarify on the meaning of CBM and IBM. As discussed in my paper: “CBM and IBM is not a purely RF capability but also relates to the baseband algorithm. For CBM, the UE maybe just maintain one beam management procedure for CA case but have 2 set of RF chain to support each band. While for IBM, it does not mean the gNB need to configure RS signal on each CC always.” Hence:  ***CBM UE may not requires for stringent MRTD(e.g. 0.26us) as for intra-band CA.***  Ericsson: yes  Qualcomm: No opinion  Apple: For the sake of progress we are ok to introduce IBM/CBM capability per band pairs.  Verizon: Yes. Need clear definition |
| Issue 2-1-2: CBM attributes | Intra-band non-contiguous CA requirements apply to CBM band pair in inter-band DL CA. (Y/N) | Intel: Yes, it is reasonable to consider them as an intra-band with CBM.  Samsung: generally speaking it is okay in principle.  Nokia: Technically yes, but the specification impact may be complicated. In that case, it may be simpler to introduce a new band for n257+n258 such that intra-band CA with can be easily defined; the concept of frequency separation class can simply be reused.  LGE: Yes  MediaTek: CBM is a UE capability for certain band pairs. There should not be definite definition for certain band pairs to either CBM or IBM. Intra-band CA requirements should be defined based on collocated scenario, but it can be handled by UE either with CBM or IBM which is UE’s own choice.  OPPO: Generally it is ok, but maybe better to consider it case by case for each requirement whether it can be reused or not.  SONY: Yes.  Huawei: No. There is misunderstanding on the meaning of CBM and IBM. “the UE maybe just maintain one beam management procedure for CA case but have 2 set of RF chain to support each band.”  For “intra-band CA requirement”, it means a lot, not only from RF side. It means MTTD and MRTD requirements! Then deployment is limited with collocated.  TAE is also limited as 0 for an inter-band combination. We would like to know whether it can be accepted by network side.  Secondly, for 28GHz+39GHz combination, if it is CBM indicated, whether intra-band requirement can be applied?  Therefore, the answer is “no” here.  Ericsson: yes  Qualcomm: support this proposal  NTT DOCOMO, INC.: Yes for L+L, H+H. No for L+H.  Verizon: The intra-band non-contiguous CA could be in collocated under CBM, but it should not be only operation assumption.  FR2 spectrum is wide enough, and RAN4 has defined different power classes. Non-collocated intra-band CA is also possible scenarios in operation for indoor (PC3) and outdoor (PC1 and PC4) applications. |
| UE shall assume that the transmitted signals from the serving cells have the same downlink spatial domain transmission filter on one OFDM symbol in all CCs. gNB for all CCs are co-located. (Y/N) | Intel: Yes  Nokia: Yes. For CBM, gNB may configures beam management only on Pcell by assuming that all Scells follow the same beam as Pcell.  LGE: Yes, gNB shall co-located when UE assume CBM  MediaTek: In principle Yes. But again, we should not tie CBM or IBM to certain band pairs.  SONY: Yes.  Huawei: No.  CBM and IBM is UE capability, why we need to assume deployment here? If the intersection angle between 2 DL CCs is small, why not CBM? But the gNB canbe non-collocated here.  Ericsson: yes, this is the rationale for introducing the CBM.  Qualcomm: We can make an assumption that for UE requirements that is assumed but CA should be opportunistic.  Apple: Yes, as provided in our contribution (R4-2006633) that to guarantee the same DL spatial domain transmission filter, the common beam management is only viable when the gNB for all CC are collocated and all CC should be aligned in slot level with MRTD less than CP. |
| MRTD=[TBD](depends on RRM session) (Y/N) | Intel: Yes  Nokia: Should be decided by RRM.  LGE : agree with Nokia. RRM session will decide MRTD.  MediaTek: For intra-band CA and intra-group inter-band CA, the deployment should be collocated where the MRTD should be 260 ns to allow CBM operation. The UE can still choose CBM or IBM to handle these combinations.  SONY: To our understanding, MRTD is related with spatial filter rather than IBM/CBM to our understanding  Huawei: we consider MRTD further more. From RRM requirement perspective, MRTD definition generally comes from the practical deployment demand. E.g. 0.26us is assumed collocated and DL sync between cells (TAE). It is hard to request RRM session provide MRTD requirement which considers the differnet type of UE, and this limitation inversely add limitation to deployment.  So for MRTD, we think it could be a separate UE capability regardless of CBM or IBM. It just signaled per band combination. If UE signals MRTD=Xus, then gNB will decided on the configuration based on the capability.  Hence, the MRTD requirement for FR2 inter-band CA is kept with 8us, meanwhile, UE is allowed to signal its MRTD capability per inter-band CA band combination.  Ericsson: this should not be linked to the MRTD, the primary attribute is the spatial filters. UEs indicating support of CBM can expect antenna co-siting, hence common beams, and the MRTD relevant for that scenario.  Qualcomm: MRTD would be inherited from intra-band. No discussion needed.  NTT DOCOMO, INC.: It should be decided by RRM. |
| Issue 2-1-3: IBM attributes | Support of IBM for a band combination implies support of CBM (Y/N)  (Note: there is already agreement in R4-2006736 that ‘Network assumes IBM UE supports both co-located and non-co-located deployments’) | Intel: Conditionally Yes. It depends on how to define spherical coverage for IBM.  Samsung: Yes  Nokia: CBM does not require beam management resource in Scell. However, IBM require the resource for both Pcell and Scell. Support of IBM does not always mean the support of CBM. But both IBM and CBM shall support collocated deployment.  LGE: maybe UE only support either BM skill. Specially UE only assume CBM for collocated gNB deployment.  MediaTek: Not necessarily true. It depends on the requirements for the band combinations to be defined.  OPPO: Yes.  SONY: Yes, as mentioned the agreed WF, the IBM has to support co-located scenario, which is same to CBM.  Huawei: generally yes, but we need time to check some details.  Ericsson: yes.  Qualcomm: Agree with Nokia, we should assume IBM means supporting co-located i.e. same AoA deployment but if UE can QCL two bands is separate issue and should not be assumed with IBM.  NTT DOCOMO, INC: IBM requirement should be specified to support both co-located and non-co-located deployments.  Apple: We think this point needs further clarification. An IBM UE can support both co-located and non-collocated gNBs, however the proposal of “IBM for a band combinations implies support of CBM” can be understood differently. In a scenario in which the gNBs are distributed with a support of IBM, would it mean that the UE has to support with CBM a non-collocated scenario?  We have shown in our paper (R4-2006633) that CA deployment is not possible in a distributed scenario with CBM due to the path loss difference between CC1 and CC2.  In case the support of IBM for a band combination implies support of CBM, the network should also provide support and configure CBM as defined from RRM perspective. |
| support MRTD=8us (Y/N) | Intel: This is an RRM requirement. Should be determined by RRM session.  Nokia: we support 7-8 usec.  LGE: It will be determined by RRM session.  MediaTek: MRTD = 8us was defined based on non-collocated deployment scenario. Network needs to ensure gap symbols are sufficiently added from the nearby cell to avoid simultaneous Tx/Rx observed on UE side between the two CCs.SONY: To our understanding, MRTD is related with spatial filter rather than IBM/CBM to our understanding  Ericsson: IBM should not be linked to the MRTD. The UE is expected to manage independent spatial filters expected for non-collocated cells.  Qualcomm: Yes, and it should be ensured with a test  NTT DOCOMO, INC.: It should be decided by RRM.  Apple: No |
| Issue 2-2-1: Spherical Coverage Metric for CBM band pair | Adopt requirement on area of sphere (or equivalently, solid angle) where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply) (Y/N) | Intel: Yes  Samsung: not applicable if no spherical coverage requirement for CBM band pair.  Nokia: Yes. Both bands shall cover the same 50% area. The relaxations for each band can be introduced in EIS spherical coverage. The relaxation can be different per band for each inter-band CA. This is included in our TP.  LGE : Yes  MediaTek: For collocated scenario, the corresponding spherical requirement shall consider common area of sphere, but it can be handled by UE either with CBM or IBM which is UE’s own choice.  OPPO: In principle ok, but relaxation will be needed on at least one of the bands due to beam squit.  SONY: We think the common area metric can be adopted for both CBM and IBM, and it is preferred to use a single metric to evaluate the inter band CA spherical coverage. Then, the PSD difference can be set differently for CBM and IBM to distinguish these two types of UEs.  Huawei: introduce a single bit to indicate whether common sphere requirement can be supported. If not, UE need satisfy spherical requirement separately with no common range limitation.  Ericsson: yes.  Apple: Yes |
| No spherical coverage requirement for CBM band pair | Samsung: No spherical coverage requirement for CBM band pair. The same principle as intra-band CA.  MediaTek: As above comment: For collocated scenario, the corresponding spherical requirement shall consider common area of sphere, but it can be handled by UE either with CBM or IBM which is UE’s own choice.  SONY: If the majority prefer to leave the CBM and intra-band CA spherical coverage requirement to be undefined, we could also accept it.  Huawei: if there is no spherical coverage requirement for intra-band CA, why we define intra-band CA beam correspondence requirement as same of single carrier? BC requirement is defined on spherical grids. Do not understand the consideration here. No matter whether there is a test, the requirement is there.  Ericsson: acceptable if the outcome of the above is “yes”.  NTT DOCOMO, INC: Yes, to support co-located deployment. |
| Issue 2-2-2: Spherical Coverage Metric for IBM band pair | Adopt requirement on area of sphere (or equivalently, solid angle) where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply) (Y/N) | Intel: Yes  Samsung: Yes but an extra requirement relaxation factor due to common coverage should be taken into account.  Nokia: Yes. Both bands shall cover the same 50% area. The relaxations for each band can be introduced in EIS spherical coverage. (the relaxation can be different per band for each inter-band CA.) This is included in our TP.  LGE :Yes  MediaTek: For collocated scenario, the corresponding spherical requirement shall consider common area of sphere, but it can be handled by UE either with CBM or IBM which is UE’s own choice. For non-collocated scenario, no need to consider common area of sphere.  OPPO: Yes  SONY: Yes  Huawei: introduce a single bit to indicate whether common sphere requirement can be supported. If not, UE need satisfy spherical requirement separately with no common range limitation.  Ericsson: yes.  Qualcomm: Yes, support this  NTT DOCOMO, INC: Yes, to support not only non-co-located deployment but also co-located deployment.  Apple: Yes |
| Issue 2-3-1: PSD for CBM band pair | Minimize PSD difference in test condition (Y/N) | Intel: Yes if intra-band non-contiguous requirements apply as well.  Samsung: Yes if it means PSD difference at baseband.  Nokia: Yes  LGE: Yes  MediaTek: There should not be CBM band pair. CBM is a UE capability for certain band pairs.  OPPO: Yes  SONY: Yes if minimize means PSD difference around 0 dB.  Huawei: clarify, we are talking about test or requirement? If it is requirement. ~6dB if preferred. It is from the observation from the real network. If it is for test of RAN5, I think it depends on RAN5 decision.  Ericsson: yes, if minimize means around 0 dB.  Qualcomm: yes  NTT DOCOMO, INC: We don’t think 0dB PSD is sufficient for L+H case.  Apple: For CBM we should consider L + L and H + H. For these scenarios the PSD difference in terms of difference of spherical coverage is 0 dB. |
| Issue 2-4-1: PSD for IBM band pair | Set untested band to link condition (DL power level is set equivalent to EIS spherical coverage criterion) (Y/N) | Intel: Need to set such that PSD imbalance is met.  Samsung: Considering EIS is an average of two EIS test corresponding to different downlink polarization, the two EIS data may be unbalanced. In this case, how to set the DL power level for the untested band for each polarization EIS test respectively?  Nokia: Ok. PSD imbalance is anyway bounded by testability.  LGE: we need to verify EIRP requirements with the min. PSD difference.  MediaTek: There is no need to introduce a stress test for both REFSENS and EIS spherical coverage with [6.5 – 30] dB PSD difference between the two DL carriers as such test has neither been introduced in LTE nor NR FR1 inter-band CA combinations.  OPPO: Yes  SONY: It is not very clear to us how to set the PSD in this case: How do we select the DL power level such that the EIS spherical coverage criterion is guaranteed on all the spatial angles for the untested band? How is the PSD imbalance be controlled in this case?  Ericsson: unclear how this can be achieved in the test.  Qualcomm: Yes  NTT DOCOMO, INC.: We would like to clarify the meaning of this proposal correctly. Assuming n257+n260:  Peak EIS for n257=-88.3dBm/50MHz  Peak EIS for n260=-85.7dBm/50MHz  Spherical EIS for n257=-77.4dBm/50MHz  Spherical EIS for n260=-73.1dBm/50MHz  When we test peak EIS for n257, -88.3dBm/50MHz, then power level of n260 is set as -73.1dBm/50MHz, that is PSD difference is -73.1-(-88.3)=15.2dB. Is this correct understanding?  Apple: Yes. |
| Issue 2-5-1: Inter CA spherical coverage capability to indicate if a UE can or cannot support common coverage | New capability is required | Intel: Yes. For CBM, it implies common coverage. But for IBM, the answer for this question depends on how two beams are formed. If two beams are from same panel, then common coverage makes more sense. If two beams from different panels, and if they face the same direction, then common area still makes sense. But if two panels face different directions, then common coverage makes no sense. If UE is allowed to have flexibility to place panels, then new capability is required.  Nokia: There is no need to further split IBM capability. IBM shall support common coverage.  MediaTek: Yes. Basically, after considering more UE implementation possibilities, decouple IBM/CBM and common coverage capability has better flexibility.  OPPO: For clarification, how to define the criteria of the “common coverage”?  SONY: No. Since both IBM and CBM need to support the co-located scenario, we don’t see how the UE cannot support common coverage can be valid.  Huawei: introduce a single bit to indicate whether common sphere requirement can be supported. If not, UE need satisfy spherical requirement separately with no common range limitation.  Ericsson: No. IBM must imply support of CBM.  Qualcomm: We are ok but not in favor of this. Bit 0 must signify common coverage area support and that is default behavior. |
| Proposed capability can be absorbed into IBM/CBM capability | Intel: No. Cannot be resolved by IBM/CBM capability.  Nokia: Yes. Common coverage among bands shall be supported regardless of IBM/CBM.  MediaTek: No, as explained above.  NTT DOCOMO, INC: Yes. Not introduce additional capability. If UE support FR2 inter-band CA, the UE shall support common spherical coverage regardless of CBM/IBM. |
| Issue 2-6-1: Inter CA relaxation | Applies only during inter-band operation due to simultaneous operation (Y/N) | Intel: Yes  Samsung: Yes. And inter CA relaxation is independent to multi-band relaxation.  Nokia: Yes. It is our view that the inter-band relaxation is applied when both Pcell and Scell are activated. Even if UE is not receiving data in Scell, inter-band relaxation to Pcell can be applied.  LGE: Yes  MediaTek: Yes. Some extra loss components only introduced while CA operation active.  OPPO: Yes.  SONY: Yes.  Huawei: no. ΔRIB is not only used for simultaneous operation. For UE support inter-band CA, ΔRIB can be used for single carrier scenario. It is what we have for FR1. The same approach should applied for FR2. |
| Applies only during inter-band operation due to architecture change during inter-band operation (single pol vs dual pol) (Y/N) | Intel: No. This is not a relaxation but power reduction by reducing two polarizations to single polarization for one band. We suggest to not consider this approach explicitly. It is up to UE implementation if UE can meet all requirements by split polarizations btw two bands. I believe there are many other ways to do the split.  Samsung: we think dual pol RX is the assumption for UE side.  Nokia: Dual pol per band shall be assumed in inter-band CA. The proposed architecture to fallback to 1RX in interband CA means that Pcell performance degrades when Scell is activated due to 3 dB drop. Such behavior will cause significant loss in system performance and should not be allowed.  MediaTek: It does not matter for DL signals provided the dual polarization is linearly polarized and the PSD is calibrated at the quiet zone.  Huawei: we have agreement that MIMO=2 for single carrier, for CA, seems MIMO=1 is allowed for the current RAN2 spec. this is related to the baseline of refsens definition not the relaxation.  Qualcomm: no additional relaxation due to inter-band CA. Only due to common coverage and possibly peak EIRP direction deviation relaxation. |
| Does not apply for single band operation (Y/N) | Intel: Does not apply for single band operation  Samsung: Does not apply for single band operation  Nokia: The inter-band relaxation shall not be applied to the single band operation, as MBR is already introduced for the static/passive part of the relaxation. Dynamic/active part (caused by inter-band CA activation) is included in the inter-band relaxation.  LGE: Does not apply for single band operation  MediaTek: If extra loss component(s) is introduced for inter-band CA UE hardware architecture compared to non-CA UE hardware architecture, the inter-band CA relaxation still shall be applied, even if the CA operation is not active.  Huawei: no. ΔRIB is not only used for simultaneous operation. For UE support inter-band CA, ΔRIB can be used for single carrier scenario. It is what we have for FR1. The same approach should applied for FR2.  NTT DOCOMO,INC: Does not apply single band operation.  Apple: It does not apply for single band operation. |
| Includes radiated relaxation (beam squint effect) (Y/N) | Intel: Yes  Samsung: Yes for REFSENS. And inter CA relaxation is independent to multi-band relaxation.  Nokia: The beam squint effect in inter-band CA shall be included in the general inter-band CA relaxation. It is not necessary to split the budget between conducted and radiated relaxation.  LGE: Yes  MediaTek: Yes.  SONY: Yes, but this term is only valid for the CC without DL RS in CBM case.  Huawei: beam squint effect is only used for CBM UE?  And it depends on whether there is necessity on additional relax for beam squint.  The relaxation on conducted domain is definitely needed.  Qualcomm: yes for CBM, in case we agree intra-band like treatment.  Apple: In our view the beam squint should be discussed separately. |
| This term is not necessary (Y/N) | Intel: It is needed  Samsung: It is needed  Nokia: Inter-band CA relaxation shall include both conducted and radiated relaxation, which is applied when inter-band CA is activated. It shall not be applied in single band operation.  LGE: It is needed for inter-band CA only  MediaTek: Relaxation is needed.  SONY: It is needed for CBM but not IBM  Qualcomm: This term (Inter-CA relaxation) is not necessary for IBM.  Apple: This term is necessary. |
| Issue 2-6-2: common coverage relaxation for PC3 Common coverage relaxation for IBM band pairs | Common coverage relaxation is common to all IBM band pairs | Intel: Common to all IBM band pairs. Since if UE is optimized for L+H, it is not optimal for L+L or H+H. On the other hand, if UE is optimized at L+L (H+H), may not be optimized for L+H and H+H (L+L). So common relaxation can be defined to all UEs with considering their optimization.  Samsung: common to all IBM band pairs. There is no absolute definition for “L” and “H” considering future extension.  Nokia: Our proposal in our TP is to have inter-band relaxations for peak EIS and EIS spherical coverage, respectively, like we already have in MBR framework.  Common coverage relaxation shall be included within the budget of EIS spherical coverage relaxation. It is not necessary to split the budget into multiple parts, more than static/passive part in MBR and dynamic/active part in inter-band relaxation. Common spherical coverage relaxation is included in inter-band relaxation, as a relaxation to EIS spherical coverage.  MediaTek: Be more accurate, we think common coverage requirement and corresponding relaxation is applied for collocated scenario, no matter CBM/IBM. Based on this situation, the band pairs which support collocated scenarios shall meet common coverage requirement with relaxation, and the relaxation value shall be discussed and defined based on different band groupings. We may start the discussion from “L+H, L+L, H+H”, and may split to more band pair categories if need during discussion.  SONY: We think it is better to define a single relaxation based on the worst scenario (L+H). Rather than decompose this problem into too many small pieces.  Huawei: Firstly, common coverage relaxation is also needed by CBM UE on the band pairs.  Whether it is common, it is complicated. For conducted part, it comes from the loss on inter-stage, 3dB is OK. For beam squint, it depends on the study on next topic…  Qualcomm: relaxation should be per band pair. |
| Create different classes of IBM band pairs for common coverage relaxation: L+H, L+L, H+H | Nokia: We propose that the inter-band relaxation is defined per band for each band combination (similar to deltaRib). The common coverage relaxation should be included within the budget of EIS spherical coverage relaxation (per band for each band combination). (See our Text proposal.)  MediaTek: Same comment as above:  Be more accurate, we think common coverage requirement and corresponding relaxation is applied for collocated scenario, no matter CBM/IBM. Based on this situation, the band pairs which support collocated scenarios shall meet common coverage requirement with relaxation, and the relaxation value shall be discussed and defined based on different band groupings. We may start the discussion from “L+H, L+L, H+H”, and may split to more band pair categories if need during discussion.  Qualcomm: No different classes, only CBM and IBM.  Apple: There is no need to consider common coverage relaxation for L+L. and H+H of IBM pairs, only L+H should be considered. |
| Issue 2-7: Extend intra-band frequency separation class signalling to CBM inter-band band pairs | For CBM band pairs, extend separation class signalling to ‘be indicated per band combination per receiving chain for L+L and H+H CA combinations’ | Intel: Yes. It is helpful for UE to signal its CBM support frequency separation class which can be extended beyond current separation class for intra-band. For example, [2600, 2800, 3000, …], the granularity can be further discussed. If the actual frequency separation is larger than UE claimed frequency separation class, then UE will use IBM if supported.  Nokia: This approach looks complicated in terms of the signaling. In that case, it may be simpler to introduce a new band for n257+n258 such that intra-band CA with can be easily defined; the concept of frequency separation class can simply be reused.  MediaTek: A bit more complicated but can be considered. This is a good example that depending on the CC frequency separation in the band pair, UE may choose CBM or IBM to handle the CA. So we cannot specifically define this band pair as CBM or IBM.  SONY: it is probably helpful when we define the spherical coverage requirement accordingly.  Huawei: Yes. Both IBM and CBM UE need this extended UE capability. To Nokia, Define new Band for n257+n258 means full set of RF requirement need to be defined in Rel-16, in my view, time is not enough.  Qualcomm: UE should use existing inter-band capability signalling, no motivation to re-invent. Both bands should have their own freq separation class. |
| CBM and IBM both use same inter-band capability signalling framework | Nokia: Yes. It is our view that the signaling framework is common to both L+L and L+H pairs.  MediaTek: Not sure what this means. Some more clarifications is appreciated.  Ericsson: yes, preferably.  Qualcomm: yes |

### 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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| **T-doc number** | **Title** | **Company** | **Company Comments** |
| [**R4-2006592**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006592.zip) | TP to TR 38.831 on FR2 inter-band CA | Nokia, Nokia Shanghai Bell |  |
| [**R4-2008052**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2008052.zip) | DraftCR on Introduction of inter-band CA to 38.101-2 | Qualcomm Incorporated |  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| Issue 2-1-1: Introduce IBM/CBM Capability |  | *Tentative agreements:*  IBM/CBM capability is introduced but MRTD clarification on CBM required  *Recommendations for 2nd round:*  ***(see 2-1-2)*** |
| Issue 2-1-2: CBM attributes | Intra-band non-contiguous CA requirements apply to CBM band pair in inter-band DL CA. (Y/N)  Yes:  Intel(\*), Samsung, Nokia, LGE, MediaTek, Oppo, Sony, Ericsson, Qualcomm, NTT Docomo but not for L+H band pairs,  No:  Huawei, NTT Docomo (L+H band pairs), Verizon  (\*) proponent | *Recommendations for 2nd round:*  Discuss if this condition applies:  CBM UEs are required to comply with higher MRTD than for intra-band CA (i.e greater than 0.26 us).  Huawei:…. ***CBM UE may not requires for stringent MRTD(e.g. 0.26us) as for intra-band CA.***  Also there is opinion that MRTD constraints and BM choice should not be mixed  SONY: To our understanding, MRTD is related with spatial filter rather than IBM/CBM to our understanding |
| UE shall assume that the transmitted signals from the serving cells have the same downlink spatial domain transmission filter on one OFDM symbol in all CCs. gNB for all CCs are co-located. (Y/N)  Yes:  Intel, Nokia, MediaTek Sony(?), Ericsson, Apple(\*)  (\*) proponent  No:  Huawei, Qualcomm |
| MRTD=[TBD](depends on RRM session) (Y/N)  Yes:  Intel, Nokia, LGE, NTT Docomo  No:  MediaTek, Qualcomm, Sony (?), Ericsson  Other:  (Make new UE capability for MRTD)  Huawei (\*)  (\*) Proponent |
| Issue 2-1-3: IBM attributes | Support of IBM for a band combination implies support of CBM (Y/N)  (Note: there is already agreement in R4-2005736 that ‘Network assumes IBM UE supports both co-located and non-co-located deployments’)  Yes:  Intel (conditional, but condition not specified), Samsung, Oppo, Huawei, Ericsson, Sony  No:  Nokia, LGE, MediaTek, Qualcomm | *Recommendations for 2nd round:*  Discuss further.  It was pointed out that there is difference between IBM with co-located gNBs and CBM  Nokia: CBM does not require beam management resource in Scell. However, IBM require the resource for both Pcell and Scell. Support of IBM does not always mean the support of CBM. But both IBM and CBM shall support collocated deployment.  It was also pointed out MRTD capability is independent of BM type:  Ericsson: IBM should not be linked to the MRTD. The UE is expected to manage independent spatial filters expected for non-collocated cells. |
| support MRTD=8us (Y/N)  Yes:  Intel, Nokia,LGE MediaTek, Qualcomm (with test)  No:  Apple, Ericsson, Sony (?) |
| Issue 2-2-1: Spherical Coverage Metric for CBM band pair | Adopt requirement on area of sphere (or equivalently, solid angle) where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply) (Y/N)  Yes:  Intel, Nokia, MediaTek, Oppo, Sony, Ericsson, Apple, Huawei (capability), NTT Docomo  No:  Samsung, Huawei (capability), Qualcomm (\*)  (\*) proponent | *Recommendations for 2nd round:*  It appears the ‘common area’ method has majority view, and is based on single CC coverage in each band, i.e no new test is being defined.  Can Qualcomm and Samsung reconsider based on above? |
| Issue 2-2-2: Spherical Coverage Metric for IBM band pair | Adopt requirement on area of sphere (or equivalently, solid angle) where both bands meet their respective single CC EIS spherical coverage requirements (separate inter-band CA relaxations may apply) (Y/N)  Yes:  Intel, Samsung (w/ relax), Nokia, LGE, Oppo, Sony, Ericsson, Qualcomm, Apple, NTTDocomo, Huawei (with capability)  No:  MediaTek (not required for non-colocated scenario) | *Recommendations for 2nd round:*  Can proceed with majority view? |
| Issue 2-3-1: PSD for CBM band pair | Minimize PSD difference in test condition (Y/N)  Yes:  Intel, Samsung (at BB), Nokia, LGE, Sony, Ericsson, Qualcomm, Huawei (6 dB)  No:  NTTDocomo (L+H) | *Recommendations for 2nd round:*  Can proceed with majority view? |
| Issue 2-4-1: PSD for IBM band pair | Set untested band to link condition (DL power level is set equivalent to EIS spherical coverage criterion) (Y/N) | *Recommendations for 2nd round:*  Qualcomm (proponent) to clarify technical queries raised in first round  Is NTTDocomo summary |
| Issue 2-5-1: Inter CA spherical coverage capability to indicate if a UE can or cannot support common coverage | New capability is required  Discussion seemed to split CBM and IBM  IBM:  Yes:  Intel, MediaTek, Huawei  No:  Nokia, Sony, Ericsson, NTTDocomo  CBM:  Yes:  MediaTek, Huawei  No:  Intel, Sony, Ericsson, NTTDocomo | *Recommendations for 2nd round:*  IBM common coverage capability:  Discuss further in relation to agreement in R4-2005736 that ‘Network assumes IBM UE supports both co-located and non-co-located deployments’    CBM common coverage capability:  Discuss how ‘common beam’ for both bands does not imply ‘common coverage’ |
| Issue 2-6-1: Inter CA relaxation |  | *Recommendations for 2nd round:*  The following majority view has emerged:   1. Relaxation applies only when UE is configured for inter-band operation 2. Relaxation is not intended to cover for UE implementation choices like shutting down receiver in one polarization during inter-band operation 3. Relaxation is intended to cover physical phenomena like beam squint degradation, or self heating in RFIC   Some physical phenomena do not apply for IBM or CBM and needs further discussion  Can adopt majority view? |
| Issue 2-6-2: common coverage relaxation for PC3 Common coverage relaxation for IBM band pairs | Common coverage relaxation is common to all IBM band pairs | No clear majority, more discussion needed |
| Issue 2-7: Extend intra-band frequency separation class signalling to CBM inter-band band pairs | For CBM band pairs, extend separation class signalling or use existing inter-band capability signalling | No clear majority, more discussion needed |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on FR2 inter-band DL CA | MediaTek |

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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

# 3 Topic #2: 6.14.1.9 FR2 Beam Squint

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| [**R4-2006327**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006327.zip) | Analysis on EIS degradation due to larger frequency separation for PC3 Ues | Sony, Ericsson | Observation 1: The radiative degradation due to the beam squint happens when common beam management is adopted for collocated inter-band or intra-band CA operation.  Observation 2: The following EIS spherical coverage degradation on secondary CC is obtained:   |  |  |  |  | | --- | --- | --- | --- | | Frequency separation (Fs) | Fs < 1400 MHz | 1400 MHz < Fs < 2400 MHz | 2400 MHz < Fs < 5200 MHz | | Primary CC at 24 GHz | 0 dB - 0.2 dB | 0.2 dB - 1 dB | 1 dB -1.5 dB | | Frequency separation (Fs) | Fs < 1400 MHz | 1400 MHz < Fs < 2400 MHz | 2400 MHz < Fs < 6400 MHz | | Primary CC at 37 GHz | 0 dB - 0.2 dB | 0.2 dB – 0.8 dB | 0.8 dB -2.1 dB |   **Proposal 1: For CBM inter-band CA spherical coverage, allowing X dB relaxation on the secondary CC, where X depends on the frequency separation between primary and secondary CCs.** |
| [**R4-2006781**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006781.zip) | Beam squint analysis for FR2 UEs | Qualcomm Incorporated | **Proposal 1: In FR2 CA cases, requirements apply when the BM RS is provided in a CC with a configured UL BWP**  **Proposal 2: CA EIS degradation shall be quantified in terms of CDF of increase in effective antenna gain for a CC at any AoA, due to frequency separation from the CC configured the beam management reference signal.**  **Proposal 3:** **Beam squint effect can be captured as CA EIRP CDF degradation, if proposal 2 can be adopted.**  Observation 1: FR2 PC1 REFSENS does not need special consideration due to beam squint for Rel-16  Observation 2: FR2 PC1 CA EIRP (peak and spherical coverage) does not need special consideration due to beam squint for Rel-16, assuming condition listed in proposal 1  Observation 3: FR2 PC3 REFSENS does not need special consideration due to beam squint for Rel-16  Observation 4: FR2 PC3 CA EIRP (peak and spherical coverage) does not need special consideration due to beam squint for Rel-16, assuming condition listed in proposal 1 |
| [**R4-2006842**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_95_e/Docs/R4-2006842.zip) | Views on radiative degradation mechanisms for larger frequency separation | Apple Inc. | Observation 1: With increasing Fs, the phase of CC1 steering vector distorts the array response of CC2, and best beam selection optimized for CC1 degrades CC2 performance.  **Proposal 1:** **The Rel-16 requirement on beam correspondence for CA needs to be enhanced to include scope for UL intra-band non-contiguous CA.**  **Proposal 2:** **Further discussion is needed whether Rel-15 beam correspondence for CA requirement on UL intra-band non-contiguous CA with Fs ≤ 1400 can be relaxed.**  **Proposal 3:** **Further study is needed to determine whether the following scenario is valid: a UE is configured and activated for inter-band DL CA between common band groups (e.g. 28 GHz + 28 GHz or 39 GHz + 39 GHz) needs to select the UL beam for a CC in one group based on DL measurements made in a CC of another group.**  **Proposal 4:** **The impact of both of the above effects on transmit power control tolerance and TPC loop convergence is also recommended to be studied.**  **Proposal 5:** **Further discussion is needed whether relaxations on EIS spherical coverage for intra-band non-contiguous DL CA are needed in Rel-16.**  **Proposal 6:** **For inter-band DL CA within the 28 GHz band group, the impact on EIS spherical coverage is 1.8 dB**  **Proposal 7:** **For inter-band DL CA within the 39 GHz band group, the impact on EIS spherical coverage is 2.6 dB** |

## Open issues summary

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

### Sub-topic 3-1

*Sub-topic description:* CA EIS Impact

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

**Issue 3-1-1: Quantifying CA EIS impact due to beam squint**

* Proposals
  + For CBM inter-band CA spherical coverage, allowing X dB relaxation (at spherical coverage point on CCDF) on the secondary CC, where X depends on the frequency separation between primary and secondary CCs
  + CA EIS degradation quantified in terms of delta gain CDF, due to frequency separation from the CC configured the beam management reference signal.

**Issue 3-1-2: Intra-band DL CA impact of beam squint on CA EIS**

* Proposal (Y/N)
  + No impact for intra-band REFSENS, and no further impact to consider because spherical coverage requirement is absent

**Issue 3-1-3: Inter-band DL CA impact of beam squint on CA EIS**

* Proposals
  + CCDF Relaxation
  + No impact for inter-band REFSENS, and no further impact to consider because there is no intra-band spherical coverage requirement to extend to inter-band

### Sub-topic 3-2

*Sub-topic description* : CA EIRP Impact

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

**Issue 3-2-1: Beam management reference signal location**

* Proposal (Y/N)
  + In FR2 CA cases, requirements apply when the BM RS is provided in a CC with a configured UL BWP

**Issue 3-2-2: Intra-band DL CA impact of beam squint on CA ~~EIS~~ EIRP**

* Proposals
  + Beam squint effect can be captured as CA EIRP CDF degradation, if (see 3-1-1) ‘antenna gain change CDF’ is captured elsewhere

## Companies views’ collection for 1st round

### Open issues

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| Issue 3-1-1: Quantifying CA EIS impact due to beam squint | For CBM inter-band CA spherical coverage, allowing X dB relaxation (at spherical coverage point on CCDF) on the secondary CC, where X depends on the frequency separation between primary and secondary CCs | Intel: Yes. This one is relatively simple with less test effort  Samsung: not applicable if no spherical coverage requirements for CBM inter-band CA.  LGE: Needed. X dB relaxation on SCC  MediaTek: Relaxation is relative to single CC requirements for REFSENS and EIS spherical coverage. It is proposed perform the tests simultaneously for both CCs. The relaxation is applied to both CCs.  OPPO: OK with this option.  SONY: As we have discussed, the beam squint degrades the EIS spherical coverage of the CC without DL RS in CBM operation (assuming the DL RS is always configured on a fixed CC in the inter band CA EIS test). In this case, the beam squint can be simply captured when we define the relaxation for CBM inter-band CA spherical coverage.  However, if RAN4 would decide no requirement for CBM spherical coverage, then we don’t need to further discuss this for Rel-16.  Huawei: it is not the same for different antenna element number assumption. It not only depends on frequency separation between 2 CCs.  Ericsson: our preference.  Apple: In our view the impact of the beam squint should be quantified as the 50%-tile CDF in terms of the frequency separation. |
| CA EIS degradation quantified in terms of delta gain CDF, due to frequency separation from the CC configured the beam management reference signal. | Intel: This method is not preferred. In order to get delta gain CDF, the test effort is significant.  Samsung: not applicable if no spherical coverage requirements for CBM inter-band CA.  Nokia: First of all, for UE capable of inter-band CA, UE shall support the maximum frequency separation of the two bands. For example, for n257+n258, the lowest center frequency in n258 and highest center frequency in n257 shall be supported. It is ok to introduce the inter-band CA relaxation, which depends on the frequency separation. But there should no UE capability for frequency separation in inter-band CA.  The same relaxation budget can be applied to both Pcell and Scell in our view, but we could also consider to allow relaxation only to the Scell band, if such proposal is acceptable.  MediaTek: As above comment, equivalent absolute inter-band CA requirement is suggested by using single-band requirement with extra relaxation, compared to define delta value or delta CDF.  Huawei: new concept, need time check. |
| Issue 3-1-2: Intra-band DL CA impact of beam squint on CA EIS | No impact for intra-band REFSENS, and no further impact to consider because spherical coverage requirement is absent (Y/N) | Samsung: agree on no further impact to consider for spherical coverage, but wondering why no impact to peak EIS caused by beam squint. Does it because the RX beam peak direction is corresponding to zero delta phase between antenna elements in simulation? In real products, due to form factor and material, there may be non-zero delta phase between antenna elements for beam peak direction.  Nokia: No impact means that the network assumes that UE meet the same EIS requirement in each CC. If that is not the case, we may better to discuss this in Rel-16, as we have not defined requirement in Rel-15.  The same framework as the inter-band CA requirement for CBM can be introduced to intra-band CA with wider spectrum more than 1400 MHz. (as already discussed.)  LGE: Agree with Samsung. Maybe some phase difference will be impact to CA EIS for intra-band CA  Huawei: it is only for PC3? Ambiguous question.  Apple: The impact is not in the intra-band REFSENS but in the EIS spherical coverage. In our contribution we have shown that the impact could be up to 0.6 dB for intra-band non-contiguous CA with 1400 < Fs ≤ 2400 MHz. |
| Issue 3-1-3: Inter-band DL CA impact of beam squint on CA EIS | CCDF Relaxation | Nokia: The relaxation due to beam squint should be included within the inter-band CA relaxation budget. There is no need to split the relaxation budget between conducted and radiated domain.  LGE: needed  MediaTek: Beam squint is an important loss components of “conceptual inter-band CA relaxation factor”, we shall consider it while evaluating inter-band CA relaxation factor value.  Sony: Yes, but only on the CC without DL RS in CBM.  Huawei: it is only for PC3,only for CBM? Ambiguous question. |
| No impact for inter-band REFSENS, and no further impact to consider because there is no intra-band spherical coverage requirement to extend to inter-band | Samsung: agree on no further impact to consider for spherical coverage, but wondering why no impact to peak EIS caused by beam squint. Does it because the RX beam peak direction is corresponding to zero delta phase between antenna elements in simulation? In real products, due to form factor and material, there may be non-zero delta phase between antenna elements for beam peak direction.  Apple: The impact is not in the inter-band REFSENS but in the EIS spherical coverage. In our contribution we have proposed 1.8 dB for 28 GHz band group and 2.6 dB for 39 GHz band group. |
| Issue 3-2-1: Beam management reference signal location | In FR2 CA cases, requirements apply when the BM RS is provided in a CC with a configured UL BWP (Y/N) | Intel: Yes  Nokia: BM RS is provided in Pcell for CBM. BM RS is provided in Pcell and one of Scell in IBM.  Ericsson: yes, another configuration would be somewhat odd.  LGE : Agree with Nokia  MediaTek: No. For non-collocated scenario, BM RS shall be provided for both CCs.  Sony: Yes.  Huawei: share view with Nokia. But whether pecell can be not configured for UL and only DL Pcell is configured? |
| Issue 3-2-2: Intra-band DL CA impact of beam squint on CA ~~EIS~~ EIRP | Beam squint effect can be captured as CA EIRP CDF degradation, if (see 3-1-1) ‘antenna gain change CDF’ is captured elsewhere (Y/N) | Nokia: All relaxation should be included in one value as intra-band CA relaxation, which is defined per band for each band combination. No need to split between conducted and radiated relaxation.  MediaTek: Equivalent absolute CA requirement is suggested, compared to delta value.  Huawei: new concept, need time check. |

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *(see WF below)* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 | WF on FR2 Beam Squint Effect | Sony |

### CRs/TPs

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

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

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

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

# 4 Version Tracking

|  |  |
| --- | --- |
| Version | File |
| v0 | Initial |
| v1 | Summary\_123\_1st\_v0\_Intel\_Samsung\_Nokia2\_LGE\_mtk \_OPPO\_Sony |
|  | Summary\_123\_1st\_v0\_Intel\_Samsung\_Nokia\_LGE\_HW |
|  | Summary\_123\_1st\_v0\_Intel\_Samsung\_Nokia\_EAB |
|  | Summary\_123\_1st\_v0\_Intel\_Samsung\_Nokia\_QC2\_DCM |
|  | Summary\_123\_1st\_v0\_Intel\_Samsung\_Nokia\_LGE\_HW\_Verizon-r1 |