**3GPP TSG-RAN4 Meeting #95-e *R4-200xxxx***

**Electronic meeting, August 18 - 27 2020**

**Agenda item: 7.12.2.1**

**Source:** Moderator (Apple)

**Title:** [96e][220] NR\_RF\_FR2\_req\_enh\_RRM

**Document for:** Information

# Introduction

The email discussion is intended to cover topics in AI 7.12.2.1 on MRTD for NR FR2 inter-band CA.

In RAN4#95e, the following WF on MRTD for CBM and IBM has been agreed

* At least 260ns is feasible from UE perspective
* At least 3us MRTD is feasible from network perspective for co-located deployments
* Further study feasibility to support up to 3us MRTD from UE perspective under assumption of co-located deployment in terms of impact on performance (e.g. possible scheduling restrictions)
  + Option 1: complete this work by Rel-16. If not consensus can be reached by RAN4#96e, do not define CBM RRM requirements in Rel-16
  + Option 2: continue discussing this in Rel-17. No CBM RRM requirements in Rel-16 are defined.
* If no consensus can be made to define MRTD value for CBM and the study on the feasibility to support up to 3us MRTD by RAN4#96e, no CBM RRM requirements in Rel-16 are defined

Agreement: 8us MRTD is defined for IBM based FR2 inter-band CA

# Topic #1: MRTD and MTTD for CBM and IBM in FR2 inter-band CA

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2009766**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2009766.zip) | Xiaomi | **Proposal 1: The MRTD for FR2 inter-band CA with CBM is defined as 260ns.**  **Proposal 2: If a larger value of MRTD, e.g. 3us is defined, it is necessary to add a note of “If the receive timing difference exceeds the cyclic prefix length, performance degradation is expected for the first symbol of the slot” in TS38.133.** |
| [**R4-2009984**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2009984.zip) | Qualcomm | **Observation 1:** If 260ns MRTD is not feasible for all scenarios, then some mitigation techniques for MRTD larger than a threshold (e.g. 260ns) should be discussed.  **Observation 2:** In an FR2 inter band CA with CBM scenario, when gNB switches its TCI state, where the new reference signal is not QCLed to the previous reference signal, UE would use one band’s timing as the reference time and use that to simultaneously change RX beams for all bands.   * If RTD among these bands is greater than a threshold (e.g. cyclic prefix), UE loses a symbol in all other bands.   **Observation 3:** UE may have to change its RX beam even if gNB TX beam remains the same, e.g. 1) to tackle rotation or 2) to train its RX beam set while gNB transmits CSI-RS with repetition parameter ON.  **Observation 4:** The mitigation techniques mentioned in proposal 3 are needed while switching between DL and UL, as well, and this may impact RAN1 spec.  **Observation 5:** The discussion regarding MRTD for CBM UEs needs to be completed by RAN4 #96e. Designing all mitigation techniques for MRTD > 260 ns, within RAN4 #96e, is infeasible.  **Observation 6:** Rel-15 did not define MTTD for intra-band CA because it assumed that UE uses only one TAG in intra-band CA.  **Observation 7:** If MTTD is defined for CBM UEs in FR2 inter band CA, then mitigation techniques also need to be introduced when gNB changes UL spatial relationship and UE changes UL TX beams.  **Proposal 1:** MTTD for FR2 inter band CA with IBM should be 8.5 us.  **Proposal 2:** If MRTD > CP duration is allowed for CBM UEs, gNB and UE should have a common understanding about the reference band, i.e., the band whose time UE uses as a reference time during TCI state switch. This can be done in one of the following two ways:   1. gNB can explicitly inform UE about the reference band or 2. the reference band can be defined through spec, e.g. the band containing the PCell/PSCell (if PCell/PSCell is in FR2) or the band with the lowest CC index within FR2.   **Proposal 3:** If MRTD > CP duration is allowed for CBM UEs, RAN4 allows one of the following two techniques to mitigate impact to non-reference bands during TCI state switch, where the new reference signal is not QCLed to the previous reference signal:   1. Inserting guard symbol before every TCI state switch or 2. Allowing scheduling restrictions in non-reference bands during TCI state switch   E.g. UE is not expected to transmit PUCCH/PUSCH/SRS or receive PDCCH/PDSCH/TRS/CSI-RS for CQI on the symbol and on one symbol before the symbol where gNB switches its TCI state.  **Proposal 4:** If MRTD > CP duration for CBM UEs, RAN4 allows one of the two mitigation techniques shown in proposal 3 while gNB transmits CSI-RS with repetition parameter ON.  **Proposal 5:** RAN4 can discuss limiting the number of symbol losses in non-reference bands within a specified time due to UE’s autonomous RX beam changes.  **Proposal 6:** RAN4 should send a LS to RAN1 and check if RAN1 is OK with MRTD >> CP duration for CBM UEs before approving it.  **Proposal 7:** MRTD for FR2 inter band CA with CBM should be 260ns in Rel-16. Discuss MRTD > 260 ns for CBM UEs in Rel-17.  **Proposal 8:** No MTTD requirement is specified in FR2 inter band CA for CBM UEs. Discuss MTTD = 3.5 us for CBM UEs in Rel-17. |
| [**R4-2010051**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010051.zip) | Apple | **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 1: The following revision is proposed for TS38.133**  Table 7.6.4-2: Maximum receive timing difference requirement for inter-band NR carrier aggregation   |  |  | | --- | --- | | Frequency Range of the pair of carriers | Maximum receive timing difference (µs) | | FR1 | 33 | | FR2 | 8note1 | | Between FR1 and FR2 | 25 | | Note1: this MRTD requirement applies to independent beam management only. | |   **Proposal 2: 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 3: In case of common beam management, it is assumed that gNB for all CC are collocated and the same Rx antenna array at UE is shared by all CC.**  **Proposal 4: It is proposed to reuse FR2 intra-band CA MRTD, i.e. 260ns for the MRTD of FR2 inter-band CA in case of common beam management.** |
| [**R4-2010311**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010311.zip) | Mediatek | **Observation 1: For FR2 inter-band CA with CBM, the MRTD should be smaller than CP/2 in order to provide UE sufficient to switch the common Rx beam of all CCs.**  **Observation 2: If MRTD > 260ns, the time and condition to trigger DL interruption caused by Rx beam sweeping could be completely unknown to network.**  **Observation 3: If MRTD > 260ns, the interruption caused by Rx beam sweeping is very likely to impact the PDCCH symbol of a slot, making the whole slot useless.**  **Proposal 1: For FR2 inter-band CA with CBM, the MRTD should be 260ns to avoid unexpected interruption to DL reception. If 260ns is not agreeable, no MRTD and MTTD requirements for CBM are introduced in Rel-16.** |
| [**R4-2010616**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010616.zip) | Ericsson, KDDI Corporation, NTT DOCOMO INC | ***Observation-1: There are many options before scheduling restrictions are needed, like available time in UL and DL (if carriers not full) and UL to DL switch, where UE could safely switch beams.***  ***Observation-2: A beam switch change during TDL-UL guard period would not impact reception of another 3 µs late DL carrier.***  Given these observations, we propose the following:  ***Proposal-1: Any change in MRTD should not impact already defined BS TAE of 3 µs for FR2 inter-band CA; i.e. keep Rel-15 values for BS TAE unchanged.***  ***Proposal-2:***   * ***The beam management is implementation dependent, thus not applicable to all UEs and to all band combinations.*** * ***The relevant UEs should be identified and distinguished (e.g. via capability indication, etc.) and the restrictions shall not be applied (e.g. deployment restrictions, etc.) for all UEs and all band combinations for the future of NR.*** * **An agreed and approved UE capability indication, as in the bullet above, is a precondition for proposals in this document.**   ***Proposal-3: Define MRTD for inter-band FR2 NR CA with common beam management as 3 µs.***  ***Proposal-4: Corresponding MTTD for inter-band FR2 NR CA with common beam management as 3.5 µs.*** |
| [**R4-2010710**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010710.zip) | OPPO | **Proposal 1: For MRTD of FR2 inter-band CA with CBM, reuse FR2 intra-band CA MRTD, i.e. 0.26us.**  **Proposal 2: Do not define CBM RRM requirements in Rel-16 if no consensus can be made.**  **Proposal 3: For R15, revise Table 7.6.4-2 in TS38.133 to clarify 8us MRTD only applies to IBM.**  **Proposal 4: For R16, new MRTD for IBM with smaller value than 8us is also ok, i.e., 5us.**  **Proposal 5: Reuse 8.5us for MTTD for IBM, and MTTD for CBM depends on the conclusion of MRTD of CBM.** |
| [**R4-2010757**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010757.zip) | NEC | **Proposal 1: RAN4 to introduce new MRTD of 3us for an UE which is only capable of CBM.**  **Proposal 2: RAN4 to agree that MRTD value for a UE which supports both IBM and CBM is 8us for IBM and 3us for CBM.**  **Proposal 3: RAN4 to agree that performance degradation of upto 1 OFDM symbol is allowed for UE operating in CBM during RX beam switch.**  **Proposal 4: RAN4 should further study scheduling restriction/performance degradation in Rel-17.** |
| [**R4-2011062**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2011062.zip) | Huawei, HiSilicon | ***Observation 1: 260ns MRTD for CBM UE would require 260ns BS TAE for FR2 inter-band CA, which results in BS implementations that are neither backward compatible with current FR2 intra-band CA nor forward compatible with new FR2 CA band combinations in future.***  ***Proposal 1: If the interruption due to UE beam switching is not acceptable for CBM UE, we suggest not to define RRM requirements for CBM based FR2 inter-band CA in Rel-16.*** |
| [**R4-2011429**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2011429.zip) | Nokia, Nokia Shanghai Bell | 1. RAN4 will define MRTD requirements for IBM capable UE assuming collocated deployments using an L+H FR2 inter-band CA combo for Rel-16. 2. RAN4 does not define MRTD and MTTD requirements for CBM capable UE in Rel-16. |
|  |  |  |
| **[R4-2011322](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2011322.zip)** | Intel | **Proposal 1: In case of common beam management in FR2 inter-band CA, for MRTD it is proposed to reuse FR2 intra-band CA requirements, i.e. MRTD = 260ns.** |

## Summary of Open Issues

*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: MRTD with CBM in Rel-16

*Agreement in RAN4#95e: If no consensus can be made to define MRTD value for CBM and the study on the feasibility to support up to 3us MRTD by RAN4#96e, no CBM RRM requirements in Rel-16 are defined*

* **Option 1: 260ns (Apple, Mediatek, Qualcomm, Xiaomi, OPPO, Intel)**
* **Option 2: 3us (Ericsson, NTT DCM, KDDI, NEC, Huawei)**
* **Option 3: RAN4 does not define MRTD and MTTD requirements for CBM capable UE in Rel-16. (Nokia, Huawei)**

### Sub-topic 1-2: Potential system impact and performance degradation related to MRTD>CP with common beam management

* **Option 1: If 260ns MRTD is not feasible for all scenarios then some performance degradation for MRTD larger than a threshold (e.g. 260ns) should be discussed (Xiaomi)**
* **Option 2: performance degradation of up to 1 OFDM symbol is allowed for UE operating in CBM during RX beam switch. (NEC)**
* **Option 3: if MRTD>CP, mitigation techniques and the related system impacts should be investigated and approved (Qualcomm)**
* **Option 4:No further system impact and performance degradation should be discussed and specified in Rel-16**

### Sub-topic 1-3: Applicability of existing MRTD in R15 and R16 on common beam management

**Proposal: The following revision is proposed for TS38.133**

Table 7.6.4-2: Maximum receive timing difference requirement for inter-band NR carrier aggregation

|  |  |
| --- | --- |
| Frequency Range of the pair of carriers | Maximum receive timing difference (µs) |
| FR1 | 33 |
| FR2 | 8note1 |
| Between FR1 and FR2 | 25 |
| Note1: this MRTD requirement applies to independent beam management only. | |

* **Option 1: yes (Apple, OPPO)**
* **Option 2: no**

### Sub-topic 1-4: MTTD with IBM

* **Option 1: 8.5us (Qualcomm, OPPO)**

### Sub-topic 1-5: MTTD with CBM

* **Option 1: 3.5us (Ericsson, KDDI, DCM)**
* **Option 2: No requirement is specified. (OPPO, Qualcomm)**

## Companies views’ collection for 1st round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
| ZTE | Sub-topic 1-1:  Support Option 2. But considering requirements work to be done with 3us MRTD, it may not be feasible to finish the work in Rel-16. So Option 3 is also fine.  Sub-topic 1-2:  Firstly scheme to handle 3us MRTD needs to be decided. A lot of schemes have been proposed, e.g. allowing 1 OFDM symbol of interruption, mitigation techniques, Rx beam switching during guard period, allowing performance degradation. In our view these schemes needs further evaluation in RAN4. So option 4 would be feasible from this point of view.  Sub-topic 1-3:  The issue seems not correct. It would be for IBM rather than CBM. If for IBM then the answer is yes.  Sub-topic 1-4:  Option 1 is fine.  Sub-topic 1-5:  Depending on outcome of MRTD discussion. |
| Huawei | Sub-topic 1-1:  As we mentioned in our discussion paper, we suggest to define MRTD requirements for CBM UEs and IBM UEs based on the same BS TAE requirements. If MRTD for CBM UEs was defined as 260ns, then it means that the CBM UE requires a stricter BS TAE requirements, i.e. 260ns BS TAE. However, the MRTD for IBM UE is defined as 8us, based on 3us BS TAE. Support of CBM IBM is a UE capability. If CBM UE and IBM UE require different BS TAE requirements, then it would make the BS meet the stricter TAE requirements. 260ns BS TAE would bring a big challenge for BS implementation and cause both backward and forward compatible issues.  Our preference is option 2 with allowing interruptions for UE beam switching. If option 2 is not agreeable, we can compromise to option 3.  Sub-topic 1-2:  If 3us MRTD for CBM UE is agreeable for sub-topic 1-1, then we support option 2.  Sub-topic 1-3:  Generally, we can agree with option 1. However, the wording of Note 1 need to be updated as follows:  “This requirement applies to the UE capable of independent beam management for FR2 inter-band CA.”  Sub-topic 1-4:  We support option1.  Sub-topic 1-5:  This depends on the conclusion of Sub-topic 1-1. If 3us MRTD for CBM UE is agreeable, then option 1 is suggested. |
| MediaTek | Sub-topic 1-1:  Support Option 1, since the interruption will be unexpected and likely to corrupt PDCCH symbols, which makes the whole slot useless.  If 260ns is not agreeable, we can support Option 3, i.e., no MRTD/MTTD requirement for CBM UE in R16.  Sub-topic 1-2:  Option 4. It’s related to topic 1-1. If Option 1 or Option 3 in topic 1-1 got agreed, then the topic 1-2 discussion is not necessary.  One comment on Option 2. If the impact occurs on the PDCCH symbol, the performance degradation will not just on 1 symbol.  Sub-topic 1-3  Option 1, while the typo can be corrected.  Sub-topic 1-4  Option 1.  Sub-topic 1-5  Option 2. We can follow the same logic as in Rel-15, where MRTD for intra-band CA is specified but not for MTTD requirement. |
| Nokia | Sub-topic 1-1: MRTD with CBM in Rel-16  We support option 3. RRM requirements work for FR2 inter-band CA should be aligned with the deployments, scenarios, band combinations and RF architectures discussed for release 16 for FR2 inter-band CA in the RF session. As this discussion on RF session is still ongoing and this meeting is the last meeting for this Rel-16 topic, we should focus on the deployments and scenarios which already achieved or may achieve in this meeting.  Sub-topic 1-2: Potential system impact and performance degradation related to MRTD>CP with common beam management  We support option 4. it will also depend on the conclusion of sub-topic 1-1.  Sub-topic 1-3: Applicability of existing MRTD in R15 and R16 on common beam management  This is Rel-16 work item to add a new feature to Rel-16, Rel-15 should not be discussed. We can revise Rel-15 after we are all ok with this Rel-16 stuff. For Rel-16, our view is that the MRTD requirement (8us for FR2 inter-band CA) is only applicable to independent beam management with collocated deployment and do not define the MRTD requirements for CBM in Rel-16.  Sub-topic 1-4: MTTD with IBM  MTTD=8.5us for IBM with collocated deployment.  Sub-topic 1-5: MTTD with CBM  It will depend on the conclusion of sub-topic 1-1. |
| Ericsson | Sub-topic 1-1: We prefer option 2 (3 µs). Existing TAE requirement is TAE = 3 µs and MRTD ≥ TAE. There are many conditions to consider before secluding restrictions are needed, or before performance degradation happen, like not all data symbols occupied, or utilize DL to UL guard, manage the frequency of beam switches and keep switch time short in relation to symbol time to mitigate a hit, if and when it happens.   Furthermore, operator deployment of transmission network presuppose existing TAE = 3 µs from current specification and smaller TAE imply operator and BS cost since not compatible with existing requirements.  Sub-topic 1-2: We prefer option 3 (if MRTD>CP, mitigation techniques and the related system impacts should be investigated and approved). In our tdoc R4-2010616 we discuss that there are many conditions to be fulfilled, before any scheduling restriction or performance degradation has to happen.  Sub-topic 1-3: We do not agree with the proposed revision, so we prefer option 2 (do not revise as proposed). If we have CBM and IBM then both have to be considered, at the same time, in any revision of TS 38.133 Table 7.6.4-2. We do not want to approve a change which leaves CBM case undefined, if we agree to have CBM. If we agree not to have CBM in rel-16 then existing TS 38.133 is fine.  Sub-topic 1-4: Existing specification is fine. This corresponds to option 1 (8.5 µs).  Sub-topic 1-5: Option 1 (3.5 µs). |

### CRs/TPs comments collection

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

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| **CR/TP number** | **Comments collection** |
| [**R4-2009767**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2009767.zip) **CR on MRTD requirement for FR2 inter-band CA** | Nokia: NOK, for IBM it is agreed to be 8us in last meeting. |
| Company B |
|  |
| [**R4-2010056**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010056.zip) **CR on MRTD for inter-band CA** | Nokia: CR can wait until the conclusion of open issues. |
| Company B |
|  |
| [**R4-2010617**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010617.zip) **Updates on MRTD and MTTD requirements for FR2 inter-band DL CA** | Nokia: CR can wait until the conclusion of open issues. |
| Company B |
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| [**R4-2010758**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2010758.zip) **CR to TS 38.133 on MRTD values for FR2 inter-band CA** | Nokia: CR can wait until the conclusion of open issues. |
| Company B |
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| [**R4-2011430**](http://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_96_e/Docs/R4-2011430.zip) **CR on 38133 MRTD for FR2 inter-band DL CA** | Nokia: CR can wait until the conclusion of open issues. |
| Company B |
|  |

## Summary for 1st round

### Status Summary

### Open issues

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

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|  | **Status summary** |
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*Recommendations on WF/LS assignment*

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

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

## Companies views’ collection for 2nd round

### Open issues

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| --- | --- |
| **Company** | **Comments** |
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## Summary on 2nd round (if applicable)

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

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