**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.14.1.3, 8.14.1.4, 8.14.1.7

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Email discussion for RAN4#94e\_#22\_NR\_RF\_FR2\_req\_enh\_Part\_3

**Document for:** Information

# Introduction

Scope of this email discussion is listed in Table 1.

In this meeting following open issues will be discussed

**Sub-topic 1: Intra-band cont DL CA for aggregated BW larger than 1400 MHz**

1.1 Do we define new contiguous BW classes or remove from WID

**Sub-topic 2: Intra-band non-cont DL CA for aggregated BW larger than 1400 MHz**

 2.1 Type of DL-only spectrum

 2.2 EIS relaxation

 2.3 Radiative sensitivity degradation mechanisms

TP to TR, CRs, other proposals can be addressed after convergence on above

**Sub-topic 3: Inter-band DL CA**

 3.1 Quantifying spherical coverage

3.2 L+L topics: PSD difference, Relaxation framework, Beam management

 3.3 L+H topics: PSD difference, Relaxation framework

 3.4 Formalizing L+L/L+H split

 3.5 Testing considerations

TP to TR, CRs, other proposals can be addressed after convergence on above

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

* 1st round: Topics listed above with numbers (x.x)
* 2nd round: TBA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Email title** | **WI** | **Topic areas** | **AI** |
| 22 | RAN4#94e\_#22\_NR\_RF\_FR2\_req\_enh\_Part\_3 | R16 NR FR2 RF | * Intra-band cont DL CA for aggregated BW larger than 1400 MHz
* Intra-band non-cont DL CA for aggregated BW larger than 1400 MHz
* Inter-band DL CA
 | 8.14.1.3, 8.14.1.4, 8.14.1.7 |

# Topic #1: Intra-band contiguous DL CA for aggregated BW larger than 1400 MHz

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** | **Title** | **Company** | **Proposals / Observations** |
| **R4-2000756** | FR2 CA bandwidth classes for aggregated channel BW > 1200 MHz | MediaTek Inc. | ***Proposal 1****: RAN4 to consider the following two options on handling the objective of defining UE RF requirements for intra-band contiguous DL CA for aggregated channel bandwidth larger than 1200 MHz in FR2 RF requirement enhancement work item.** ***Option 1****: Remove this objective in the work item.*
* ***Option 2****: At least define CA bandwidth classes for aggregated channel BW > 1200 MHz and allow the completion of the work item without any real CA combination proposed in these CA bandwidth classes.*

***Observation 1****: Compared to LTE, it is less straightforward to comprehend the relation between the CA bandwidth class notations and the number of component carriers in NR due to the multiple fallback groups, especially for FR2.* ***Observation 2****: The approach of introducing new CA bandwidth classes as shown in Table 2-2 would make the relation between the CA bandwidth class notations and the number of component carriers in each fallback group even less straightforward to comprehend than the Rel-15 CA bandwidth class definition.* ***Proposal 2****: If RAN4 adopts option2 in proposal 1, it is proposed to only introduce new CA bandwidth classes in fallback group “1” for aggregated channel bandwidth up to 2400 MHz as highlighted in Table 2-3 for Rel-16.* |

## 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: Intra-band DL CA for aggregated BW larger than 1400 MHz

**Issue 1-1.1: RAN4 to determine if new contiguous BW classes must be defined**

***Proposal 1****: RAN4 to consider the following two options on handling the objective of defining UE RF requirements for intra-band contiguous DL CA for aggregated channel bandwidth larger than 1200 MHz in FR2 RF requirement enhancement work item.*

* ***Option 1****: Remove this objective in the work item.*
* ***Option 2****: define new CA bandwidth classes for aggregated channel BW > 1200 MHz*
* Recommended WF
	+ TBA

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Issue** | **Company Comments** |
| Issue 1-1.1: RAN4 to determine if new contiguous BW classes must be defined | Qualcomm: We agree with the options. We would however like to continue studying the technical issues with very wide signals (>1 GHz) with common analog beam forming towards making a decision. |
| Huawei: It depends on deployment demand. We are open to both options. If there is no real deployment demand, we would prefer option1 since larger aggregated channel bandwidth will cost some resource on UE design. We all know power consumption is very limited factor for FR2. |

## 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:* |

*Recommendations on WF/LS assignment*

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

## 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”* |

# Topic #2: Intra-band non-contiguous DL CA for aggregated BW larger than 1400 MHz

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

## Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc number** |  | **Company** | **Proposals / Observations** |
| [**R4-2000013**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000013.zip) | Remaining issues with the FR2 frequency separation class | Apple Inc. | **Proposal 1:** **RAN4 to introduce Fsd according to Alt 1 in the WF from RAN4 #93, such that the spectrum covered by the DL-only frequency separation shall be extended equally on both sides (half on each side) relative to bidirectional spectrum.****Proposal 2:** **RAN4 should discuss whether an additional restriction on CC allocation according to Case 3 is needed.****Proposal 3:** **Assuming RAN4 can finalize the open issues related to the signaling aspects for DL-only frequency spectrum, a CR is needed to merge the technically endorsed content from RAN4 #93 with the additional agreements.** |
| [**R4-2000014**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000014.zip) | CR to 38.101-2 on FR2 frequency separation class enhancement | Apple Inc. |  |
| [**R4-2000015**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000015.zip) | Views on FR2 DL intra-band CA REFSENS | Apple Inc. | Observation 1: The wider bandwidth will lower the Q-factor, which will increase the noise figure of the receiver. Consequentially the increase of the NF will affect directly the receiver reference sensitivity.**Proposal 1:** **Define 1.0 dB for the EIS relaxation ΔRIB for a cumulative aggregated channel BW from 1400 MHZ to 2400 MHz in intra-band non-contiguous CA reference sensitivity requirement.** |
| [**R4-2000207**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000207.zip) | FR2 DL Intra-band CA BW Enhancement Feature Parameters | Qualcomm Incorporated | Observation 1: It is not clear if the network benefits from a UE with split DL-only spectrum coverageObservation 2: A UE with contiguous DL-only spectrum leaves no gaps in UL coverage.**Proposal 1: DL-only spectrum shall be restricted to a single contiguous spectrum.****Proposal 2: (Definition) ‘DL-only spectrum’ is the width of contiguous UE frequency spectrum available to the network to configure a DL CC but not an UL CC, in addition to and adjoining the DL spectrum capability declared via ‘DL frequency separation class’ signalling.** **Proposal 3: Send LS to RAN2 to inform them of definition of new per-band capability parameter ‘DL-only Spectrum Class’ describing the UE’s enhanced DL intra-band CA BW.**  |
| [**R4-2000208**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000208.zip) | TP to TR38.831: FR2 UE architectures for DL Intra-band CA BW Enhancement | Qualcomm Incorporated |  |
| [**R4-2000209**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000209.zip) | LS on FR2 DL Intra-band CA BW Enhancement Feature Parameters | Qualcomm Incorporated |  |
| [**R4-2000210**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000210.zip) | FR2 enhanced DL BW definitions | Qualcomm Incorporated | Observation 1: In Rel-15 UEs, a UE’s bidirectional spectrum capability was captured by its DL frequency separation class declaration. **Proposal 1: (Definition) ‘DL frequency separation’ is the frequency span between lower edge of lowest component carrier and upper edge of highest component carrier in DL CA configuration, limited by the DL frequency separation class declaration.****Proposal 2: (Definition) ‘DL-only spectrum’ is the width of UE frequency spectrum available to the network to configure a DL CC but not an UL CC, in addition to and adjoining the DL spectrum capability declared via ‘DL frequency separation class’ signalling.**  |
| [**R4-2000211**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000211.zip) | Draft CR to 38.101-2: DL CA BW Enhancement for Rel-16 | Qualcomm Incorporated |  |
| [**R4-2000759**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000759.zip) | On FR2 DL intra-band CA cumulative aggregated BW enhancement | MediaTek Inc. | ***Observation 1****: For DL-only frequency separation class (Fsd) where the extended separation can only be equally added to both sides of the UL/DL common coverage range, the usage scenario is quite restricted and the architecture is less likely be practically implemented.* ***Observation 2****: The receiver chain dependent frequency separation signalling would not really benefit UE implementation nor the network scheduling to optimize the spectrum utilization.* ***Proposal 1: For DL intra-band CA cumulative aggregated BW enhancement, adding the new frequency separation classes up to 2400 MHz as technically endorsed in RAN4 #93 meeting is sufficient. It is not necessary to introduce additional DL-only frequency separation class (Fsd) and new signalling capability.*** ***Observation 3****: To support DL frequency separation wider than 1400 MHz, the receiver likely would suffer higher sensitivity degradation regardless of the number of down-conversion paths used to receive the signal*.***Proposal 2: Rel-16 RIB EIS relaxation requirement is revised as in the table below to support DL intra-band non-contiguous CA with cumulative aggregated bandwidth > 1400 MHz and up to 2400 MHz.******Proposal 3: Rel-16 MPR requirements for CA are revised as in the table below (PC3 used as example) to support DL intra-band non-contiguous CA with cumulative aggregated bandwidth > 1400 MHz and up to 2400 MHz.*** |
| [**R4-2001044**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001044.zip)(from AI 8.14.1.7) | Discussion on FR2 intra-band DL CA enhancement | Nokia, Nokia Shanghai Bell | ***Proposal 1: Alt 1 shall be supported for the signalling for DL-only frequency spectrum. (****Introduce a new DL-only frequency separation class, ‘Fsd’)****Proposal 2: There shall be no restriction in UL spectrum coverage when the maximum DL separation Fs+Fsd is configured in downlink, i.e., uplink shall be configurable for the entire Fs+Fsd (though not simultaneously).*** |
| [**R4-2001760**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001760.zip) | On intra-band NC DL CA\_FR2 | Huawei, HiSilicon | ***Proposal 1: two sided DL only spectrum shall be dropped.*** *Observation 1: one sided DL-only spectrum UE capability also have deployment/configuration limitation for network/operators.**Observation 2: there is RF solution for the problem of spectrum position limitation.**Observation 3: one sided DL-only spectrum can be only served for multi receiving chains architecture****.******Proposal 2: Extending separation class into a List in Rel-16, each separation class value belongs to each chain. The List can be described as below:***

|  |  |
| --- | --- |
| FreqsSeparationSet  | Separation class capability belongs to each chain |
| 1 | One of separation Class(I,II,III,IX) |
| 2 | One of separation Class(I,II,III,IX) |
| … |  |
| maxNrofFreqSeparationSet | One of separation Class(I,II,III,IX) |

***Proposal 3: considering potential limitation on the FR2 deployment, we prefer there is no limitation on the DL-only spectrum position, one-sided or two-sided or un-symmetrically two sided shall be mandatory supported by the UE.*** |
| [**R4-2002147**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002147.zip)(from AI 8.14.1.6)  | Beam squint analysis for FR2 PC3 UEs | Qualcomm Incorporated | **Proposal: RAN4 to discuss how to capture consideration for radiative degradation mechanisms like beam squint for larger frequency separation.** |

## 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: DL-only spectrum type supported by UE

**Issue 2.1-1: Current Proposals**

* (for reference only: some proposals are inconsistent with WF [1])
	+ Option 1: contiguous, extends on one side relative to bidirectional spectrum
	+ Option 2: split (2-sided), extends equally on both sides (half on each side) relative to bidirectional spectrum
	+ Option 3: split (2-sided), no restriction on how DL-only spectrum is arranged on either side of bidirectional spectrum
* Recommended WF: Please limit discussion to DL-only spectrum options outlined in WF [1]



### Sub-topic 2-1: the EIS relaxation ΔRIB

**Issue 2.2-1: Breaks in frequency for row definition**

* Proposals
	+ Option 1:

|  |  |
| --- | --- |
| **Cumulative Aggregated Channel BW (MHz)** | **ΔRIB (dB)** |
| ≤ 800 | 0.0 |
| > 800 and ≤ 1400 | 0.5 |
| > 1400 and ≤ 2400 | 1.0 |

* Option 2:

|  |  |
| --- | --- |
| **Cumulative Aggregated Channel BW (MHz)** | **ΔRIB (dB)** |
| ≤ 800 | 0.0 |
| > 800 and ≤ 1400 | 0.5 |
| > 1400 and ≤ 2000 | TBD |
| > 2000 and ≤ 2400 | TBD |

**Issue 2.2-2: Relaxation dB values**

* Proposals
	+ Option 1: 1 dB for > 1400 MHz
	+ Option 2: TBD

### Sub-topic 2-3: Relaxation for Beam squint

**Issue 2.3-1: Should RAN4 discuss how to incorporate EIS/ REFSENS degradation due to beam squint**

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

## Companies views’ collection for 1st round

### Open issues

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| 2.1-1: DL-only spectrum type supported by UE, per [1] | Option #1:Only 1 type allowed: contiguous (extends on one side) | Qualcomm: We are ok with either option, but we note that choosing option #1 simplifies signaling and network management. With Fs > Fsd, option 1 has no holes in UL coverage.Huawei: in the last meeting, there is agreements that up to 3 subblocks in UL NC CA. before discussing on whether DL only spectrum is contiguous, we would like to make it clear that whether it means DL NC CA will also limited into 3 subblocks in Rel-16. And the agreement shall be captured into the WF.For options, there is another option shall be captured that no limitation on DL-only. As discussed in our paper, both 1sided and 2 sided have limitation deployment, we strongly RAN4 agrees on the “no limitation” option.  |
| Option #2:Both types allowed:1. Contiguous (extends on one side)
2. split (2-sided), extends equally on both sides
 |
| 2.2-1: EIS relaxation table breaks | Treat 1400 to 2000 MHz range separately from 2000 to 2400 MHz | Huawei: would like to clarify that ∆Rib is only for peak direction or both peak and CDF point? Recommend both peak and CDF point. Then we may need two tables.For the table range, prefer option 2(with 4 parts), but may need further evaluation the segment point. |
| Treat 1400 to 2400 MHz as one range |
| 2.2-2: EIS relaxation values | 1.0dB | TBD |
| TBD |
| 2.3-1: RAN4 to discuss how to capture EIS/EIRP degradation due to beam squint | Yes/No | Yes. Would like to clarify whether it belongs to ∆Rib discussion for Rx part? Since DL beam squint will impact on EIS requirement. |

## 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:* |

*Suggestion on WF/LS assignment*

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

## 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”* |

# Topic #3: Inter-band 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** |
| [**R4-2000017**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000017.zip) | Views on FR2 DL inter-band CA REFSENS | Apple Inc. | Observation 1: The wider bandwidth will lower the Q-factor, which will increase the noise figure of the receiver. Consequentially the increase of the NF will affect directly the receiver reference sensitivity.**Proposal 1: Define 1.0 dB for the EIS relaxation ΔRIB for inter-band CA combination (CA\_n257-n258, CA\_n258-n261, CA\_n259-n260) with a frequency separation span larger than 1400 MHz.** |
| [**R4-2000018**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000018.zip) | EIS spherical coverage for inter-band CA in FR2 | Apple Inc. | **Proposal 1: RAN4 assumes Alt. 1 (UE is assumed to have common beam management) for beam management for the bands that are part of supported band configuration in inter-band CA for 28 GHz + 28 GHz or 39 GHz + 39 GHz combinations.****Proposal 2: Equal PSD among 28+28 and 39+39 band groups can be confirmed for the conformance test configuration.****Proposal 3: RAN4 to study further the conformance test configuration for the 28+39 CA scenario.**Proposal 4: The common spherical coverage CDF is computed using the joint criterion of {EIS1≤s and EIS2≤s}, such that the resulting function of signal level s is equivalent to the diagonal of the joint empirical CDF P(EIS1≤s1,EIS2≤s2)*Observation 1: A requirement on the value at the 50th percentile of this common CDF can be derived in terms of the degradation relative to the strongest CC and defined in the specification as an absolute value*Observation 2: The value of the 50%-tile of the common CDF for 28+28 and 39+39 band groups is degraded by up to 6 dB relative to the strongest carrier in the combination.Observation 3: The value of the 50%-tile of the common CDF for 28+39 band groups is degraded by up to 7.5 dB relative to the strongest carrier in the combination.. Proposal 5: RAN4 continues to study further the common CDF definition and parameters for CA within 28+28/39+39 band groups and does not pursue the common CDF for CA within 28+39 band groups. |
| [**R4-2000115**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000115.zip) |  Inter-band CA remaining open requirements | Qualcomm Incorporated | **Proposal 1: Relaxation for spherical coverage for inter-band CA between 28 GHz and 39 GHz band groups is 1.5 dB****Proposal 2: Relaxation to peak EIS for inter-band CA between 28 GHz and 39 GHz band groups is 1.5 dB** **Proposal 3: No additional multiband relaxations are defined because of inter-band CA** **Proposal 4: UE requirements at sensitivity level conditions are valid for maximum 6.5 dB PSD difference between the bands part or inter-band CA configuration for CA between 28 and 39 GHz band groups** **Proposal 5: In band blocking and adjacent channel selectivity requirements will be specified in same manner as for LTE and NR FR1 inter-band CA.**  |
| [**R4-2000116**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000116.zip) | draftCR: Introduction of inter-band CA to 38.101-2 | Qualcomm Incorporated |  |
| [**R4-2000357**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000357.zip) | Inter-band CA with/without independent Rx beam  | Qualcomm Incorporated | Observation 1: Inter-band CA with independent beam management for both bands is well understood and work could be concluded in this meeting. Observation 2: Inter-band CA with common beam management needs more work and requirements may differ from inter-band CA with independent beam management**Proposal: Distinguish two sub-categories for FR2 inter-band CA in the WID [1] objective** |
| [**R4-2000395**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000395.zip) | PSD imbalance in Inter-band DL CA | Intel Corporation | **Proposal 1: on EIS spherical coverage, equal PSD is assumed among 28+28 and 39+39 band groups.****Proposal 2: In OTA conformance test of FR2 inter-band DL CA, both 28GHz and 39GHz bands should be within a common single AoA.**Observation 1: Based on reasonable hardware design, 30dB power imbalance can be tolerated at sensitivity level with non-zero MSD. **Proposal 3: For inter-band CA between two band groups, 30dB PSD imbalance between bands in different band groups should be specified at sensitivity test with MSD = 0.5dB.**  |
| [**R4-2000443**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000443.zip) | Test system for inter-band DL CA in FR2 | Anritsu Corporation | *Observation 1: Test system needs to be designed flexible as much as possible to avoid adding an impact on the existing (Rel-15) and future requirements. Otherwise even the existing core requirements and test requirements will have to be revisited by adding multiple CA test cases****.*** ***Proposal 1: Figure out possible necessary requirements in Release 16 which are related to FR2 inter band CA.******Proposal 2: Allow a use of additional offset antennas for measurement of FR2 RF TRx requirements even with one AoA measurement condition. FFS if there is any needs of additional measurement uncertainty caused by the offset antennas.*** |
| [**R4-2000444**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000444.zip) | Consideration on two-DL spherical coverage test with power imbalance | Anritsu Corporation | *Observation 1: By having a power imbalance between 28 GHz and 39 GHz bands, two DL inter-band spherical coverage test becomes rather a part of out-of-band blocking test.**Observation 2: As far as a frequency of the higher PSD signal is defined only at one test point, its condition cannot always be the worst case as the spherical coverage test with a blocker.* *Observation 3: Out-of-band blocking requirement for FR2 was extensively discussed and concluded that the in-band blocking requirement covers the OOB test.* ***Proposal 1: There is no need to define the power imbalance condition with two DL signals for the inter-band spherical coverage test.****Observation 4: To avoid an unnecessary impact to the existing Rel-15 test requirements, it is reasonable to choose a test system configuration which incorporates independent offset antennas for the inter-band CA test cases.**Observation 5: On condition that the test configuration is assuming multiple antennas for transmission of each band, achievable power imbalance is roughly 20 dB@50 MHz CBW, 17 dB@100 MHz, 14 dB@200 MHz and 11 dB@400 MHz in a case the spherical coverage test is carried out with n260 band. Note this estimation does not include multi-band relaxation****.*** |
| [**R4-2000445**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000445.zip) | Consideration on capability of multi signal transmission from single AoA in FR2 OTA test system | Anritsu Corporation | *Observation 1: It is not possible for the system simulator to create multiple DL signals simultaneously which are not within a range of approx. 1 GHz by single DAC.**Observation 2: It is challenging to apply method 1 without giving an impact on the existing Rel-15 RF test requirements and test systems.**Observation 3: Method 2 has a limitation with a polarization of the test signals which can be transmitted simultaneously from SS. (i.e. two signals with same polarizations cannot be transmitted)**Observation 4: It is reasonable to add a flexibility of using offset antennas for secondary cell or blocker* ***signal.******Proposal 1: Allow a flexibility of using offset antennas in the FR2 test configuration for inter-band/ blocking measurements and assume it as a system with single AoA.*** |
| [**R4-2000446**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000446.zip) | Influences of multiple offset antennas in FR2 chamber | Anritsu Corporation | *Observation 1: It is important that the FR2 OTA test system has a capability of its calibration incorporating multiple measurement antennas to maintain a compatibility and a flexibility to multiple test cases.**Observation 2: There is a possibility that an influence of a mutual coupling effect can be seen in a case offset antennas are arranged in a vicinity of the in-band antenna.**Observation 3: Reduction of gain with the AUT due to the offset antenna measurement was approximately 2 to 3 dB at the worst case.**Observation 4: The gain reduction of reference antenna in a case of measurement from the offset antenna can be reduced by an optimization of chamber / antenna arrangement / reflector design and also by a calibration of the loss at the center of the quiet zone.**Observation 5: Input from the UE vendor/ chipset vendor is appreciated whether a significant impact can be expected by the angular error from the offset antenna (approx. 2 to 4 degrees’ angular error at the center of QZ).**Observation 6: By an electromagnetic field simulation, in a case aluminium blocks are arranged at both sides of the in-band antenna, the mutual coupling effect was observed with the horizontal polarization source from the feed antenna, and the gain of the in-band antenna increased approx. 0.25 dB at 23.45 GHz. Influence of aluminum blocks is small with the vertical polarization source (< 0.1 dB).* *Observation 7: In a case an aluminum block is arranged above the in-band antenna, the mutual coupling effect was observed with both the horizontal and vertical polarization sources, and the gain of the in-band antenna varied approx. 0.2 dB at 23.45 GHz within +/- 10 degree range.**Observation 8: Though a gain reduction of the reference antenna caused by an offset of feed antennas can be observed, it is possible to minimize this influence by a proper design in a chamber and also the calibration of the loss with the reference antenna at the center of the quiet zone. Necessity of the additional MU with regards to the gain loss of the reference antenna or the antenna in a UE is FFS.**Observation 9: Though a mutual coupling occurs by the existence of offset antennas, it is possible to calibrate out this influence by including it as the QoQZ measurement uncertainty.****Proposal 1: Interested companies are encouraged to bring views on the impact of the angular error to the UE caused by the offset antenna measurement.***  |
| [**R4-2000796**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2000796.zip) | FR2 inter-band DL CA relaxation framework | MediaTek Beijing Inc. | ***Proposal1:*** *Apply extended relaxation framework after considering FR2 inter-band DL CA as Fig 2.****Proposal2:*** *Define ∑DLCAP as UE FR2 inter-band DL CA relaxation factors for peak EIS****Proposal3:*** *Define ∑DLCAs (dB) as UE FR2 inter-band DL CA relaxation factors for EIS spherical coverage****Proposal4:*** *Use Table 2 as table format for UE FR2 inter-band DL CA relaxation factors.****Proposal5:*** *Companies are encouraged to share market demand on specific FR2 inter-band DL CA operations and associated multiband operations.****Proposal6:*** *Apply peak EIS and EIS spherical coverage test reduction:**．If UE passes equal DL CA peak EIS requirement, the non-CA peak EIS requirement can be skipped.**．If UE passes equal DL CA EIS spherical requirement, the non-CA EIS spherical requirement can be skipped.* |
| [**R4-2001494**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001494.zip) | Views spherical coverage relaxation for inter band DL CA | Sony, Ericsson | Observation 1: Distribute the total relaxation on each band equally demands a smaller total relaxation comparing to place all the relaxation on one single band. **Proposal 1: UE is assumed to have common beam management for the bands that are part of supported band configuration in inter-band CA for 28 GHz + 28 GHz or 39 GHz + 39 GHz combinations.****Proposal 2: Define the relaxation for inter-band CA operation per band rather than the total relaxation.****Proposal 3: For high band + low band inter-band CA spherical coverage, allowing 2 dB relaxation on each band for the UE to meet the common spherical coverage requirement.**  |
| [**R4-2001776**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001776.zip) | On inter band DL CA\_FR2 | Huawei, HiSilicon | ***Proposal 1: For 28GHz+39GHz inter-band CA, RAN4 do not define PSD difference limitation when define the RF requirement.******Proposal 2: For 28GHz+39GHz inter-band CA, a test case with 30dB PSD difference shall be evaluated and defined.******Proposal 3: 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.******Proposal 4: 3dB per band is defined additionally for inter-band 28GHz+39GHz CA on min peak EIS.******Proposal 5: RAN4 Define UE capability simultaneous Tx/Rx optional for inter-band 28GHz+39GHz, UE behavior shall be dependent on implementation.****Observation 1: common beam management and equal PSD for 28+28 and 39+39 inter-band CA actually requires for collocated deployment only.****Proposal 6: If collocated deployment is confirmed in RAN4 for 28+28 and 39+39 inter-band CA, separation class extends to be indicated per band combination per receiving chain.******Proposal 7: If both collocated and non-collocated deployment are existed for 28+28 and 39+39 inter-band CA, same conclusion as in inter-band 28+39GHz CA on beam management and PSD condition shall be utilized.***  |
| [**R4-2001779**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2001779.zip) | TP for inter-band CA refsens FR2\_Rel-16 | Huawei, HiSilicon |  |
| [**R4-2002114**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_94_e/Docs/R4-2002114.zip) | PSD imbalance for FR2 Inter-band DL CA of 28GHz + 40GHz | NTT DOCOMO INC. | Observation:The required capability for PSD imbalance should be 15 dB for co-located scenario and 25dB for non-co-located scenario.**Proposal:****Take either of below options for FR2 inter-band DL CA of 28GHz + 40GHz:*** **Option 1: Specify 25dB PSD imbalance requirement and test in RF conformance testing.**
* **Option 2: Introduce a new UE capability signalling to distinguish the capability of handling PSD difference for co-located or non-co-located scenario**
	+ **When the capability is set to 0, 15dB PSD imbalance requirement shall apply.**
	+ **When the capability is set to 1, 25dB PSD imbalance requirement shall apply.**
 |

## 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: Quantifying spherical coverage for inter-band CA

**Issue 3.1-1:**

* Proposals
	+ Option 1: spherical coverage for each band determined separately and common coverage area established. (see R4-2000116 for detail)
	+ Option 2: common CDF shall be used for L+L, common CDF shall not be used for L+H
* Recommended WF: Please limit discussion to options outlined in WF [2]



### Sub-topic 3-2: LB + LB, HB + HB inter-band CA

**Issue 3.2-1: PSD difference as a capability**

* Proposal: UE capability to distinguish UE’s capability of handling PSD difference
	+ Option 1: Yes
	+ Option 2: No

**Issue 3.2-2: PSD difference**

* Proposals
	+ Option 1: ≥ 25 dB, ≤ 30 dB
	+ Option 2: 6.5 dB
	+ Option 3: 0 dB

**Issue 3.2-3: EIS Relaxation Framework**

* Proposals
	+ Option 1: single band + MBR+ inter-band DL CA relaxation factor
	+ Option 2: single band + inter-band DL CA relaxation factor
	+ Option 3: other

**Issue 3.2-4: Beam management**

* Proposals
	+ Option 1: Common Beam Management
	+ Option 2: Separate beam management

### Sub-topic 3-3: LB + HB inter-band CA

**Issue 3.3-1: PSD difference as a capability**

* Proposal: UE capability to distinguish UE’s capability of handling PSD difference
	+ Option 1: Yes
	+ Option 2: No

**Issue 3.3-2: PSD difference**

* Proposals
	+ Option 1: ≥ 25 dB, ≤ 30 dB
	+ Option 2: 6.5 dB

**Issue 3.3-3: EIS Relaxation Framework**

* Proposals
	+ Option 1: single band + MBR + inter-band DL CA relaxation factor
	+ Option 2: single band + inter-band DL CA relaxation factor
	+ Option 3: Other

### Sub-topic 3-4: Split item in WID to separate L+H from L+L/H+H

**Issue 3.4-1:**

* Proposals
	+ Option 1: Treat L+H separately from L+L (or H+H)
	+ Option 2: treat all FR2 inter-band CA as one category

### Sub-topic 3-5: testing considerations for inter-band CA

**Issue 3.5-1: Allow a flexibility of using offset antennas in the FR2 test configuration for inter-band/ blocking measurements and assume it as a system with single AoA.**

* Proposals
	+ Option 1: yes
	+ Option 2: no

**Issue 3.5-2: Allow a use of additional offset antennas for measurement of FR2 RF TRx requirements even with one AoA measurement condition. FFS if there is any needs of additional measurement uncertainty caused by the offset antennas.**

* Proposals
	+ Option 1: yes
	+ Option 2: no

## Companies views’ collection for 1st round

### Open issues

|  |  |  |
| --- | --- | --- |
| **Issue** | **Options** | **Company Comments** |
| 3.1-1: Quantifying spherical coverage for inter-band CA | spherical coverage for each band determined separately, and common coverage area established | Qualcomm: We would like further clarification on common CDF approach. We would like to explain through an example for PC3, in an n257+n260 case. Ignoring MBR or other relaxations for this example, RAN4 seek to establish for common coverage:P(X≥8.0, Y≥11.5) ≥ 0.5, Where:X = sph. coverage of EIRP of n260 (dBm)Y = sph. coverage of EIRP of n257 (dBm)The common CDF approach however captures a different parameter:P(X≤8.0, Y≤11.5) (note sign difference). We would like to go with the common coverage area approach as in WF. Huawei: common spherical coverage range works well for co-located case, while for non-collocated may not much adaptable. For L+H, we are open for not use common CDF, would like to request information on most deployment scenarios for L+H. |
| common CDF shall be used for L+L, common CDF shall not be used for L+H |
| 3.2-1: LB + LB, HB + HB PSD difference capability signaling | Yes/No | Huawei: for L+L and H+H, we think it depends on deployment. If PSD difference is not existed (gNB can gurantee, collocation), no need to have capability signaling. If it is existed, the UE shall support the PSD difference mandatory. |
| 3.2-2: LB + LB, HB + HB PSD difference |  ≥ 25 dB, ≤ 30 dB | Qualcomm: We would like to go with the agreement in brackets in WF [2]: “PSD difference ….and [equal] PSD among 28+28 and 39+39 band groups”Huawei: depends on whether 2 bands can be collocated deployed. For non-collocated case, ≥ 25 dB, ≤ 30 dB is expected. |
|  6.5dB |
|  0 dB |
| 3.2-3: LB + LB, HB + HB EIS relaxation framework | single band + MB-R+ inter-band DL CA relaxation factor | Qualcomm: delta R IB (inter-band) should be the only additional relaxation compared to single-band operation. Our preference is not to create a new relaxation for single band operation just because UE supports inter-band CA. Huawei: option1, for both peak and spherical coverage |
| single band + inter-band DL CA relaxation factor |
| other |
| 3.2-4: LB + LB, HB + HB Beam Management | Same | Qualcomm: With the agreements on inter-band testing (single AoA), same beam management should be assumed for the RF requirements. Huawei: testability limitation shall not be the bottleneck of UE implementation and behavior in real network. It depends on deployment case, for non-collocated independent shall be assumed. Additionally, there is no contradiction, Independent BM can also support single AOA. |
| Independent |
| 3.3-1: LB + HB PSD difference capability signaling | Yes/No | No capability but may with PSD difference |
| 3.3-2: LB + HB PSD difference |  ≥ 25 dB, ≤ 30 dB | Qualcomm: We can compromise to 7.5 dB for EIS conditions and higher SNR conditions need to be discussed separately, possibly in BB agenda.Huawei: should not have limitation when defining RF requirement, since we already agree on TAE keep 3us. We need to have a test case to verify the PSD difference issue. From network implementation perspective, we can see ≥ 25 dB, ≤ 30 dB PSD is possible. We don’t recommend to introduce UE capability, it is mandatory for UE if UE can support inter-band CA. we don’t have such capability in FR1 and UE work well. |
|  6.5dB |
| New UE capability to distinguish UE’s capability of handling PSD difference |
| 3.3-3: LB + HB EIS relaxation framework | single band + MBR+ inter-band DL CA relaxation factor | Qualcomm: delta R IB should be only relaxation because of inter-band CA operation. Our preference is not to add relaxation to single band operation just because UE supports inter-band CA. Huawei: prefer single band + MBR+ inter-band DL CA relaxation factor, since MBR and inter-band DL CA relaxation factor do not come from the same issue. For issue whether apply to single band, need further evaluation. If it is not applied for single band, it may need some adjustment when condition is changed, it actually depends on the RF architecture used for inter-band CA.  |
| single band + inter-band DL CA relaxation factor |
| other |
| 3.4-1: separate L+H from L+L/H+H in WID | Yes/No |  |
| 3.5-1: allow offset antennas as equivalent to single AoA for IBB | Yes/No | Qualcomm: This Ran5 facing question should not delay introduction of core requirements. Huawei: IBB issue may need to discuss in enhanced test SI or Rel-15.  |
| 3.5-2: allow offset antennas for TRx requirements | Yes/No | Qualcomm: This Ran5 facing question should not delay introduction of core requirements.Huawei: Firstly, we think it is in the range of this WI as agreed in the WF. Would like to clarify that whether there is other test method to generating 2 DL signals with single AOA simultaneously? According to R4-2000445, we can see it is not possible. We would like hear the comments from TE vendors. If it is not possible, we would like to clarify that how much angle difference reached UEs on these 2 DL signals with antenna offset method. I mean, we may need to initiate the 2AOA test environment discussion for inter-band CA in RAN4. |

## 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:* |

*Suggestion on WF/LS assignment*

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

## 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”* |

# References

[1] R4-1916021, “WF on intra-band NC DL CA”, Qualcomm, RAN4#93, Reno, NV, USA

[2] R4-1916024, “WF on FR2 inter-band DL CA”, Nokia, RAN4 #93, Reno, NV, USA