**3GPP TSG-RAN WG4 Meeting # 100-e R4-2115206**

**Electronic Meeting, Aug. 16th – 27th, 2021**

**Agenda item:** 9.4.6

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

**Title:** Email discussion summary for [100-e][216] NR\_RF\_FR2\_req\_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 9.4.6 in the agenda.

In last RAN4#99-e meeting, RAN4 down selected the candidate MRTD options for FR2 inter-band CA and encouraged companies to further study the compromised solutions. In addition, some agreements were reached on the other RRM requirements for CBM. The agreements and open issues are captured in the way forward R4-2108037.

Based on the agreements, the target of this meeting is to conclude on the MRTD principles for CBM capable UEs and discuss the RRM requirements in FR2 inter-band DL CA and UL CA. 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.
* 2nd round: Conclude at least on the MRTD principles for CBM capable UEs, and move forward on the RRM requirements for CBM UEs in FR2 inter-band DL CA and IBM UEs in FR2 inter-band UL CA.

# 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

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112426 | Xiaomi | Observation 1: When the MRTD is larger than CP, the demodulation performance can be significantly degraded at any DL symbol(s) due to the unpredictable UE Rx beam switching.  Observation 2: For the CBM capable UE, the MRTD should be smaller than CP length and should not be defined based on FR2 inter-band TAE requirement provided that the TAE is defined as 3us, otherwise the unpredictable interruption is expected to UE.  **Proposal 1: MRTD requirements for FR2 inter-band DL CA with CBM UE shall not rely on FR2 inter-band TAE requirement provided that the TAE is defined as 3us.**  **Proposal 2: For FR2 inter-band DL CA with CBM UE, the MRTD shall not be larger than “CP length - UE Rx beam switch time - 2 x DL timing error”.**  Observation 3: if the single chain is shared by both bands, the existing interruption requirement of intra-band CA should be applied.  Observation 4: if the multiple chains are used and each dedicated to one band, for the cell(s) in the band including aggressor CC, the existing interruption requirement of intra-band CA shall be applied. And for the victim cell in the band without aggressor CC, the existing interruption requirement of inter-band CA shall be applied.  **Proposal 3: For inter-band CA with CBM, the existing Rel-16 interruption requirements of intra-band CA shall be applied.** |
| R4-2112052 | NTT DOCOMO, INC. | **Proposal 1: MRTD of 3us for inter-band CA in FR2 under CBM with a note to stating if the MRTD exceed [TBD us or CP or CP/2] a performance degradation is expected for the first N symbols of the slot**   * + **N is 14**   + **Degradation applies to each slot** |
| R4-2112339 | LG Electronics | **Proposal 1: Define MRTD of 260ns for inter-band DL CA based on CBM.**  **Proposal 2: Do Rx beam switch in slot boundary in one CC which is received later.** |
| R4-2112484 | MediaTek inc. | **Error! Reference source not found.**  **Error! Reference source not found.**  **Error! Reference source not found.**  **Error! Reference source not found.**  Error! Reference source not found.  Error! Reference source not found. |
| R4-2112637 | vivo | Observation 1: For the MRTD value for CBM scenario for FR2 inter-band CA, it is not clear how to use option 2 to achieve a compromise.  **Proposal 1: Suggest to use either option 1 or option 3 for MRTD value. For option 1, the value of UE Rx beam switch time may need further discussion.**  **Proposal 2: Use “Do not define any requirements for CBM UEs for FR2 inter-band CA” as the backup option, option 4, if there is no consensus on which option among option 1-3 can be used.**  **Proposal 3: For the issue where performance degradation due to Rx beam switching, we support option 2.** |
| R4-2112702 | Qualcomm Incorporated | **Proposal 1: For CBM UEs in FR2 inter-band CA, MRTD shall not be larger than “CP length - UE Rx beam switch time - 2 x DL timing error” and the max SCS is 120kHz. For instance, assuming 200ns for UE Rx beam switch time and 16.2ns for DL timing error, MRTD shall not be larger than 350ns.**  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 2: If MRTD for CBM inter-band CA can be up to the current OTA (3us), RAN4 should add the following note to the corresponding MRTD table. And when UE switches Rx beam shall be left to UE implementation and the allowed/expected performance loss due to Rx beam switch across inter-bands doesn’t have to be specified.**   * **If the receive time difference exceeds [X]us, demodulation performance degradation is expected for the first and the last OFDM symbols of slot in a band where beam management reference resource(s) is not configured.** * **X can be 385us or 350usc assuming 200ns of UE Rx beam switch time and 16.2ns of DL frame boundary estimation error.** * **If UE is scheduled to apply different beams within a slot, e.g. PDCCH-to-PDSCH, additional performance degradation is expected.** |
| R4-2113200 | ZTE Corporation | **Proposal 1: Option 1 is used to derive MRTD for FR2 inter-band CA.**  **Proposal 2: Support option 2: Define MRTD of 3µs for inter-band CA in FR2 under CBM with a note indicating the number of OFDM symbols to be affected.** |
| R4-2113268 | OPPO | **Proposal 1: MRTD for UE capable of common beam management for FR2 inter-band CA shall not be larger than “CP length - UE Rx beam switch time - 2 x DL timing error” and the max SCS is 120kHz.**  **Proposal 2: As compromise, UE capability to support different levels of MRTD can also be considered.** |
| R4-2113524 | Ericsson | Observation 1: Even with a fast beam switch time of 50 ns and a resulting MRTD of 500 ns for SCS = 120 kHz, MRTD is to sort to enable simple and efficient reuse of site equipment (adapted to existing MRTD of 3 µs).  Observation 2: 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 3: If one symbol per slot is restricted for a site with inter band FR2 CA then the UE can safely switch RX beam with very high frequency.  Observation 4: A scheduling restriction is preferred over a unspecified degradation in a note in the specification.  Observation 5: the statement “scheduling restrictions on first and last symbol of each slot in the cell”, can be modified to “scheduling restrictions of one symbol either immediately before DL -> UL switch, or immediately after UL -> DL switch in the cell”  Observation 6: If UE capability for MRTD = 3 µs is not mandatory, most UE will only support small MRTD.  **Proposal 1: A modified option 2, MRTD of 3us for inter-band CA in FR2 under CBM with a scheduling restriction of one symbol either immediately before DL -> UL switch, or immediately after UL -> DL switch in the cell.** |
| R4-2113816 | Huawei, HiSilicon | **Proposal 1: It is suggested that the MRTD requirement for FR2 inter-band CA with CBM UE is defined as 3us.**  Observation 1: UE Rx beam switching due to L1/L3 measurements can be performed on the scheduling restricted symbols without performance degradation.  **Proposal 2: It is suggested that an interruption up to 1 symbol is allowed for UE Rx beam switching due to TCI state change.**  Observation 2: UE autonomous RX beam switching can be performed on non-scheduled symbols or associated with UL-DL switching period without causing performance degradation.  Observation 3: CBM UE can perform RX beam switching without major performance degradation even if MRTD is larger than CP length.  Observation 4: With the assumption of separate RF chains for inter-band CA since Rel-15, there is no performance degradation due to AGC settling for FR2 inter-band CA with CBM. |
| R4-2114017 | Nokia, Nokia Shanghai Bell | 1. MRTD of 3us is agreed 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 [CP length - UE Rx beam switch time] of that SCS, demodulation performance degradation is expected for the first symbol of the slot in the SCells of the other band.’  |  |  | | --- | --- | | Frequency Range of the pair of carriers | Maximum receive timing difference (µs) | | FR1 | 33 | | FR2 | 8 note1 | | FR2 | 3note2 | | 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 [CP length - UE Rx beam switch time] of that SCS, demodulation performance degradation is expected for the first symbol of the slot in the SCells of the other band. | | |
| R4-2114192 | Intel Corporation | Observation 1: We can not guarantee absence of major performance degradation due to CBM UE Rx beam switch if MRTD is equal to 3us  **Proposal 1: For FR2 inter-band CA with CBM introduce the scheduled gaps for UE to switch its beam. Network informs UE about the exact timing locations of these gaps (offset and periodicity).**  **Proposal 2: Scheduling restrictions on SCell (or both PCell and SCell) are applied during beam switching gap.**  **Proposal 3: The beam switching gaps can be scheduled based on UE feedback on the preferable beam switch periodicity**  Observation 2: Similar issue can be observed in NR ext. to 71GHz WI, where new SCSs have very short CP which may not be enough for device to switch its beam. The approach of scheduled beam switching gap can be reused there |
| R4-2112703 | Qualcomm Incorporated | * Interruption Requirements   **Proposal 1: The existing Rel-16 interruption requirements of intra-band CA shall be applied**   * SCell activation for CBM UE   **Proposal 2: For CBM UEs, SSB samples for Rx beam sweeping shall not be accounted for in unknown SCell activation latency requirement. If it can be assumed that Tx beams of the same SSB-ID from cells on the inter-band face the same geographical direction and channel propagation directions for the both bands are the same, L1-RSRP measurement/report can be also excluded from the latency requirement. Additionally, if MRTD smaller than CP length is adopted for CBM inter-band CA, SSB-ID search latency for coarse timing estimation can be skipped.**  **Proposal 3: The definition of T\_SMTC\_MAX in SCell activation requirements shall be updated as bellow.**   * **For CBM Inter-band UE, the longer SMTC periodicity between active serving cells and SCell being activated in the bands supported for CBM** * Scheduling Restriction   **Proposal 4: The current scheduling restriction imposed on FR2 intra-band CA should be also applied to CBM-based FR2 inter-band CA. And the MRTD shall be also taken into account in the definition of “the fully or partially overlapped symbols”.**   * RRM   + 9.2.5.3.3  Scheduling availability of UE performing measurements on FR2   + 9.10.2.6.2  Scheduling availability of UE performing CSI-RS based measurements in FR2 * RLM   + 8.1.7.3  Scheduling availability of UE performing radio link monitoring on FR2 * Link recovery   + 8.5.7.3  Scheduling availability of UE performing beam failure detection on FR2   + 8.5.8.3  Scheduling availability of UE performing L1-RSRP measurement on FR2 * L1 measurement   + 9.5.6.3  Scheduling availability of UE performing L1-RSRP measurement on FR2   + 9.8.6.3  Scheduling availability of UE performing L1-SINR measurement on FR2 * Measurement Restriction   **Proposal 5: RAN4 to not define additional measurement restrictions for CBM operation in FR2 inter-band CA assuming that CBM UEs perform RLM, BFD, CBD, L1-RSRP measurements only on one SpCell.** |
| R4-2113267 | OPPO | **Proposal 1: For CBM based FR2 inter-band CA, the existing interruption requirements of intra-band CA can be applied.**  Observation 1: The measurement restriction requirements rely on the conclusion of MRTD for CBM UEs for FR2 inter-band CA.  **Proposal 2: RAN4 can discuss in detail whether and how to introduce scheduling restriction case by case.**  Observation 2: The SCell activation requirements of CBM capable UE for case 2 depend on both RF architecture and MRTD requirements for CBM type UE.  **Proposal 3: The SCell activation requirements shall be reduced if PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is unknown, compared to the existing SCell activation delay requirements for FR1+FR2 CA.**  **Proposal 4: Consider the above text proposal for corresponding CR preparation of TS38.133.**  If the SCell being activated belongs to FR2 and if there is no active serving cell on that FR2 band provided that PCell or PSCell is in FR2:  If the PCell/PSCell and the target SCell are in a 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 + 7\*TSMTC\_MAX + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).  If the PCell/PSCell and the target SCell are in a 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 + 7\*TSMTC\_MAX + max{(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.  Note: in case of FR2 inter-band SCell activation, TSMTC\_MAX is the SMTC periodicity of SCell being activated. |
| R4-2113507 | Ericsson | **Proposal 1: The existing Rel16 interruption requirements of intra-band CA shall be applied for FR2 inter-band CA for CBM UE.**  **Proposal 2: RAN4 not to define any measurement restrictions for CBM operation in FR2 inter-band CA.**  **Proposal 3: When PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is unknown, following components can be reduced/removed from SCell activation requirements.**   * + **SSB samples for Rx beam sweeping**   + **L1-RSRP measurement and reporting delay**   **Proposal 4: SCell activation delay requirement for FR2 inter-band CA for CBM UE is given by:**   * **If the PCell/PSCell and the target SCell are configured as FR1-FR2 CA or 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 + Trs + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).**   * **If the PCell/PSCell and the target SCell are configured as FR1-FR2 CA or 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 + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.**  **Proposal 5: For FR2 inter-band CA for CBM UE, RAN4 to agree that Scheduling restriction is needed when SCS of data channels and SCS of measurement RS (RRM RS, RLM RS, BFD-RS, CBD-RS, BFR-RS, L1 measurement RS) are not same and UE do not have capability to receive different numerologies at the same time, and in this case scheduling restriction is 1 OFDM symbol.** |
| R4-2113817 | Huawei, HiSilicon | **Proposal 1: It is proposed the existing interruption requirements for FR2 inter-band CA in R15/R16 can be reused for CBM type UE in R17.**  **Proposal 2: 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 + Trs + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, 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 + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. |   **Proposal 3: For FR2 inter-band CA with CBM UE, there is no need to introduce the measurement restrictions among layer 1 measurements on different CCs in different bands.**  **Proposal 4: For FR2 inter-band CA with CBM, the scheduling restrictions due to L1 or L3 measurements on a given serving cell should also apply to all other serving cells in different band(s) on the symbols that fully or partially overlap with the restricted symbols, which need to be introduced in the following sections:**   |  | | --- | | * *RRM*   + *9.2.5.3.3 Scheduling availability of UE performing measurements on FR2*   + *9.10.2.6.2 Scheduling availability of UE performing CSI-RS based measurements in FR2* * *Radio Link Monitoring*   + *8.1.7.3 Scheduling availability of UE performing radio link monitoring on FR2* * *Link Recovery*   + *8.5.7.3 Scheduling availability of UE performing beam failure detection on FR2*   + *8.5.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2*   + *8.5.8.3 Scheduling availability of UE performing L1-RSRP measurement on FR2* * *L1-RSRP/SINR measurements (Serving cell measurement)*   + *9.5.6.3 Scheduling availability of UE performing L1-RSRP measurement on FR2*   + *9.8.6.3 Scheduling availability of UE performing L1-SINR measurement on FR2* | |  | |
| R4-2114018 | Nokia, Nokia Shanghai Bell | 1. It is feasible to re-use Rel-15 existing UE RRM requirements for developing UE requirements for Rel-17 CBM capable UE. 2. Existing (non-IBM) inter-band CA UE interruption requirements would be applicable for an inter-band CA CBM UE. 3. Existing intra-band UE scheduling availability requirements would be applicable for an inter-band CA CBM UE, but it needs clarification for all the listed cases.   One example how this could be captured using section 9.2.5.3.3 as example:  A UE is 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   1. Agree the TP provided. 2. Measurement restriction requirements need to be defined for CBM capable UE for FR2 inter-band CA scenario.   How to define the UE measurement restrictions for the CBM FR2 inter-band CA scenario is again depending on the MRTD discussion outcome. However, assuming MRTD is fulfilled they could look like (section 8.1.2.3):  A UE is capable of common beam management on this FR2 band pair, when configured with FR2 inter-band CA, when the SSB for RLM measurement on one CC is in the same OFDM symbol as CSI-RS for RLM, BFD, CBD or L1-RSRP measurement on the same CC or different CCs in the same band, or the other band, UE is required to measure one of but not both SSB for RLM and CSI-RS. Longer measurement period for SSB based RLM is expected, and no requirements are defined.   1. Agree the TP provided. 2. If the to-be-activated target SCell is unknown but PCell/PSCell is in FR2, the target SCell activation delay requirements defined for the scenario where there is at least one active serving cell in the band, can be applied.   The detailed requirement would need to be adapted to address that the one active serving cell may be in the other band of the supported inter-band CA combo. As one example TP:  For a UE supporting inter-band CA, when the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band or on a supported inter-band CA FR2 combo, then Tactivation\_time is TFirstSSB+ 5ms provided:  - The UE is provided with SMTC for the target SCell, and  - The SSBs in the serving cell(s) and the SSBs in the SCell fulfil the condition defined in clause 3.6.3,  - The parameter *ssb-PositionsInBurst* is same for the serving cell(s) and the SCell.  If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, if the UE is not provided with any SMTC for the target SCell, Tactivation\_time is 3 ms, provided   * the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on that FR2 band.  1. Agree the TP provided. |

## 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 in FR2 inter-band DL CA.

**Issue 1-1-1: MRTD principles in FR2 inter-band CA**

*Agreements in GTW at RAN4#99-e meeting:*

* *Candidate options*
* *Option 1: MRTD shall not be larger than “CP length - UE Rx beam switch time - 2 x DL timing error” and the max SCS is 120kHz*
* *Option 2: MRTD of 3us for inter-band CA in FR2 under CBM with a note to stating if the MRTD exceed [TBD us or CP or CP/2] a performance degradation is expected for the first N symbols of the slot*
  + *N is FFS*
  + *FFS if degradation applies to each slot*
  + *Example requirement:*

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| --- | --- |
| ***Frequency Range of the pair of carriers*** | ***Maximum receive timing difference (µs)*** |
| *FR1* | *33* |
| *FR2* | *8 note1* |
| *FR2* | *3 note2* |
| *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 [the cyclic prefix length of that SCS], demodulation performance degradation is expected for the first N symbols of the slot.* | |

* *Option 3: Introduce UE capability to support*

*MRTD = [260ns] and/or MRTD = [3us]*

* *Further study the candidate options and investigate at least the following open issues*
* *Impact of UE RX beam switching and AGC periodicity restrictions on the performance*
* *Candidate RRM requirements and performance impacts for the case of MRTD larger than “CP length - UE Rx beam switch time - 2 x DL timing error” and below 3us*
* Proposals
  + Option 1: MRTD shall not be larger than “CP length – UE Rx beam switch time – 2 x DL timing error” and the max SCS is 120kHz (Xiaomi, Mediatek, vivo, Qualcomm, OPPO)
  + Option 2: MRTD of 3us for inter-band CA in FR2 under CBM with a note to stating if the MRTD exceed [TBD us or CP or CP/2] a performance degradation is expected for the first N symbols of the slot (Docomo, Qualcomm, ZTE, Ericsson, Nokia, , Huawei)
    - Option 2a: MRTD of 3us for inter-band CA in FR2 with a note to recommend UE which is under CBM conditions to switch its beam during the scheduled instances provided by Network (Intel)
  + Option 3: Introduce UE capability to support MRTD = [260ns] and/or MRTD = [3us] (vivo, OPPO)
  + Option 4: 260us (LG)
  + Option 5: 3us (Huawei)
  + Option 6: Do not define any requirements for CBM UEs for FR2 inter-band CA, if there is no consensus on option 1-3. (vivo)
* Recommended WF
  + In last meeting, it was agreed to further study the candidate compromised solutions in Option 1-3. It is suggested not reverting back to Option 4-6 in order to move forward. Companies are encouraged to provide comments on Option 1-3.
* **Agreements on GTW (Aug.17):**
  + MRTD for inter-band CA in FR2 under CBM is 3us
    - For the receive time difference below X us no performance degradation is expected
    - For the receive time difference equal or higher than X us a performance degradation is allowed
      * Degradation of UE demodulation and [RRM] performance is allowed.
        + Note: companies are encouraged to bring more analysis on Demodulation and RRM performance impacts.
      * FFS on the performance degradation including affected symbols, slots
      * FFS on solutions to reduce performance degradation and whether and how to introduce restrictions for UE Rx beam change
        + Option 1: Use network scheduled/controlled instances for UE Rx beam change
        + Other options not precluded
    - X is FFS
      * Option 1: CP
      * Option 2: CP/2
      * Option 3: CP length – UE Rx beam switch time – 2 x DL timing error
      * Option 4: CP length – UE Rx beam switch time
      * Other options not excluded

Recommended WF after GTW Aug.17:

* This issue 1-1-1 is considered concluded following GTW agreements. No need to discuss it further. Discussion continues on FFSs according to the agreements in Issue 1-1-2.

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| **Company** | **Comments** |
| Ericsson | Ericsson understands the WF, that options are limited and we prefer a slightly modified option 2, as we state in our proposal R4-2113524 “A modified option 2, MRTD of 3us for inter-band CA in FR2 under CBM with a scheduling restriction of one symbol either immediately before DL -> UL switch, or immediately after UL -> DL switch in the cell”. Option 2a is also fine for us, since it is more flexible with a signaled UE RX beam switch opportunity (as Intel propose) compared to a fixed scheduling restriction (as in Ericsson’s proposal).  A signaled opportunity, like option 2a, can point out free data symbols to UE at lower traffic to manage UE RX beam switch at MRTD = 3 µs, without any degradation at all. Ericsson´s proposal offer a fixed scheduling opportunity. We think that a UE can safely defer beam switch to this fixed opportunity with no or minor impact. The advantage is that this does not have to be signaled, but the disadvantage is less scheduling flexibility. |
| Qualcomm | We support Option 1.  If Option 2 is adopted, we propose to modify it as follows:   * If MRTD exceeds [X]us, a performance degradation is expected for the first and the last OFDM symbols of slot in a band where beam management reference resource(s) is not configured. * If UE is scheduled to apply different beams within a slot, e.g. PDCCH-to-PDSCH, additional performance degradation is expected.   X can be 385us or 350usc assuming 200ns of UE Rx beam switch time and 16.2ns of DL frame boundary estimation error.  Adding the following comment in the version of QC2:  Thanks LGE for spotting the typo. X should be in ns not us. |
| Huawei | Support option 2.  The UE with supporting MRTD < CP is not compatible with the existing BS TAE requirements. So, 3us MRTD need to be supported by CBM UE. For the UE Rx beam switching which can be expected, e.g. due to L1/L3 measurements, the scheduling restrictions can be specified. For the UE Rx beam switching which cannot be predicted, e.g. UE autonomous beam switching, the performance degradation can be allowed. The performance degradation can be allowed for the first or last symbol of the slot. The UE may perform Rx beam switching in any slot, but does not perform Rx beam switching in every slot. We can further study how to capture the performance impacts. |
| LG Electronics | For Option 1 of “CP length-UE Rx beam switch time-2xDL timing error”. We think that ‘2xDLtiming error’ can be removed because ‘2xDL timing error” is already included in MRTD.  For Option2, performance degradation should be noted if the MRTD exceed ‘X = CP length-UE Rx beam switch time’. X can be 370ns assuming UE Rx switch time of 200ns (570ns – 200ns). And, to avoid interruption on symbol of control channel, it can be considered that Rx beam switch is performed in slot boundary in one CC which is received earlier.  To QC, for X, unit ‘us’ seems be typo. |
| vivo | We support option 1 or option 3.  If option 2 is used as a compromise, we prefer the value in the bracket (TBD) could be selected from 260us or 350 us. |
| MTK | We support Option 1.  Comment on Option 2 (MRTD>CP), UE would apply different RX beam and AGC on different channels/RSs within a slot. E.g.  PDCCH with TCI#1, PDSCH with TCI#2, TRS with TCI#3, CSI-RS with TCI#4, then then performance degradation will occur on every +/- 1 symbol on the transit between channels/RSs. Then the scheduling restriction/performance degradation on the 1st and the last symbol will be insufficient. |
| Xiaomi | Follow the conclusions made in GTW session. |
| Apple | OK with GTW agreements.  Some thoughts on why RRM performance can be impacted by MRTD. Depending on the MRTD, interruption, scheduling restriction, measurement restriction related requirements should be investigated. Considering large MRTD will impact more on other CC. To some extent, it can be considered as performance degradation. |

Moderator: With the FFSs in the agreements, the Issue 1-1-2 are further split into following sub-issues i.e. Issue 1-1-2a - Issue 1-1-2d after GTW Aug.17 and can be further discussed in 1st round:

* **Issue 1-1-2a: the performance degradation including affected symbols, slots** Proposals
  + Option 1: N is 14, degradation applies to each slot (Docomo)
  + Option 2: Add a note to the corresponding MRTD table (Qualcomm):
    - If the receive time difference exceeds [X]us, demodulation performance degradation is expected for the first and the last OFDM symbols of slot in a band where beam management reference resource(s) is not configured.
    - X can be 385us or 350usc assuming 200ns of UE Rx beam switch time and 16.2ns of DL frame boundary estimation error.
    - If UE is scheduled to apply different beams within a slot, e.g. PDCCH-to-PDSCH, additional performance degradation is expected.
  + Option 3: Add a note (Nokia):
    - * If the receive time difference exceeds [CP length - UE Rx beam switch time] of that SCS, demodulation performance degradation is expected for the first symbol of the slot in the SCells of the other band
  + Option 4: A modified option 2, MRTD of 3us for inter-band CA in FR2 under CBM with a scheduling restriction of one symbol either immediately before DL -> UL switch, or immediately after UL -> DL switch in the cell. (Ericsson)
  + Option 5: An interruption up to 1 symbol is allowed for UE Rx beam switching due to TCI state change (Huawei)
  + Option 6: Introduce the scheduled gaps for UE to switch its beam. Scheduling restrictions on SCell (or both PCell and SCell) are applied during beam switching gap (Intel)
* Recommended WF
  + The options in original Issue 1-1-2 are still valid. Comments can be further updated if necessary.

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| **Company** | **Comments** |
| Ericsson | Option 6 and option 4 and option 5 are fine to us.  The technical motivation is that option 6 (intel) is more flexible with a signaled UE RX beam switch opportunity compared to a fixed scheduling restriction, as in Ericsson’s proposal, option 4. The advantage with fixed restriction is less signaling. At full load both option 4, 5 and option 6 have to make the same room for ue rx beam switch, but, again, option 6 to signal ue rx beam switch opportunities is more flexible and work for us, as well. |
| Qualcomm | As mentioned in Issue 1-1-1, we support Option 2. When UE is allowed to switch its Rx beam shall be left to UE implementation and the allowed/expected performance loss due to Rx beam switch across inter-bands doesn’t have to be specified.  The slot boundary of anchor carrier (the carrier where BM resource is configured) is MRTD behind that of non-anchor carrier (the carrier in a band where BM resource is not configured), the last OFDM symbol of the non-anchor’s slot gets distorted (UE Rx beam switching time is assumed to follow the anchor-carrier’s slot boundary) as shown below. In such a case, the performance degradation can be severe especially when the PDSCH is scheduled with a high MCS and/or rank-2 because the segmented last code block mapped to the last OFDM symbol on the non-anchor carrier will be almost lost.    For Option 1, please clarify what N=14 means. Does that mean none of slots are effectively available?  For Option 4, considering CBM is not different from FR2 non-CA in terms for BM, we don’t think the mentioned UE autonomous beam change restriction can be imposed.  For Option 5, we understand the issue during TCI state change. If the proposal of Option 5 needs to be limited to specific cases, we would like to have a further discussion. Please provide more details about the proposal. The argument provided in the contribution seems to limit it to some specific cases which is not the case in the proposal.  For Option 6, based on what information, can UE expect NW to be able to properly configure the scheduling gap? What would be UE behavior and the performance impact if the gap is not configured at all or inappropriately configured?  Adding the following comment in the version of QC3:  To Huawei, in R4-2113816 the following argument is provided to support Option 5, can you please explain why we need 1 symbol interruption for UE beam switch is needed?   * “or DCI-based TCI state switch, the switching delay is defined as timeDurationForQCL, which is indicated as {0.5slot, 1slot, 2slot}, .If the switching delay does not include the UL-DL switching period or the non-scheduled symbols, then up to 1 symbol interruption can be allowed for DCI-based TCI state switch.” |
| Huawei | Generally, we can agree with option 2 and option 3, but the wordings may need to be revised.  In RF session, it has been agreed that only one CC which is configured with UL BWP will be configured with BM-RS. It can be expected that CBM UE only needs to perform L1 measurements on the SpCell. The performance degradation can be expected for the first or last symbol of the slot(s) in the band without SpCell. |
| LG Electronics | We would like to add Option3a with following note.  Option 3a : If the receive time difference exceeds ‘CP – Rx beam switch time’, i.e, 370ns (for SCS of 120kHz), demodulation performance degradation is expected for the last OFDM symbol of slot in a other CC when Rx beam switch is performed in slot boundary in a received CC earlier. |
| MTK | Support Option 1 as the worst case.  As mentioned in Issue 1-1-1, if the channels/Rs within a slot are indicated with different TCI, then the performance degradation will occur on every +/- 1 symbol on the transit between channels/RSs.  As the worst case, it could be on all symbols, as Option 1. |
| Xiaomi | The proposed scheduling restriction only applies to the case of the Rx beam switching due to L1/L3 measurement. For the case of UE autonomous Rx beam switching, scheduling restriction does not work, as it can happen at any slot. |
| ZTE | Support option 3 and option 4. Both demodulation performance degradation and scheduling restriction need to be specified. |
| apple | For demod performance degradation, it is proposed to assume one slot is punctured per L1-RSRP measurement periodicity.  RRM performance degradation should be also investigated. |

**Issue 1-1-2b: Solutions to reduce performance degradation and whether and how to introduce restrictions for UE Rx beam change**

* Proposals：
  + Option 1: Use network scheduled/controlled instances for UE Rx beam change
  + Other options not precluded
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| Apple | It is preferrable to leave UE Rx beam switching as UE’s decision including when the Rx beam is switched. We can firstly identify the performance degradation. Depending on the level of performance degradation, enhancement like option 1 can be further discussed. |

**Issue 1-1-2c: the value of X**

* Proposals**:**
  + Option 1: CP
  + Option 2: CP/2
  + Option 3: CP length – UE Rx beam switch time – 2 x DL timing error
  + Option 4: CP length – UE Rx beam switch time
  + Other options not excluded
* Recommended WF
  + TBD

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| **Company** | **Comments** |
| Apple | Option 1 is fine |

**Issue 1-1-2d: Demodulation and [RRM] performance impact**

* + - * Degradation of UE demodulation and [RRM] performance is allowed.
        + Note: companies are encouraged to bring more analysis on Demodulation and RRM performance impacts.
* Recommended WF
  + This sub-issue is quite open. Companies are encouraged to provide options or comments.

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| **Company** | **Comments** |
| Apple | This can be discussed together with issue 1-1-2a |

**Issue 1-1-3: Performance impacts due to Rx beam switch when MRTD is larger than “CP length - UE Rx beam switch time - 2 x DL timing error” and below 3us**

* Proposals (Note: the sub-options below are not exclusive to each other.)
  + Option 1: UE can switch RX beams without major performance degradation even if MRTD is larger than CP length (Ericsson, Huawei)
    - Option 1a: UE could safely switch beams before scheduling restrictions are needed, like available time in UL and DL (if carriers not full) and UL to DL switch (Ericsson)
    - Option 1b: The UE can safely switch RX beam with very high frequency if one symbol per slot is restricted for a site with inter band FR2 CA. (Ericsson)
    - Option 1c: UE Rx beam switching due to L1/L3 measurements can be performed on the scheduling restricted symbols without performance degradation (Huawei)
    - Option 1d: UE autonomous RX beam switching can be performed on non-scheduled symbols or associated with UL-DL switching period without causing performance degradation (Huawei)
    - Option 1e: With the assumption of separate RF chains for inter-band CA since Rel-15, there is no performance degradation due to AGC settling for FR2 inter-band CA with CBM (Huawei)
  + Option 2: The timing impacts should be identified and need to be accounted in the UE requirements (docomo, vivo)
  + Option 3: The performance degradation is significant and unacceptable (Xiaomi, Mediatek).
    - Option 3a: When the MRTD is larger than CP, the demodulation performance can be significantly degraded at any DL symbol(s) due to the unpredictable UE Rx beam switching (Xiaomi)
    - If MRTD > “CP length - UE Rx beam switch time - 2 x DL timing error”, DL symbols could be dropped every slot. (Mediatek)
  + Option 4: Do Rx beam switch in slot boundary in one CC which is received later (LG)
* Recommended WF
  + The performance degradation discussion is also relevant to Issue 1-1-1. The companies going for Option 2 in Issue 1-1-1 are identifying the performance impact using a note, which is in line with the Option 2 in Issue 1-1-2. And the companies going for Option 1 are mostly assume Option 3 in Issue 1-1-3. It is recommended to comment on the sub-options to better understand the potential impacts.

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| **Company** | **Comments** |
| Ericsson | Option 1, since, we have a fixed extra symbol freed up for UE RX beam switch. We understand that some UE RX beam switch is autonomous, but if the free symbol is offered often (up to 1 per slot) then UE can defer UE RX beam switch to that slightly later point without significant impact. Or, again, Intel’s proposal to signal a UE RX beam witch opportunity which is coordinated with scheduler, is another way to make sure UE can switch RX beams without major performance degradation even if MRTD is larger than CP length. |
| Qualcomm | Although we support Option 2 in Issue 1-1-2, we agree that the performance degradation can be severe as mentioned in Option 3. For example, with MRTD 3us, almost 30% of the first or the last OFDM symbol will be lost. If that is the first OFDM symbol, 1 or 2 OFDM symbol based PDCCH can be properly decoded even with a high aggregation level. Besides, if there is front-loaded DMRS, non-slot based PDSCH can be decoded. If that is the last OFDM symbol, the code block segmented and mapped to the last OFDM symbol will not be properly decoded, which results in TB error.  However, we don’t think the degradation can be really quantified and specified in RAN4 spec. And we also don’t think this can be tested and verified. Therefore, we would like to add a simple note to the MRTD table implying the performance losses if MRTD 3us gets agreed. This would allow UE to switch Rx beam without too much implementation restriction. And as the desirable way of UE implementation is to minimize the performance impact, if the circumstances allow UE to switch Rx beam switch in UL-DL gap or non-scheduled symbol/slot, it is not precluded by the note. |
| Huawei | Support option 1.  As we comments on issues 1-1-1/2, the UE may perform Rx beam switching in any slot, but does not perform Rx beam switching in every slot. Some performance impacts can be avoided by defining the necessary scheduling restriction requirements. So, the performance degradation will not be significant. |
| LG Electronics | We found out that Option 4(LG) has typo. We would like to correct as follows.  Option 4: Do Rx beam switch in slot boundary in a CC which is received ~~later~~earlier.  As mentioned in Issue 1-1-1 and 1-1-2, an interruption on symbol of control channel can be avoided with the Rx beam switch in a received CC earlier. Instead, a last symbol on data channel can be interrupted. |
| vivo | Support option 2. Agree with option 3 that the performance degradation is notable and should be addressed. |
| MTK | Option 3, as mentioned in issue 1-1-1/2, when different TCIs configured on different channels/RS within a slot, then multiple RX beam switch within every slot would occur. |
| Xiaomi | Option 3, for UE autonomous Rx beam switching, the interruption is unpredictable at any slot. |
| ZTE | Support option 1. |

**Issue 1-1-4: How to derive MRTD for FR2 inter-band CA?**

* Proposals
  + Option 1: MRTD = TAE + Δ\_propagation\_time (ZTE)
    - TAE is 3µs, i.e. keep Rel-15 values for BS TAE unchanged
  + Option 2: MRTD requirements for CBM UEs shall not rely on FR2 inter-band TAE requirement. (Xiaomi)
* Recommended WF
  + As this Issue is relevant to MRTD values. It is recommended to focus on Issue 1-1-1.

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| **Company** | **Comments** |
| Ericsson | Option 1. |
| Qualcomm | Better to discuss it directly under Issue 1-1-1. |
| Huawei | Support option 1.  For option 2, there will be compatible issue between UE and network. |
| LG Electonics | Focus issue 1-1-1 at first. |
| Xiaomi | As issue 1-1-1 has been concluded in GTW session, no need to have further discussion on this issue. |
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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**

* Proposals
  + Option 1: The existing Rel16 interruption requirements of intra-band CA shall be applied (Xiaomi, Qualcomm, OPPO, Ericsson)
  + Option 2: Existing interruption requirements for (non-IBM) inter-band CA in R15/R16 can be reused for CBM type UE in R17 (Huawei, Nokia)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | Option 1.  Though multiple RF chains are supported by UE, for CBM operation RF chain used may be only one. Since this is similar to intra-band CA, interruption requirements can be assumed to follow intra-band CA requirements. |
| MTK | Option 1. It should allow intra-band-alike UE implementation for CBM, assuming 1 RF chain. |
| Qualcomm | Option 1.  It should be a common understanding that RAN4 minimum requirement spec assumes CBM inter-band CA will be more or less the same as intra-band CA in terms of UE hardware/network architecture which will determine interruption characteristics.  Adding the following comment in the version of QC2:  We are open to Option 2. We think the argument provided in R4-2113817 seems to make sense. |
| vivo | Support option 1. |
| Xiaomi | Option 1, according to the agreement in RF session:  “RAN4 agrees to define CBM requirements in such manner that both single chain and multi chain architectures are possible.”  The interruption requirements should be applied to all possible UE topologies. |
| apple | We can take intra-band CA as the baseline. However, depending on MRTD, interruption length can be different from intra-band case. This can be another impact on RRM |

**Issue 1-2-2: Scheduling restriction**

* Proposals
  + Option1: The current scheduling restriction imposed on FR2 intra-band CA should be also applied to CBM-based FR2 inter-band CA. And the MRTD shall be also taken into account in the definition of “the fully or partially overlapped symbols”. (Qualcomm, Huawei, Nokia)
  + RRM
    - 9.2.5.3.3  Scheduling availability of UE performing measurements on FR2
    - 9.10.2.6.2  Scheduling availability of UE performing CSI-RS based measurements in FR2
  + RLM
    - 8.1.7.3  Scheduling availability of UE performing radio link monitoring on FR2
  + Link recovery
    - 8.5.7.3  Scheduling availability of UE performing beam failure detection on FR2
    - 8.5.8.3  Scheduling availability of UE performing L1-RSRP measurement on FR2
  + L1 measurement
    - 9.5.6.3  Scheduling availability of UE performing L1-RSRP measurement on FR2
    - 9.8.6.3  Scheduling availability of UE performing L1-SINR measurement on FR2
  + Option 2: RAN4 can discuss in detail whether and how to introduce scheduling restriction case by case (OPPO)
  + Option 3: Scheduling restriction is needed when SCS of data channels and SCS of measurement RS (RRM RS, RLM RS, BFD-RS, CBD-RS, BFR-RS, L1 measurement RS) are not same and UE do not have capability to receive different numerologies at the same time, and in this case scheduling restriction is 1 OFDM symbol (Ericsson)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | We proposed option 3 based on assumption that UE may have different RF chains for different bands for FR2 inter-band CA.  However, we are ok with option 1. Detailed scheduling restriction can be FFS based on conclusion of MRTD value. |
| MTK | Support Option 1. UE may implement only one RF chain for CBM operation.  One comment on Option 3, RX beam shall be also considered, if UE trains RX beam on the measurement RS, then it couldn't receive data. |
| Qualcomm | Support Option 1.  For Option 3, please clarify the 1 OFDM symbols is based on which cell’s SCS. |
| Huawei | Support option 1.  For FR2 inter-band CA with CBM, the scheduling restrictions shall also be applied on the symbols that fully or partially overlapped with the restricted symbol in another band. |
| vivo | Ok with option 1 |
| ZTE | Support option 1. |
| Apple | Option 1 |

**Issue 1-2-3: Measurement restriction**

* Proposals
  + Option 1: RAN4 not to define additional measurement restrictions for CBM operation in FR2 inter-band CA (Qualcomm, Ericsson, Huawei)
  + Option 2: Measurement restriction requirements need to be defined for CBM capable UE for FR2 inter-band CA scenario. (Nokia)
  + Option 3: The measurement restriction requirements rely on the conclusion of MRTD for CBM UEs for FR2 inter-band CA (OPPO, Nokia)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | We support option 1 |
| MTK | Prefer to Option 2.  One clarification question the meaning of "no additional" in Option 1. Does that mean to extend FR2 intra-band CA measurement restriction for FR2 inter-band CA, or no measurement restriction will be defined for FR2 inter-band CA?  Although requirements apply on the band where CC is configured UL BW, it doesn't preclude NW to configure measurement RS on both of bands, and UE may perform measurement on both bands. Thus, measurement restrictions need to be defined for CBM  Further comment  Although RF agreement indicate requirement apply when the BM RS is provided in SpCell form RX beam perspective, but it doesn't preclude NW to configure L1-RSRP on other CCs and also doesn’t preclude all RLM/BFD/CBD/L1-RSRP has to be on one CC. We also need to further investigate other aspect e.g. TRS on different CCs. |
| Qualcomm | Support Option 1.  RLM is only for SpCell, and BFD/CBM and L1-RSRP measurement/report are on anchor-cell in terms of BM. With this understanding, no additional measurement restrictions for CBM need to be defined. Note that it was assumed the only cell that can be served as an anchor-cell is always SpCell. |
| Huawei | Support option 1.  Based on RF agreements, CBM UE only needs to perform L1 measurements on the SpCell. So, there is no need to introduce inter-band measurement restrictions. |
| ZTE | Agree with Huawei’s comments and option 1 is supported. |
| apple | Option 2 or 3. We don’t think L1-RSRP measurement for CBM should be purely decided in RF session since this is an obvious RRM issue. If L1 measurement can be assumed for any CC in FR2 intraband CA, it is hard to understand why it is limited to SpCell for inter-band CA. RAN4 should specify how UE handle multiple colliding L1 measurements for CBM based FR2 inter-band CA. |

**Issue 1-2-4: SCell activation delay**

*Agreements in GTW at RAN4#99-e meeting:*

* Principle: Case 2: if PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is unknown,
  + Option 1: the SCell activation requirements shall be reduced
    - Option 1a: SSB samples for Rx beam sweeping shouldn’t be accounted for in unknown SCell activation latency requirement.
    - Option 1b: L1-RSRP measurement delay is not required in SCell activation delay

Principles:

* Proposals:
  + Option 1: When PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is unknown, following components can be reduced/removed from SCell activation requirements (Qualcomm, OPPO, Ericsson):
    - Option 1a: SSB samples for Rx beam sweeping (Qualcomm, OPPO, Ericsson)
    - Option 1b: L1-RSRP measurement/reporting delay (Qualcomm, OPPO, Ericsson)
      * If it can be assumed that Tx beams of the same SSB-ID from cells on the inter-band face the same geographical direction and channel propagation directions for the both bands are the same (Qualcomm)
    - Option 1c: SSB-ID search latency for coarse timing estimation can be skipped if MRTD smaller than CP length is adopted for CBM inter-band CA (Qualcomm)
    - Option 1d: AGC settling time could be reduced for UE owing to following AGC settling in PCell/PSCell (OPPO)
  + Option 2: The definition of T\_SMTC\_MAX in SCell activation requirements shall be updated as below (Qualcomm).
    - For CBM Inter-band UE, the longer SMTC periodicity between active serving cells and SCell being activated in the bands supported for CBM.
  + Option 3: The target SCell activation delay requirements defined for the scenario where there is at least one active serving cell in the band, can be applied (Nokia)

Text Proposal:

* Proposals:
  + If Semi-persistent CSI-RS is used for CSI reporting:
  + Option 1: 3ms + TFirstSSB\_MAX + Trs + THARQ +  TFineTiming + 2ms . (Ericsson)
  + Option 2: 6ms + TFirstSSB\_MAX + Trs + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP). (Huawei)
  + Option 3: 6ms + TFirstSSB\_MAX + 7\*TSMTC\_MAX + THARQ + max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP). (OPPO)
  + If periodic CSI-RS is used for CSI reporting:
  + Option 1: 3ms + TFirstSSB\_MAX + Trs + THARQ +  TFineTiming + 2ms . (Ericsson)
  + Option 2: 3ms + TFirstSSB\_MAX + TSMTC\_MAX + Trs + max {(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. (Huawei)
  + Option 3: 3ms + TFirstSSB\_MAX + 7\*TSMTC\_MAX + max{(THARQ + Tuncertainty\_MAC + 5ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}. (OPPO)
  + Option 4: Text proposal (Nokia)

For a UE supporting inter-band CA, when the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band or on a supported inter-band CA FR2 combo, then Tactivation\_time is TFirstSSB+ 5ms provided:

- The UE is provided with SMTC for the target SCell, and

- The SSBs in the serving cell(s) and the SSBs in the SCell fulfil the condition defined in clause 3.6.3,

- The parameter *ssb-PositionsInBurst* is same for the serving cell(s) and the SCell.

If the SCell being activated belongs to FR2 and if there is at least one active serving cell on that FR2 band, if the UE is not provided with any SMTC for the target SCell, Tactivation\_time is 3 ms, provided

* the RS (s) of SCell being activated is (are) QCL-TypeD with RS (s) of one active serving cell on that FR2 band.
* Recommended WF
  + It is recommended to provided comments on both principles and text proposals.

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| **Company** | **Comments** |
| XXX | Principle:  Text proposals: |
| Ericsson | In previous RAN4 meeting, co-location was assumed to derive the RRM requirements. By assuming SCell is in same band pair as PCell/PSCell, co-located with PCell/PSCell, and CBM operation, there is less chance that SCell will be (or need to) transmitting beams in other directions than PCell or PSCell. Following the above assumption, though SCell is unknown their beam directions are known because of CBM operation. In our paper we argued that RX beam sweeping and L1-RSRP component can be removed and proposed following delay requirement.  *If the PCell/PSCell and the target SCell are configured as FR1-FR2 CA or 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:*  *-    3ms + TFirstSSB\_MAX + Trs + THARQ +3ms+ max(Tuncertainty\_MAC + TFineTiming + 2ms, Tuncertainty\_SP).*  *If the PCell/PSCell and the target SCell are configured as FR1-FR2 CA or 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 + Trs + max {(THARQ + Tuncertainty\_MAC + 3ms +2ms + TFineTiming), (Tuncertainty\_RRC + TRRC\_delay)}.*  However, the uncertainty components in the above equations (highlighted in yellow) came due to the fact that beam information of SCell is not known to UE for unknown SCell and TCI state indication and CSI reporting can only be configured after beam sweeping and L1-RSRP reporting.  However, in CBM operation, since beam directions can be assumed to be same (and hence known) as PCell/PSCell, TCI state information and CSI reporting (periodic and semi-persistent) can be configured beforehand and MAC-CE to activate TCI and CSI reporting can be clubbed and sent along with SCell activation MAC CE itself.  Based on the above analysis we would like to propose one additional option for principle.  **Principle**: We would like to propose following additional option for principle.  *Option 1e:* TCI state indication and CSI reporting can be skipped as well for both semi-persistent and periodic CSI reporting.  With new additional principle, we support option 1a, option 1b and option 1e.  **Text proposal:**  By removing component arising from option 1a, 1b and 1e SCell activation delay for both semi-persistent CSI and periodic CSI reporting cases can be represented as following.  3ms + TFirstSSB\_MAX + Trs + THARQ +  TFineTiming + 2ms |
| MTK | Fine with option 1a, option 1b and option 1c.  May need more discussion on 1e, on e.g. how long CSI-RS reporting should be configured beforehand the SCell activation comment.  Fine with Proposal-Option 2 to update T\_SMTC\_MAX.  On Proposal-Option 3, does it already be captured in the current requirement of "one active serving cell in the band"? |
| Qualcomm | Principle: We support Option 1, 1a, 1b, 1c, and 2. For Option 2, maybe it depends on Issue 1-2-1 and Issue 1-1-3.  Text proposals: Our view is close to Option 2, if “T\_SMTC\_MAX” is added to the option 2 for Semi-persistent CSI-RS case. Here, the definition of “T\_SMTC\_MAX” needs to be updated as Option 2 of Principle.  For the Option 1e newly added by Ericsson, we understand the motivation/background. Maybe better to come up with a general requirement that include all the uncertainties and can give the same result as that is proposed in Option 1e when what is assumed in Option 1e is fulfilled.  Adding the following comment in the version of QC2:  For the definition of “T\_SMTC\_MAX”, it can be kept as the current one if Option 2 in Issue 1-2-1 gets agreed. |
| Huawei | Principle: support option 1a and 1b.  Text proposals: support option 2.  The Scell activation delay for CBM UE in case 2 can be derived from the current Scell activation delay for IBM UE in case 2. For CBM UE, the AGC time can be reduced from “TFirstSSB\_MAX + 15\*TSMTC\_MAX” to “TFirstSSB\_MAX + TSMTC\_MAX”, and the cell search time can be reduced from “8\*Trs” to “Trs”. |

## 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. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

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

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| --- | --- |
|  | **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.*

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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)

# 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

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2112704 | Qualcomm Incorporated | * Interruption at UL carrier RRC reconfiguration   **Proposal 1: Existing interruption requirements at UL carrier RRC reconfiguration can be reused in R17.**   * Interruption at active BWP switching   **Proposal 2: Interruption at active BWP switching is the same as the existing interruption requirement.**   * DL interruption at UE Tx switching between two uplink carriers   **Proposal 3: RAN4 to not define DL interruption at UE Tx switching between two uplink carriers.**   * DL Interruption at NR SRS carrier based switching   **Proposal 4: RAN4 to further consider whether interruption due to SRS carrier based switching can be limited to the band in which SRS carrier based switching is taking place. The decision shall be subject to confirmation by RF session, and the details are FFS, e.g. whether it depends on the signalling/triggering mechanism of SRS carrier based switching.** |
| R4-2113508 | Ericsson | **Proposal 1: RAN4 to agree that existing interruption requirements at UL carrier RRC reconfiguration can be reused in R17.**  **Proposal 2: RAN4 to agree that interruption due to active BWP switching will occur on all serving cells within FR if UE supports per FR gaps; otherwise, interruption occurs on all serving cells.**  **Proposal 3: UE TX switching between two UL carriers for FR2 is not supported in RF session. Whether to support UL TX switching for FR2 is RF issue and it should be discussed in RF session first.**  **Proposal 4: RAN4 to agree that Interruption due to SRS carrier switching in one band will occur on all serving cells within FR if UE supports per FR gaps; otherwise, interruption occurs on all serving cells.** |
| R4-2113818 | Huawei, HiSilicon | **Proposal 1: For FR2 inter-band UL CA with IBM, the existing interruption requirements for UL carrier RRC reconfiguration in R15/R16 can be applied in Rel-17.**  **Proposal 2: The existing interruption due to active BWP switching requirements for R15/R16 can also apply to IBM based FR2 inter-band UL CA.**  **Proposal 3: The Rel-16 interruption requirement for UE switching between two uplink carriers can be applied in Rel-17 since it is only applicable in FR1. There is no need to introduce the interruption requirement for UE switching between two FR2 uplink carriers in different bands.**  **Proposal 4: RAN4 need to study whether and/or how to define the interruption requirements for inter-band SRS carrier based switching in FR2.** |
| R4-2114019 | Nokia, Nokia Shanghai Bell | 1. The UL carrier reconfiguration only impact activate serving cells within the band of the UL carrier being reconfigured. 2. Only the band in which the UL BWP switch should be impacted by the BWP switch. 3. Current requirement regarding interruption requirement for a UE switching between two uplink carriers can be applied in Rel-17. 4. Clarify that the requirements apply for both frequency ranges. 5. Interruptions in DL due to SRS carrier switching in one of the two bands used in FR2 UL inter-band CA, will not cause interruptions in the DL of the 2nd band. 6. Wait for RF room on conclusion of applicable SRS carrier switching time for inter-band CA in FR2 |

## 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: Interruption due to UL carrier RRC reconfiguration**

* Proposals
  + Option 1: Existing interruption requirements at UL carrier RRC reconfiguration can be reused in R17. (Qualcomm, Ericsson, Huawei)
  + Option 2: The UL carrier reconfiguration only impact activate serving cells within the band of the UL carrier being reconfigured. (Nokia)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | Option 1  Though different RF chains may be used for different bands in the same FR, some component like local oscillator, power supply bus and PLL may be same for different bands in a FR. Hence, we think option 1 is reasonable. |
| MTK | Support Option 1. Activate serving cells one the other band would be impacted due to RF switch. |
| Qualcomm | Option 1.  Unless there is a technical justification from RF session that the interruption impact can further enhanced based on an RF architecture assumed for IBM UE, and etc, the current requirement should be applied to IBM UL CA UE. |
| Huawei | Support option 1.  The interruption is allowed on all FR2 active serving cells. |
| ZTE | Support option 1. |
| apple | Option 1 |

**Issue 2-1-2: Interruption at active BWP switching**

* Proposals
  + Option 1: Interruption at active BWP switching is the same as the existing interruption requirement (Qualcomm, Huawei)
  + Option 2: Only the band in which the UL BWP switch should be impacted by the BWP switch (Nokia)
  + Option 3: interruption due to active BWP switching will occur on all serving cells within FR if UE supports per FR gaps; otherwise, interruption occurs on all serving cells (Ericsson)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | Our understanding is option 1 and option 3 are not different.  We are ok with option 1. |
| MTK | See no difference between Option 1 and Option 3. Ok for both. |
| Qualcomm | Option 1. In the course of Rel-16 IBM CA requirement development, RAN4 made the following general agreement.   * For a FR2 inter-band CA combination with using independent beam management, the existing interruption requirements for inter-band CA can be applied.   As BWP switching is not specific to UL, the agreement above should still be applied to Rel-17 IBM UE. |
| Huawei | Support option 1.  For option 3, the interruption occurs on the active serving cells. |
| ZTE | Option 3 is reasonable. |
| apple | Option 3. We need to understand the impact of MRTD on interruption length. |

**Issue 2-1-3: DL interruption due to UE Tx switching between two UL carriers**

* Proposals
  + Option 1: Not define DL interruption at UE Tx switching between two uplink carriers (Qualcomm, Huawei)
  + Option 2: UE TX switching between two UL carriers for FR2 is not supported in RF session. Whether to support UL TX switching for FR2 is RF issue and it should be discussed in RF session first (Ericsson)
  + Current requirement regarding interruption requirement for a UE switching between two uplink carriers can be applied in Rel-17 (Nokia)
    - Clarify that the requirements apply for both frequency ranges
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | Option 2.  Our view is, since it is not agreed in RF session, it should be discussed in RF session. If RF session agreed to support it, RRM can define interruption requirements for TX switching at later stage. |
| MTK | Agree with Option 2. |
| Qualcomm | Option 1.  The motivation of the dynamic UL Tx carrier switching is to make the best of “two Tx ports” being shared between inter-bands for “FDD-TDD EN-DC”, “FDD-TDD NR CA”, and “TDD-SUL serving cell (a serving cell has two UL carriers)”, hence, not applicable to FR2. |
| Huawei | Support option 1, since the capability *uplinkTxSwitchingPeriod* is only applicable in FR1. |
| apple | Option 2 |

**Issue 2-1-4 DL interruption at NR SRS carrier based switching**

* Proposals
  + Option 1: To further consider whether interruption due to SRS carrier based switching can be limited to the band in which SRS carrier based switching is taking place. (Qualcomm, Nokia)
    - The decision shall be subject to confirmation by RF session, and the details are FFS, e.g. whether it depends on the signalling/triggering mechanism of SRS carrier based switching. (Qualcomm)
  + Option 2: Interruption due to SRS carrier switching in one band will occur on all serving cells within FR if UE supports per FR gaps; otherwise, interruption occurs on all serving cells. (Ericsson)
  + Option 3: RAN4 need to study whether and/or how to define the interruption requirements for inter-band SRS carrier based switching in FR2 (Huawei, Nokia)
    - Option 3a: Wait for RF room on conclusion of applicable SRS carrier switching time for inter-band CA in FR2 (Nokia)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| XXX |  |
| Ericsson | Can be FFS for now |
| MTK | It can be FFS. |
| Qualcomm | Option 1 and Option 3.  Compared to RRC based reconfiguration, SRS carrier switching can be relatively dynamic and is between carriers that are to some extent already active because those carriers must have been configured beforehand. With this understanding, RAN4 can further consider DL interruption enhancement for IBM UEs at NR SRS carrier based switching, e.g. interruption due to SRS carrier based switching does not spread beyond the band, SRS carrier switching time, etc. |
| Huawei | Support option 1 and option 3. RF inputs are needed. |
| ZTE | Wait for RF’s conclusion, |

## 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. For Rel-16 on-going WIs, suggest to focus on open issues discussion on 1st round.*

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

## Summary for 1st round

### Open issues

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

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic#1** | *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 |  |
|  |  |  |  |  |
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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