**3GPP TSG-RAN WG4 Meeting # 102-e R4-22xxxxx**

**Electronic Meeting, Dec.21 – Mar. 3, 2022**

**Agenda item:** 10.4.6

**Source:** Moderator (Nokia, Nokia Shanghai Bell)

**Title:** Email discussion summary for [102-e][210] NR\_RF\_FR2\_enh2\_RRM

**Document for:** Information

# Introduction

The WID on NR RF Enhancements for FR2 RP-202107 has been approved in RAN#89e meeting. The purpose of this work item is to specify the following FR2 UE features and associated requirements including RF and RRM requirements. This email discussion is to discuss the RRM core requirements for inter-band CA in FR2 corresponding to section 10.4.6, 10.4.6.1 and 10.4.6.2 in the agenda.

In last RAN4#101bis-e meeting, RAN4 concludes partially on the performance degradation due to network controlled TCI state change. In addition, some agreements were reached on the RRM requirements for IBM capable UE in FR2 inter-band UL CA. The agreements and open issues are captured in the way forward R4-2202581.

Based on the agreements, the target of this meeting is to agree on the performance degradation for network driven Rx beam switch and UE autonomous beam switch cases, and further conclude on the RRM requirements other than MRTD. If any feedback could be received from RF session on the UE Rx beam switch time, we could further conclude on the value of X. The tentative target of email discussion for 1st round and 2nd round is indicated below:

* 1st round: Companies are expected to provide views and/or comments on the listed open issues and draft CRs.
* 2nd round: Conclude on the performance degradation due to Rx beam switching and RRM requirements other than MRTD. Endorse the draft CRs if possible.

# Topic #1: Inter-band DL CA requirements for CBM

Moderator comments: All the contributions discussing or partially discussing the RRM requirements for FR2 inter-band DL CA enhancements for CBM are listed here.

## Companies’ contributions summary

14 contributions and 8 draftCRs are submitted/reserved on Topic #1.

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2205868 | Nokia, Nokia Shanghai Bell | Reserved Draft Big CR on RRM requirements for FR2 Inter-band CA |
| R4-2205869 | Nokia, Nokia Shanghai Bell | draftCR on CBM inter-band FR2 DL CA |
| **R4-2203860** | Qualcomm Incorporated | **Observation 1**: When signals from non-anchor carrier, e.g. SCell, arrives at UE 3usec of MRTD earlier than anchor-carrier’s, e.g. PCell, 31% of the first OFDM symbol (excluding CP) in a slot may not be received by the UE. Due to the ISI and ICI, UE may not be able to decode PDCCH.  **Observation 2**: When signals from non-anchor carrier, e.g. SCell, arrives at UE 3usec of MRTD later than anchor-carrier’s, e.g. PCell, 29% of the last OFDM symbol (excluding CP) in a slot may not be received by the UE. Due to the ISI and ICI, UE may not be able to decode segmented code block(s) mapped to the last OFDM symbol.  **Proposal 1:** For the performance degradation due to network driven Rx beam switch i.e. TCI state change,   * If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for the first or the last symbol of the slot in a SCell in a band where beam management reference resource(s) is not configured, where X is defined in Table 7.6.4, if the UE is configured with different QCL-TypeD sources in consecutive slots. If UE is scheduled to apply different QCL assumptions within a slot, additional performance degradation is expected within the slot. The performance degradation is not expected in the bands where multi-receiver architecture based CBM DL CA is used, if defined by RF group. FFS on the details of the bands.   **Proposal 2:** For the performance degradation due to UE autonomous Rx beam switch,   * Do not define any explicit requirements on how often and how much performance degradation is expected unless it can be tested under specific conditions where the degradation can be accurately quantified.   **Proposal 3:** RAN4 to not consider any network-controlled performance degradation mitigation technique to cope with RTD equal to or greater than [X]. Instead, it should be left to UE implementation. |
| **R4-2204149** | LG Electronics | **Proposal 1: Specify a unified requirement for performance degradation regardless of Rx beam switch and UE autonomous Rx beam switch.**  **Proposal 2: Do Rx beam switching in slot boundary in one CC which is received later to reduce performance degradation when receiving time difference exceeds X.**  **Proposal 3: If no agreement on UE Rx beam switch time, consider 200ns for UE Rx beam switch time + 2 x DL timing error for both SCSs of SSB.** |
| **R4-2204182** | MediaTek inc. | ***Observation 1: If the timing of PCell is earlier than the timing of SCell, interruption on the last symbol of SCell would occur.***  ***Proposal 1:* *Demodulation performance degradation is expected for the first or the last symbol of the slot in the SCells of the other band. (Option 1)***  ***Observation 2: Even there is no TCI state switch command to change the TCI state, if the “already configured” TCI states are different between symbols, the performance degradation still occurs.***  ***Proposal 2:* *If UE is scheduled to apply different QCL assumptions within a slot, additional performance degradation is expected within the slot. (Option 1)***  ***Proposal 3:* *For the UE autonomous Rx beam switching, add a note as Option 1 is more preferred****.* |
| **R4-2204271** | OPPO | ***Observation 1: The performance degradation should be more predictable for both UE and network.***  ***Proposal 1: For performance degradation due to network driven Rx beam switch, we can compromise to a fixed impacted symbol (e.g., first symbol)******of the SCell of the other band under the condition of some restriction on NW driven Rx beam switching.***  ***Proposal 2: If UE is scheduled to apply different QCL assumptions within a slot, additional performance degradation is expected within the slot.***  ***Proposal 3: Do not define any explicit requirements on how often and how much performance degradation is expected unless it can be tested under specific conditions where the degradation can be accurately quantified.***  ***Proposal 4: No need to define solutions to reduce/avoid performance degradation. Leave autonomous Rx beam switch to UE implementation.*** |
| **R4-2205326** | Huawei, HiSilicon | ***Proposal 1: We suggest to use option 1 to clarify the performance degradation due to network driven Rx beam switching.***   * ***Option 1: If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for the first or the last symbol of the slot in the SCells of the other band, where X is defined in Table 7.6.4.***   ***Proposal 2: We suggest to allow additional performance degradation on a slot when UE is scheduled to apply different QCL assumption within the slot.***  ***Proposal 3: We suggest to use the same note to allow the performance degradation due to both network driven Rx beam switching and UE autonomous Rx beam switching.***  ***Proposal 4: It is suggested to add a note to the MRTD requirements for CBM UE as follows:***   |  |  | | --- | --- | | **Frequency Range of the pair of carriers** | **Maximum receive timing difference (µs)** | | FR1 | 33 | | FR2 | 8 note1 | | 3 note2, note3 | | Between FR1 and FR2 | 25 | | Note1: This requirement applies to the UE capable of independent beam management for FR2 inter-band CA.  Note2: This requirement applies to the UE capable of common beam management for FR2 inter-band CA. If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for the first or the last symbol of the slot in the band where beam management reference resource(s) is not configured.  Note3: If UE is scheduled to apply different QCL assumptions within a slot, additional performance degradation is expected within the slot. | | |
| **R4-2205423** | Ericsson | **Observation 1: RAN4 tentatively agrees to [59 ns] gNB switch time.**  **Proposal 1: RAN4 tentatively agrees [59 ns] UE Rx beam switch time.**  **Proposal 2: X = 1039 ns for SCS = 60 kHz data and X = 490 ns for SCS = 120 kHz data.   Observation 2: Protect the last symbol due to network driven Rx beam switch e.g. TCI state change.**  **Proposal 3: Adding a note to the corresponding MRTD table for network driven Rx beam switch i.e. TCI state change and UE autonomous Rx beam switch:**  **“This requirement applies to the UE capable of common beam management for FR2 inter-band CA. If the receive time difference exceeds [X] of that SCS, and there are no gaps where data is not received, demodulation [performance degradation] is expected for ~~[TBD]~~ last symbol of every [Y] slot , in the band where beam management reference resource(s) is not configured, where X is defined in Table 7.6.4.3. The UE beam switch can if no gaps exist be allowed at symbol occasions assigned by the network, where occasions with a max period of Y will be guaranteed.”**  **Proposal 4: Final [performance degradation] and value of [Y] slot period are resolved in the UE demodulation performance part of WI.**  **Proposal 5: The UE beam switch can if no gaps exist be allowed at symbol occasions assigned by the network, where occasions with a max period of [Y] will be guaranteed.** |
| **R4-2205424** | Ericsson | 38.133 draftCR on MRTD/timing requirements for inter-band DL CA |
| R4-2205870 | Nokia, Nokia Shanghai Bell | UE Rx beam switch time   1. The UE Rx beam switch time is discussed in RF session AI 10.4.2.1.4.   **Case 1:** Performance degradation impact due to network driven Rx beam switch i.e. TCI state change   1. Clarification is needed when UE is scheduled to apply different QCL assumptions within a slot due to TCI state change. 2. For Case 1, Clarify the performance degradation impact for MRTD of 3us for inter-band CA in FR2 under CBM with a note stating ‘This requirement applies to the UE capable of common beam management for FR2 inter-band CA. If the receive time difference exceeds X us of that SCS, demodulation performance degradation is expected for the first or the last symbol of the slot in the SCells of the other band. where X is defined in Table 7.6.4.’ 3. For Case 1, Demodulation performance degradation is expected only after the slot n+ THARQ + where UE switch it’s Rx beam due to MAC-CE based TCI state change   **Case 2:** Performance degradation due to UE autonomous Rx beam switch   1. RAN4 should further discuss how often and when UE autonomous Rx beam switch will happen in option 2&3 based on option 1. 2. For Case 2 (performance degradation due to UE autonomous Rx beam switch), Clarify the performance degradation impact for MRTD of 3us for inter-band CA in FR2 under CBM with a note stating ‘This requirement applies to the UE capable of common beam management for FR2 inter-band CA. If the receive time difference exceeds X us of that SCS, demodulation performance degradation is expected for the first symbol of the slot in the SCells of the other band.’ where X is defined in Table 7.6.4. 3. For Case 2 (performance degradation due to UE autonomous Rx beam switch), Additional clarification notes may be needed to consider some performance degradation with a maximum limit. |
| R4-2205871 | Nokia, Nokia Shanghai Bell | draftCR on MRTD for CBM inter-band FR2 DL CA |
| **R4-2203861** | Qualcomm Incorporated | **Proposal 1**: The scheduling restriction is limited to the bands where single-receiver architecture based CBM DL CA is used, if defined by RF group. FFS on the details of the bands.  **Proposal 2**: The existing scheduling restriction for intra-band FR2 CA is extended to inter-band FR2 CA for CMB UEs. For this, the following statement is added to respective existing scheduling restriction requirements, and do not differentiate between RTD < X and RTD > X:   * For a UE capable of common beam management on this FR2 band pair, when inter-band carrier aggregation in FR2 is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band and other band on the symbols that fully or partially overlap with the aforementioned restricted symbols. The scheduling restriction is limited to the bands where single-receiver architecture based CBM DL CA is used, if defined by RF group. FFS on the details of the bands.   **Proposal 3:** Unknown SCell activation requirements for CBM based FR2 CA are as bellow:   * If RAN4 agrees MAC-CE to activate TCI and CSI reporting are sent along with SCell activation MAC CE itself, * In case of Semi-persistent CSI-RS is used for CSI reporting:   + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TFineTiming + 5ms * In case of periodic CSI-RS is used for CSI reporting:   + 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TFineTiming + 2ms * Otherwise, * In case of Semi-persistent CSI-RS is used for CSI reporting:   + 6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).   + TSMTC\_MAX: the longer SMTC periodicity between active serving cells and SCell being activated in the bands supported for CBM * In case of periodic CSI-RS is used for CSI reporting:   + 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. |
| **R4-2204183** | MediaTek inc. | *Proposal 1:* *The TCI state indication should not be skipped.*  *Proposal 2:* *For FR2 CBM unknown SCell activation, specify the requirement for the case that MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and CSI reporting are sent along with SCell activation MAC-CE, if semi-penitent CSI-RS is used for CSI reporting.*  *Proposal 3:* *For FR2 CBM unknown SCell activation, specify the requirement for the case that MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and RRC configuration message for TCI of periodic CSI for CQI reporting are sent along with SCell activation MAC-CE, if periodic CSI-RS is used for CSI reporting.*  *Proposal 4:* If semi-persistent CSI-RS is used for CSI reporting, provided that the MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and CSI reporting are sent along with SCell activation MAC-CE, then Tactivation\_time is: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TFineTiming + 2ms.  *Proposal 5:* If periodic CSI-RS is used for CSI reporting, provided that the MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and RRC configuration message for TCI of periodic CSI for CQI reporting are sent along with SCell activation MAC-CE, then Tactivation\_time is: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max{(TFineTiming + 2ms), TRRC\_delay}.  *Proposal 6:* *For FR2 CBM unknown SCell activation, clarify*  *Proposal 7:* *When inter-band carrier aggregation in FR2 with CBM is performed, the scheduling restrictions on FR2 serving PCell or PSCell apply to all serving cells in the same band or in the CBM cell group on the symbols that fully or partially overlap with restricted symbols* |
| **R4-2204184** | MediaTek inc. | **draftCR on SCell activation delay requirement for FR2 inter-band CA with common beam management** |
| **R4-2204272** | OPPO | ***Observation 1: Whether to define scheduling restrictions depends on the conclusion of performance degradation when RTX > X.***  ***Proposal 1: The existing scheduling restriction for intra-band FR2 CA is extended to inter-band FR2 CA for CMB UEs for RTX < X.***  ***Proposal 2: If PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is unknown, the SCell activation requirements shall be***   * **in case of Semi-persistent CSI-RS is used for CSI reporting:**   **6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + max (Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP)**   * **in case of periodic CSI-RS is used for CSI reporting:**   **3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}** |
| **R4-2205327** | Huawei, HiSilicon | ***Proposal 1: It is suggested to define the scheduling restriction requirements for FR2 inter-band CA with CBM regardless of RTD<X or RTD>X, i.e. option 1.***  ***Proposal 2: For CBM UE, the uncertainty time for waiting TCI state activation command of the target SCell can be skipped for defining the SCell activation delay for unknown target SCell in case 2.***  ***Proposal 3: For CBM UE, the uncertainty time for waiting CSI-RS activation command of the target SCell cannot be skipped for defining the SCell activation delay for unknown target SCell in case 2.***  ***Proposal 4: For CBM UE, the SCell activation delay Tactivation\_time for unknown target SCell in case 2 can be defined as:***   |  | | --- | | If the PCell/PSCell and the target SCell are in a FR2 band pair with common beam management, and the target SCell is unknown to UE and semi-persistent CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:  - 6ms + TFirstSSB\_MAX + TSMTC\_MAX + 8\*Trs + max(TFineTiming + 2ms, THARQ + Tuncertainty\_SP).  If the PCell/PSCell and the target SCell are in a FR2 band pair with common beam management, and the target SCell is unknown to UE and periodic CSI-RS is used for CSI reporting, provided that the side condition Ês/Iot ≥ -2dB is fulfilled, then Tactivation\_time is:  - 3ms + TFirstSSB\_MAX + TSMTC\_MAX + 8\*Trs + max {(5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. |   ***Proposal 5: It is suggested to introduce the applicability rules for CBM based FR2 inter-band CA, and the following common assumptions needs to be clarified for UE capable of CBM FR2 inter-band CA.***   * ***CBM UE can assume same QCL assumptions for all FR2 serving cells on one symbol.*** * ***CBM UE is required to perform RLM/BFD/CBD only on SpCell and perform L1-RSRP/L1-SINR measurements only on the serving cell(s) in the same band as SpCell.*** |
| **R4-2205328** | Huawei, HiSilicon | **DraftCR on applicability rules for FR2 inter-band CA with CBM** |
| R4-2205657 | Apple | **Observation: When MRTD is not small enough, the impact of Rx beam switch is not just performance degradation. Instead, it will result in the failure detection of the whole symbol. Consequently, it will further result in failing to detect the whole slot.**   * **This is a completely different situation from the MRTD in intra-frequency NC CA case in section 7.6.4**   **Proposal 1: Scheduling restriction should be introduced to prevent the significant performance degradation due to Rx beam switching in CBM when MRTD is not small enough.**  **Proposal 2:**  **When FR2 PCell and PSCell slot boundary is always used as the reference for Rx beam switching, no performance degradation can be guaranteed for PCell and PCell.**  **On all SCell, symbols right before and after the PCell/PSCell slot boundary where Rx beam switching should be subjected to the scheduling restriction.**  **Proposal 3:**  **When there is no PCell and PSCell, the slot boundary of the FR2 SCell which arrives the earliest to the UE will be used as the reference for Rx beam switching. In this case, all impacted symbols from other CC should be the last symbol of the slot.**  **Since network has not info which SCell will arrive first, scheduling restriction applies on the last symbol of the slot right before Rx beam switch happens for all CC.** |
| R4-2205830 | Ericsson | **Proposal 1: RAN4 to agree that the existing scheduling restriction for intra-band FR2 CA is extended to inter-band FR2 CA for CBM UEs, and do not differentiate between RTD < X and RTD > X.**  **Proposal 2: RAN4 to agree that MAC-CE to activate TCI and semi-persistent CSI is sent along with SCell activation MAC CE itself. There is no uncertainty term required in the SCell activation delay timeline as the beam information is known at the time of SCell activation command indication.**  **Proposal 3: RAN4 to agree that additional RRC message is not needed to activate CSI reporting. Hence RRC uncertainty and RRC processing delay are not needed in delay requirements.**  **Proposal 4: SCell activation delay (Tactivation\_time) for Semi-persistent CSI and periodic CSI reporting is 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + TFineTiming + 2ms.** |
| R4-2205831 | Ericsson | **Draft CR on scheduling restriction for FR2 inter-band DL CA for CBM UE** |
| R4-2205872 | Nokia, Nokia Shanghai Bell | Scheduling restrictions:   1. Once X is known RAN4 need to define scheduling restrictions for when RTD exceeds X. 2. Capture the UE scheduling availability requirements based on the assumption that RTD ≤ X  * Once X is known RAN4 need to define scheduling restrictions for when RTD exceeds X   SCell activation delay requirements for an unknown SCell for FR2 inter-band CA for CBM capable UE is (assuming SCell is in the other band than the band in which the BM RS is located):   1. Semi-persistent CSI-RS is used for CSI reporting: 6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + 2ms 2. Periodic CSI-RS is used for CSI reporting: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + 5ms |
| R4-2205873 | Nokia, Nokia Shanghai Bell | **draftCR on measurement restriction for CBM inter-band FR2 DL CA** |

## Open issues summary

### Sub-topic 1-1: MRTD requirements for CBM

*Sub-topic description:* This sub-topic discusses the MRTD requirements for common beam management and potential performance impact on FR2 inter-band DL CA.

*Agreement on RAN4#101bis-e GTW (Jan.24):*

* + *Performance degradation due to network driven Rx beam switch e.g. TCI state change (Case 1)* 
    - *Performance degradation will be specified as a note in MRTD clause*
    - *Option 1: If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for the first or the last symbol of the slot in the SCells of the other band, where X is defined in Table 7.6.4.*
    - *Option 2: If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for the first symbol of the SCell of the other band, where X is defined in Table 7.6.4.*

**Issue 1-1-1: performance degradation due to network driven Rx beam switch e.g. TCI state change (Case 1)**

* Proposals:
  + Option 1: If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for **the first or the last symbol** of the slot in the SCells of the other band, where X is defined in Table 7.6.4. (Qualcomm, LG, Mediatek, OPPO, Huawei, Nokia)
  + Option 2: If the receive time difference exceeds [X] of that SCS, demodulation performance degradation is expected for **the first symbol** of the SCell of the other band, where X is defined in Table 7.6.4. (LG)
  + Option 3: This requirement applies to the UE capable of common beam management for FR2 inter-band CA. If the receive time difference exceeds [X] of that SCS, and there are no gaps where data is not received, demodulation [performance degradation] is expected for ~~[TBD]~~ last symbol of every [Y] slot , in the band where beam management reference resource(s) is not configured, where X is defined in Table 7.6.4.3. The UE beam switch can if no gaps exist be allowed at symbol occasions assigned by the network, where occasions with a max period of Y will be guaranteed. (Ericsson)
    - Final [performance degradation] and value of [Y] slot period are resolved in the UE demodulation performance part of WI.
    - The UE beam switch can if no gaps exist be allowed at symbol occasions assigned by the network, where occasions with a max period of [Y] will be guaranteed.
* Recommended WF:

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| **Company** | **Comments** |
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**Issue 1-1-1A: Adding additional note considering different QCL-Type D:**

* Proposals:
  + Option 1: If UE is scheduled to apply different QCL assumptions within a slot, additional performance degradation is expected within the slot (Qualcomm, Mediatek, OPPO, Huawei)
  + Option 2: More clarification is needed when UE is scheduled to apply different QCL assumptions within a slot due to TCI state change. (Nokia)
* Recommended WF: Mediatek indicates the network driven Rx beam switch includes 2 cases and both need to be captured. This issue intends to address Case 1-2. Could proponents of Option 1 clarify when Case 1-2 would happen?
* *Case 1-1: TCI state switch, as specified in clause 8.10, TS38.133*
* *Case 1-2: Different QCL assumptions of symbols within a slot*

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| **Company** | **Comments** |
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**Issue 1-1-1B: Conditions when/where the performance degradation in Issue 1-1-1 (case 1) is expected:**

* Proposals:
  + Option 1: Demodulation performance degradation is expected only after the slot n+ THARQ + where UE switch it’s Rx beam due to MAC-CE based TCI state change (Nokia)
  + Option 2: When there are no gaps where data is not received (Ericsson)
  + Option 3: The performance degradation is not expected in the bands where multi-receiver architecture based CBM DL CA is used, if defined by RF group. (Qualcomm)
* Recommended WF: Some companies further identify the conditions when/where the performance degradation discussed in Issue 1-1-1 is expected. The options are not exclusive to each other. It is encouraged to comment on the each of the conditions.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-1-2: performance degradation due to UE autonomous Rx beam switch (Case 2)**

* Proposals:
  + Option 1: Adding a note to the corresponding MRTD table, same as in Issue 1-1-1. (LG, Mediatek, Huawei, Ericsson, Nokia)
    - Option 1a: Additional clarification notes may be needed to consider some performance degradation with a maximum limit (Nokia)
  + Option 2: Do not define any explicit requirements on how often and how much performance degradation is expected unless it can be tested under specific conditions where the degradation can be accurately quantified. (Qualcomm, OPPO)
  + Option 3: RAN4 to define UE requirement in terms of how often and/or where the performance degradation is allowed due to UE autonomous Rx beam switching, i.e. demodulation performance degradation is allowed in [Y]% of slots over [Z] ms, FFS on Y and Z.
* Recommended WF: There is no explicit proposal on Option 3, but some companies are open to discuss it. Hence Option 3 is kept for further discussion.

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| **Company** | **Comments** |
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**Issue 1-1-3: Solutions to reduce/avoid performance degradation**

* Candidate options:
  + Option 1: Do not consider any network-controlled performance degradation mitigation technique to cope with RTD equal to or greater than [X]. (Qualcomm, OPPO)
  + Option 2: Do Rx beam switch in slot boundary in one CC which is received later to reduce performance degradation when receiving time difference exceeds X. (LG)
* Recommended WF:

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| **Company** | **Comments** |
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**Issue 1-1-4: Assumed UE Rx beam switch time:**

*Agreements on GTW (Nov.9) at RAN4#101-e meeting:*

* + *X = CP length – UE Rx beam switch time – 2 x DL timing error*
  + *“DL timing error” is 18ns and 9ns for SSB SCS of 120kHz and 240kHz, respectively*
  + *Session chair: Further get feedback from the RF session on UE Rx beam switch time for FR2-1.*
* Proposals:
  + Option 1: UE Rx beam switch time is 59ns (Ericsson)
    - X = 1039 ns for SCS = 60 kHz data and X = 490 ns for SCS = 120 kHz data.
  + Option 2: (UE Rx beam switch time + 2 x DL timing error) is 200ns for both 60kHz and 120kHz (LG)
    - X = CP – 200us.
* Recommended WF: It was agreed to wait for feedback from RF session. It is recommended not to repeat the discussion in RRM. The options are listed above just for information.

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| **Company** | **Comments** |
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### Sub-topic 1-2: Other RRM requirements for CBM

*Sub-topic description:* This sub-topic discusses the RRM requirements other than MRTD in case of CBM for FR2 inter-band DL CA.

**Issue 1-2-1: Interruption requirements**

*Agreements in RAN4#101bis-e:*

* + The existing Rel-16 interruption requirements of intra-band CA shall be applied irrespective of the value of RTD (for all the RTD values less than MRTD).
* Proposals
  + Option 1: The scheduling restriction is limited to the bands where single-receiver architecture based CBM DL CA is used, if defined by RF group. FFS on the details of the bands. (Qualcomm)
* Recommended WF: The proposal discusses “scheduling restriction” but the discussion in paper was under interruption. Please Qualcomm check if Option 1 is intending for scheduling restriction or interruption. It is understood the single receiver vs. multiple receiver architecture is under discussion in RF session. Should this be revisited after there is conclusion on RF side?

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| **Company** | **Comments** |
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**Issue 1-2-2: Scheduling restriction**

*Agreements in RAN4#101-e:*

*For a UE capable of common beam management on this FR2 band pair, when inter-band carrier aggregation in FR2 is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band and other band on the symbols that fully or partially overlap with aforementioned restricted symbols*

* + - *FFS if the text proposal applies to both RTD < X and RTD>X*
* Proposals
  + Option 1: The existing scheduling restriction for intra-band FR2 CA is extended to inter-band FR2 CA for CMB UEs, and do not differentiate between RTD < X and RTD > X. (Qualcomm, Mediatek, Huawei, Ericsson)
    - Option 1a: For a UE capable of common beam management on this FR2 band pair, when inter-band carrier aggregation in FR2 is performed, the scheduling restrictions due to a given serving cell should also apply to all other serving cells in the same band and other band on the symbols that fully or partially overlap with the aforementioned restricted symbols. **The scheduling restriction is limited to the bands where single-receiver architecture based CBM DL CA is used, if defined by RF group. FFS on the details of the bands**. (Qualcomm)
    - Option 1b: When inter-band carrier aggregation in FR2 with CBM is performed, the scheduling restrictions on FR2 serving PCell or PSCell apply to all serving cells in the same band or in the CBM cell group on the symbols that fully or partially overlap with restricted symbols (Mediatek)
  + Option 2: The existing scheduling restriction for intra-band FR2 CA is extended to inter-band FR2 CA for CMB UEs for RTX < X (OPPO, Nokia)
    - Once X is known RAN4 need to define scheduling restrictions for when RTD exceeds X
  + Option 3: Scheduling restriction should be introduced to prevent the significant performance degradation due to Rx beam switching in CBM when MRTD is not small enough (Apple)
    - When FR2 PCell and PSCell slot boundary is always used as the reference for Rx beam switching, no performance degradation can be guaranteed for PCell and PCell.
    - On all SCell, symbols right before and after the PCell/PSCell slot boundary where Rx beam switching should be subjected to the scheduling restriction.
    - When there is no PCell and PSCell, the slot boundary of the FR2 SCell which arrives the earliest to the UE will be used as the reference for Rx beam switching. In this case, all impacted symbols from other CC should be the last symbol of the slot.
    - Since network has not info which SCell will arrive first, scheduling restriction applies on the last symbol of the slot right before Rx beam switch happens for all CC.
* Recommended WF
  + Proponents of Option 2 have concerns that more symbols may be impacted in case of RTD > X. Comments are welcome on the impact to scheduling restriction. It is also encouraged to check the additions in Option 1a and 1b.
  + On Option 3, is the intention to replace the note being agreed in Issue 1-1-1, or to add additional scheduling restriction?

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-3: SCell activation delay**

*Agreements in GTW at RAN4#101-e meeting:*

* + - *TSMTC\_MAX is defined as the longer SMTC periodicity between active serving cells and SCell being activated in the bands supported for CBM*
    - *SSB-ID search latency for coarse timing estimation CANNOT be skipped*

*Agreements at RAN4#101bis-e meeting:*

* + - The AGC setting *time* is (TFirstSSB\_MAX + TSMTC\_MAX).

**Issue1-2-3A: Time uncertainty due to TCI state indication**

* Proposals:
  + Option 1: The time uncertainty due to TCI state indication on SCell can be skipped.
    - Option 1a: RAN4 to agree that MAC-CE to activate TCI are sent along with SCell activation MAC CE itself. There is no uncertainty term required in the SCell activation delay timeline as the beam information is known at the time of SCell activation command indication. (Ericsson)
    - Option 1b: For CBM UE, the uncertainty time for waiting TCI state activation command of the target SCell can be skipped for defining the SCell activation delay for unknown target SCell in case 2. (Huawei)
    - Option 1c: The TCI state indication should not be skipped but can define the requirements only for the case that (Mediatek):
      * MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and CSI reporting are sent along with SCell activation MAC-CE, if semi-penitent CSI-RS is used for CSI reporting.
      * MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and RRC configuration message for TCI of periodic CSI for CQI reporting are sent along with SCell activation MAC-CE, if periodic CSI-RS is used for CSI reporting.
  + Option 2: The time uncertainty due to TCI state indication on SCell CANNOT be skipped. (OPPO)
    - The TCI state indication and CSI reporting cannot be skipped when MAC-CEs to activate TCI and CSI reporting are sent along with SCell activation MAC CE itself.
* Recommended WF:

Despites of slightly different texts, it is understood option 1a,1b,1c propose that the time uncertainty due to TCI indication is not needed for activating the SCell. The discussion on Option 1 and 2 are encouraged.

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| **Company** | **Comments** |
| XXX |  |

**Issue1-2-3B: Time uncertainty due to activation of CSI reporting (for SP-CSI reporting) and RRC configuration of CSI reporting (for periodic CSI reporting)**

* Proposals:
  + Option 1: The time uncertainty due to activation/configuration of CSI reporting on SCell can be skipped.
    - Option 1a: RAN4 to agree that MAC-CE to activate CSI reporting are sent along with SCell activation MAC CE itself. There is no uncertainty term required in the SCell activation delay timeline as the beam information is known at the time of SCell activation command indication. (Ericsson, Nokia)
    - Option 1b: RAN4 to agree that additional RRC message is not needed to activate CSI reporting. Hence RRC uncertainty and RRC processing delay are not needed in delay requirements. (Ericsson)
    - Option 1c: Define the requirements only for the case that (Mediatek):
      * MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and CSI reporting are sent along with SCell activation MAC-CE, if semi-penitent CSI-RS is used for CSI reporting.
      * MAC-CEs to activate PDCCH TCI, PDSCH TCI (when applicable) and RRC configuration message for TCI of periodic CSI for CQI reporting are sent along with SCell activation MAC-CE, if periodic CSI-RS is used for CSI reporting.
  + Option 2: The uncertainty time for waiting CSI-RS activation command of the target SCell CANNOT be skipped for defining the SCell activation delay for unknown target SCell in case 2 (Huawei, OPPO)
* Recommended WF:

Despites of slightly different texts, it is understood option 1a,1b,1c propose that the time uncertainty due to TCI indication is not needed for activating/configuring the CSI reporting. The discussion on Option 1 and 2 are encouraged.

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| **Company** | **Comments** |
| XXX |  |

**Issue1-2-3C: Text proposal in case of Semi-persistent CSI-RS is used for CSI reporting,**

* + Option 1: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs +  TFineTiming + 2ms (Mediatek, Qualcomm)
  + Option 2: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + TFineTiming + 2ms (Ericsson)
  + Option 3: 6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + 2ms (Nokia)
  + Option 4: 6ms + TFirstSSB\_MAX + TSMTC\_MAX + 8\*Trs + max(TFineTiming + 2ms, THARQ + Tuncertainty\_SP). (Huawei)
  + Option 5: 6ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP). (OPPO, Qualcomm)
* Recommended WF: The text proposal depends on the conclusion in Issue 1-2-4A and 1-2-4B. But even with common views on Issue 1-2-4A and 1-2-4B, there are still difference on the text proposals. The comments are welcome.

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| **Company** | **Comments** |
| XXX |  |

**Issue1-2-3D: Text proposal in case of periodic CSI-RS is used for CSI reporting:**

* + Option 1: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + TFineTiming + 2ms (Qualcomm)
  + Option 2: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max{(TFineTiming + 2ms), TRRC\_delay} (Mediatek)
  + Option 3: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + TFineTiming + 2ms (Ericsson)
  + Option 4: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + THARQ + 5ms (Nokia)
  + Option 5: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + 8\*Trs + max {(5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. (Huawei)
  + Option 6: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. (OPPO, Qualcomm)
* Recommended WF: The text proposal depends on the conclusion in Issue 1-2-4A and 1-2-4B. But even with common views on Issue 1-2-4A and 1-2-4B, there are still difference on the text proposals. The comments are welcome.

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| **Company** | **Comments** |
| XXX |  |

**Issue 1-2-4: RSs of SCell being activated**

* Proposals:
  + Option1: For FR2 CBM unknown SCell activation, clarify the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on the same band as SpCell. (Mediatek)
* Recommended WF: TBD

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| **Company** | **Comments** |
| XXX |  |

**Issue1-2-5: Applicability**

* Proposals:
  + Option 1: to introduce the applicability rules for CBM based FR2 inter-band CA, and the following common assumptions needs to be clarified for UE capable of CBM FR2 inter-band CA. (Huawei)
    - CBM UE can assume same QCL assumptions for all FR2 serving cells on one symbol.
    - CBM UE is required to perform RLM/BFD/CBD only on SpCell and perform L1-RSRP/L1-SINR measurements only on the serving cell(s) in the same band as SpCell.
* Recommended WF: TBD

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| --- | --- |
| **Company** | **Comments** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

*Moderator’s comments: Companies please provide your comments in the tables below each separate sub-topic summary in section 1.2.*

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2205869 (draftCR on CBM assumption) |  |
| R4-2205424  (draftCR on MRTD) | Company A |
| Company B |
|  |
| R4-2205871  (draftCR on MRTD) | Company A |
| Company B |
|  |
| R4-2204184  (draftCR on SCell activation) |  |
| R4-2205328  (DraftCR on applicability) |  |
| R4-2205831  (draftCR on scheduling restriction) |  |
| R4-2205873  (draftCR on measurement restriction) |  |

## 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:* |

### CRs/TPs

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

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **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)

# Topic #2: Inter-band UL CA for IBM

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2205832 | Ericsson | **Not available** |
| R4-2205833 | Ericsson | **draft CR on number of UL CC support for FR2 and interruption requirements for FR2 UL CA for IBM UE** |
| R4-2205874 | Nokia, Nokia Shanghai Bell | Proposal: The supported numbers of serving carriers for inter-band FR2 UL CA for IBM UEs is up to 2 CCs which each UL band is configured with a single CC. Current specification as below can fulfil the requirements.  **with 1 UL (or 2 UL if SUL is configured) in PCell and up to 1 UL (or 2 UL if SUL is configured) in SCell.**  **- SUL may be configured together with one of the UL** |
| R4-2205875 | Nokia, Nokia Shanghai Bell | draftCR on RRM requirements for IBM inter-band FR2 UL CA |
| R4-2206069 | Ericsson | **Proposal 1: Number of serving carriers capabilities of clause 3.6.2.1 for FR2 inter-band DL and UL CA shall be revised to following.**  **-     up to 16 NR DL CCs in total (8 in each band), with 1 UL CC (or 2 UL if SUL is configured) in PCell and up to 7 UL CC (or 8 UL if SUL is configured) on SCell(s).** |

## Open issues summary

### Sub-topic 2-1 RRM requirements for Independent beam management

*Sub-topic description:* This sub-topic discusses the RRM requirements for IBM in FR2 inter-band UL CA. Please note not all the options are exclusive. Companies can provide their preference on multiple options if applicable.

**Issue 2-1-1 number of UL carriers to be supported for FR2 inter-band UL CA for IBM UEs**

* Proposals:
  + Option 1: Number of serving carriers capabilities of clause 3.6.2.1 for FR2 inter-band DL and UL CA shall be revised to following. (Ericsson)
    - up to 16 NR DL CCs in total (8 in each band), with 1 UL CC (or 2 UL if SUL is configured) in PCell and up to 7 UL CC (or 8 UL if SUL is configured) on SCell(s).
  + Option 2: The supported numbers of serving carriers for inter-band FR2 UL CA for IBM UEs is up to 2 CCs which each UL band is configured with a single CC. Current specification as below can fulfil the requirements. (Nokia)
    - with 1 UL (or 2 UL if SUL is configured) in PCell and up to 1 UL (or 2 UL if SUL is configured) in SCell.
    - SUL may be configured together with one of the UL
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

*Moderator’s comments: Companies please provide your comments in the tables below each separate sub-topic summary in section 2.2.*

### CRs/TPs comments collection

*Major close to finalize WIs and Rel-15 maintenance, comments collections can be arranged for TPs and CRs.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2205833  (Draft CR on number of UL CC) | Company A |
| Company B |
|  |
| R4-2205875 (draftCR on RRM requirements for IBM inter-band FR2 UL CA) | 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** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### 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)

*Moderator can provide summary of 2nd round here. Note that recommended decisions on tdocs should be provided in the section titled ”Recommendations for Tdocs”.*

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| WF on … | YYY |  |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

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

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

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