**3GPP TSG-RAN WG4 Meeting # 98-bis-e R4-210XXXX**

**Electronic Meeting, 12th – 20th April, 2021**

**Agenda item:** 8.3.7

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

**Title:** Email discussion summary for [98-bis-e][215] [NR\_RF\_FR2\_req\_enh2\_RRM](https://www.3gpp.org/ftp/tsg_ran/WG4_Radio/TSGR4_98_e/Inbox/Drafts/%5B98e%5D%5B230%5D%20NR_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 define the RRM core requirements for inter-band CA in FR2 corresponding to section 8.3.7 in the agenda.

In last RAN4#98-e meeting, RAN4 had discussions concerning the deployment and UE assumptions for CBM and IBM capable UEs in both RRM and RF sessions.

For CBM following was agreed:

* Deployment scenarios:
  + Assumption of deployment and band pair for IBM UE and CBM UE should follow the RF session conclusions (Up to 2nd round discussion).
* UE assumptions:
  + UE is assumed to make reception with one beam at a time, i.e. similar to Rel-15 baseline UE assumption.
  + At least one active panel at a time can be assumed as baseline for RRM requirements definition.
  + A UE that supports inter-band CA with CBM selects its DL Rx beam(s) for all CCs in all configured bands based on DL measurements made in the only CC configured with the reference signal for beam management.
    - In FR2 CA cases, requirements apply when the BM RS is provided in a CC with a configured UL BWP.
* MTTD:
  + RAN4 needs to study how to handle impact on performance due to Tx beam switching.
* RRM requirements:
  + Scope of the RRM requirements for FR2 inter-band DL CA includes but not limited to MRTD, Scaling factor CSSFoutside\_gap, interruption requirements, SCell activation requirements, Beam management requirements and scheduling/measurement restriction requirements

And for IBM following was agreed:

* Deployment scenarios:
  + Assumption of deployment and band pair for IBM UE and CBM UE should follow the RF session conclusions (Up to 2nd round discussion).
  + Follow the agreements in Rel16 i.e. there is no restriction on deployment scenario i.e. network assumes IBM UE supports both co-located and non-co-located deployments.
* UE assumptions:
  + IBM capable UE is assumed to be capable of receiving signals for FR2 inter-band CA with different beam directions at the same time.
  + A UE that supports inter-band CA with IBM selects its DL Rx beam(s) for all CCs in each configured band based on DL reference signals measurements made in that band.
* MRTD:
  + For IBM capable UE, the Rel16 MRTD requirements for FR2 inter-band CA can be applied in Rel-17 and no additional discussion is required in Rel17.
* MTTD:
  + For IBM capable UE, the Rel16 MTTD requirements for FR2 inter-band CA can be applied in Rel-17 and no additional discussion is required in Rel17.

Based on the agreements, the target of this meeting is to align the deployment and UE assumptions for CBM capable UEs and identify the potential impact to RRM requirements. The tentative target of email discussion for 1st round ad 2nd round is indicated below:

* 1st round: Companies are expected to provide views and/or comments on the listed open issues.
* 2nd round: Identify the potential RRM aspects to be defined in FR2 inter-band CA and converge on the assumptions if possible for defining the RRM requirements.

# Topic #1: Inter-band DL CA enhancements

Moderator comments: All the contributions discussing or partially discussing the RRM requirements for FR2 inter-band DL CA enhancements are listed here. According to the tdoc criteria in R4-2016602, all CRs will be postponed so the CR relevant to this topic is marked with ”~~strikethrough~~”.

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2104632](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2104632.zip) | vivo | Proposal 1: For the issue whether the symbol level alignment is within the CP length or not, suggest to focus on how to define MRTD requirements for CBM UE (option 3). It is also ok to use option 1.  Proposal 2: For the interruption requirement, suggest to option 2.  Proposal 3: Scheduling restriction, suggest to use option 1 as the conclusion.  Proposal 4: For the MRTD value for FR2 inter-band CA CBM scenario, reuse FR2 intra-band CA MRTD value, i.e., 260ns. |
| [R4-2104837](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2104837.zip) | Apple | Observation 1: For FR2 intra-band CA, symbol level alignment within CP length is essential to guarantee the same downlink spatial domain transmission filter on one OFDM symbol.  Observation 2: FR2 SCell activation requirements for intra-band CA suggests that when common beam management is assumed, fine timing and spatial information from one CC can be directly re-used by the other CC. This again makes it important that symbol level alignment should be with CP length.  Observation 3: For CBM based FR2 intra-band CA, L1 and L3 measurements on one CC can be reused for all the other CC. That implies the same Tx and Rx beams used across all CCs per OFDM symbol.  Proposal 1: In case of common beam management, it is assumed that gNB for all CC are collocated.  Proposal 2: It is proposed to reuse FR2 intra-band CA MRTD, i.e. 260ns for the MRTD of FR2 inter-band CA in case of common beam management. |
| [R4-2104978](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2104978.zip) | NEC | Proposal 1: RRM requirement for CBM are derived based on co-located deployment scenarios only.  Proposal 2: RAN4 to agree that MRTD is 3us for an UE which is capable of CBM.  Proposal 3: RAN4 to agree that symbol level alignment should be within MRTD value (3us) and not within the CP length.  Proposal 4: RAN4 to agree that RX beam switch (measurements) should be based on CC configured with beam management RS.  Proposal 5: RAN4 to agree on the RX beam switch value to be 150ns.  Proposal 6: RAN4 to agree that UE can switch RX beams (for example if it can switch during start of UL to DL transition) without major performance degradation.  Proposal 7: RAN4 to agree that there is no need to introduce scheduling restrictions on other bands due to measurements performed on one band.  Proposal 8: RAN4 not to define any measurement restrictions for CBM operation in FR2 inter-band CA.  Proposal 9: SCell activation delay for CBM operation of FR2 inter-band DL CA is 3ms. |
| [R4-2105141](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2105141.zip) | Ericsson | *Observation-1: There are many options before scheduling restrictions are needed, like available time in UL and DL (if carriers not full) and UL to DL switch, where UE could safely switch beams.*  *Observation-2: A beam switch change during TDL-UL guard period would not impact reception of another 3 µs late DL carrier.*  Given these observations, we propose the following:  *Proposal-1: Any change in MRTD should not impact already defined BS TAE of 3 µs for FR2 inter-band CA; i.e. keep Rel-15 values for BS TAE unchanged.*  *Proposal-2:*   * *The beam management is implementation dependent, thus not applicable to all UEs and to all band combinations.* * *The relevant UEs should be identified and distinguished (e.g. via capability indication, etc.) and the restrictions shall not be applied (e.g. deployment restrictions, etc.) for all UEs and all band combinations for the future of NR.* * An agreed and approved UE capability indication, as in the bullet above, is a precondition for proposals in this document.   *Proposal-3: Define MRTD for inter-band FR2 NR CA with common beam management as 3 µs.*  *Proposal-4: Corresponding MTTD for inter-band FR2 NR CA with common beam management as 3.5 µs.* |
| [R4-2106302](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106302.zip) | LG Electronics Polska | Proposal 1: UE RRM requirements for CBM should be derived based on co-located deployment scenario same as RF requirements.  For MRTD  Proposal 2: Define MRTD requirements based on co-located deployment for CBM UE.  Proposal 3: If MRTD larger than CP length is defined for inter-band DL CA based on CBM, demodulation performance degradation should be noted due to Rx beam switch.  Proposal 4: If MRTD less than CP length is defined for inter-band DL CA based on CBM, reuse Rel-16 FR2 intra-band non-contiguous MRTD of 260ns. |
| [R4-2106393](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106393.zip) | Nokia, Nokia Shanghai Bell | 1. It is feasible to re-use Rel-15 baseline UE RRM requirements as baseline UE requirements for Rel-17 CBM capable UE.   UE assumptions:   1. Capture that for an IBM capable UE, with more than 1 panel, the UE is able to actively operate with multiple panels simultaneously. 2. Rel-15 RRM requirements can be re-used as baseline for Rel-17 FR2 inter-band CBM UE RRM requirements. 3. Rel-15 requirements should be readily applicable as UE requirements for the Rel-17 inter-band CA scenario for a CBM capable UE. 4. Rel-15 CA requirements are applicable for Rel-17 FR2 inter-band CA for CBM even if the SCS different between the bands. 5. If the DL timing between the bands is different, changing UE TCI state (Rx spatial settings) based on DL timing in band 1 may impact DL reception on band 2, which may lead to an loss of the DL signal in band 2. 6. Any timing impacts should be identified and should need to be accounted in the UE requirements.   CBM and UE interruption requirements:   1. Define UE interruption requirements for FR2 inter-band CA for a CBM capable UE. 2. Existing non-IBM UE interruption requirements would be applicable.   CBM and UE scheduling restrictions:   1. introduce UE scheduling restriction requirements for a CBM capable UE for the inter-band CA scenario. 2. Existing non-IBM UE scheduling restriction requirements would be applicable   CBM and UE measurement restrictions:   1. Measurement restriction requirements need to be defined for CBM capable UE for inter-band CA scenario. 2. Existing Measurement restriction requirements would be applicable.   CBM and SCell activation requirements:   1. If the FR2 SCell being activated is known the existing SCell activation requirements can be readily be re-used for CBM capable UE in inter-band CA scenario. 2. If the activated SCell is unknown but PCell/PSCell is in FR2, the SCell activation delay requirements defined for the scenario where there is at least one active serving cell in the band, apply.   CBM and CSSFoutside\_gap:   1. Existing R15 requirements for CSSFoutside\_gap can be used as the baseline for CBM UE   CBM and beam management:   1. The existing BFD/CBD requirements in Rel-16 can be applied for CBM type UE.   MRTD and MTTD for inter-band CA:   1. The MRTD requirements for inter-band CA in FR2 under CBM shall be 3us. |
| [~~R4-2106394~~](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106394.zip) | ~~Nokia, Nokia Shanghai Bell~~ | 1. ~~Including the abbreviations for CBM and IBM.~~ 2. ~~Defining the conditions for when CBM and IBM UE requirements can apply.~~ |
| [R4-2106506](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106506.zip) | Intel Corporation | Proposal 1: RRM requirements for CBM UEs will be derived based on co-located deployment scenario only  Observation 1: Inter-band TAE was increased from 260ns to 3us in order to support Non-Collocated deployments.  Proposal 2: MRTD requirements for CBM UEs should not rely on FR2 inter-band TAE requirement as it was defined for Non-co-located deployments.  Proposal 3: MRTD=260ns for CBM UEs |
| [R4-2106531](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106531.zip) | OPPO | Proposal 1: Symbol level alignment should be with CP length.  Proposal 2: Demodulation performance degradation due to Rx beam switch should be noted in MRTD requirements for CBM UE if MRTD is larger than CP.  Proposal 3: For MRTD of FR2 inter-band CA with CBM, reuse FR2 intra-band CA MRTD, i.e. 260ns.  Proposal 4: For a FR2 inter-band CA with CBM, the existing interruption requirements of intra-band CA can be applied.  Proposal 5: As compromise, RRM discussion on DL interruption at NR SRS carrier-based switching can be hold until we have conclusion of FR2 inter-band UL CA in RF session.  Observation 1: The SCell activation requirements of CBM capable UE for case 2 depend on both RF architecture and MRTD requirements for CBM type UE.  Proposal 6: SCell activation delay would be reduced for the case provided that 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 7: If FR2 inter-band CA with two bands are only considered in Rel-17, then the existing requirements on scaling factor CSSFoutside\_gap in Rel-16 can be applied to Rel-17.  Proposal 8: The existing BFD/CBD requirements in Rel-16 can be applied for CBM type UE |
| [R4-2106944](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106944.zip) | Huawei, HiSilicon | *Proposal 1: The existing scaling factor* *CSSFoutside\_gap requirements for FR2 inter-band CA in R16 can be applied in Rel-17 when the number of bands for FR2 inter-band CA is 2 bands.*  *Proposal 2: For IBM UE, the existing R16 RRM requirements for FR2 inter-band CA can be applied in Rel-17.*  *Proposal 3: For CBM type UE, the MRTD requirements for FR2 inter-band CA in Rel-17 can be defined as 3us with the assumption of co-located deployment.*  *Proposal 4: If there is no further RF inputs on the RF architecture of CBM type UE, the assumption of RF implementation for inter-band CA in R15/R16 can be reused in R17, and the existing interruption requirements for inter-band CA in R15/R16 can be reused for CBM type UE in R17.*  *Proposal 5: For known target SCell, the existing SCell activation requirements in Case 2 can be reused for CBM type UE.*  *Proposal 6: For unknown target SCell, the existing SCell activation requirements in Case 2 with removing L1-RSRP measurement delay can be used for CBM type UE.*  *Proposal 7: In Rel-17, the existing scheduling restriction requirements applied for FR2 intra-band CA need to be extended to FR2 inter-band CA with CBM type UE, and the scheduling restriction requirements for CBM UE can be defined as below:*   * *When inter-band carrier aggregation in FR2 is configured, the scheduling restrictions on one serving cell apply to all serving cells in a different band on the symbols that fully or partially overlap with restricted symbols, provided that UE is capable of common beam management on this FR2 band pair.*   *Proposal 8: For FR2 inter-band CA with CBM, RAN4 needs to study whether the UE would be configured with RS resources on different FR2 bands for layer 1 measurement.*  *Proposal 9: No additional scheduling restriction requirements are needed for Rx beam switching of intra-frequency measurement and layer 1 measurements, if the existing scheduling restriction requirements applied for FR2 intra-band CA are extended to FR2 inter-band CA with CBM type UE.* |
| [R4-2107289](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2107289.zip) | Qualcomm Incorporated | General aspects of CBM and IBM  Proposal 1: In accordance with the agreement made in RF session, UR RRM requirements for CBM shall be derived based on co-located deployment scenario only.  Timing aspects of IBM and CBM  Observation 1: No further discussion is needed for inter-band IBM UE.  Proposal 2: For CBM UEs in FR2 inter-band CA, if MRTD is larger than CP length with respect to serving cell numerology, serving cell(s) shouldn’t expect the UE to be able to receive/detect PDCCH(s) on search spaces including at least the first or last OFDM symbol of slot in a band where beam management reference resource(s) it not configured. FFS on multiple numerologies. FFS on further scheduling restrictions on PDCCH and/or PDSCH.  SCell activation for CBM UE  Proposal 3: For CBM UEs, SSB samples for Rx beam sweeping shouldn’t be accounted for in SCell activation latency requirement.  Measurement and Scheduling restrictions for CBM UE  Proposal 4: For CBM UEs in FR2 inter-band CA, measurement and/or scheduling restriction for RRM/RLM/Link Recovery/L1-RSRP/SINR measurements shall be applied across FR2 bands. The following sections shall be updated accordingly:   * For RRM (Neighbor cell measurement) * 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 * For Radio Link Monitoring * 8.1.2.3 Measurement restrictions for SSB based RLM * 8.1.3.3 Measurement restrictions for CSI-RS based RLM * 8.1.7.3 Scheduling availability of UE performing radio link monitoring on FR2 * For Link Recovery * 8.5.2.3 Measurement restriction for SSB based beam failure detection * 8.5.3.3 Measurement restrictions for CSI-RS beam failure detection * 8.5.5.3 Measurement restriction for SSB based candidate beam detection * 8.5.6.3 Measurement restriction for CSI-RS based candidate beam detection * 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 * For L1-RSRP/SINR measurements (Serving cell measurement) * 9.5.5.1 Measurement restriction for SSB based L1-RSRP * 9.5.5.2 Measurement restriction for CSI-RS based L1-RSRP * 9.5.6.3 Scheduling availability of UE performing L1-RSRP measurement on FR2 * 9.8.5.1 Measurement restriction if SSB configured for L1-SINR Measurement * 9.8.5.2 Measurement restriction if CSI-RS configured for L1-SINR measurement * 9.8.5.3 Measurement restriction if CSI-IM configured for L1-SINR measurement * 9.8.6.3 Scheduling availability of UE performing L1-SINR measurement on FR2 * If MRTD between the two bands is larger than CP length with respect to serving cell numerology, * Measurement and/or Scheduling restriction to serving cell(s) on the other band should account for the MRTD, e.g. [x] slots before and after SSB symbols and/or CSI-RS symbol(s) |
| [R4-2104691](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2104691.zip) | Xiaomi | Proposal 1: The RRM requirements for CBM capable UE shall be derived based on co-located deployment scenario only.  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 in order to guarantee the UE Rx beam switching can be performed within CP and avoid the interruption on DL reception.  Proposal 2: For FR2 inter-band DL CA with CBM, the MRTD shall be defined as 260ns.  Observation 3: For the CBM capable UE, the MTTD should be smaller than CP length to avoid the interruption on uplink transmission.  Proposal 3: For FR2 inter-band DL CA with CBM, the MTTD shall be defined as 375ns.  Observation 4: if the single beam forming is shared by both bands, the existing interruption requirement of intra-band CA should be applied.  Observation 5: if the multiple beam forming is 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 4: For inter-band CA with CBM, the existing Rel-16 interruption requirements of intra-band CA shall be applied. |

## Open issues summary

### Sub-topic 1-1: General

*Sub-topic description:* This sub-topic discusses the general issues relevant to defining the RRM requirements for FR2 inter-band DL CA e.g. the deployment and UE assumptions for IBM and CBM UEs.

Following was agreed in RF session at last RAN4 meeting:

* *network deployment restriction for CBM*
  + *There are no deployment restrictions (Non-co-located/co-located) for network to configure inter-band DL CA for CBM UEs.*
  + *UE RF requirements for CBM shall be derived based on co-located deployment scenario only.*

**Issue 1-1-1: Deployment scenarios assumption for CBM**

* Proposals
  + Option 1: In case of CBM, it is assumed that gNB for all CC are collocated (Apple)
  + Option 2: The cell deployment assumption in the inter-band CA scenario may be fully co-located or almost co-located (Nokia)
  + Option 3: Define MRTD and RRM requirements for CBM capable UEs based on co-located deployment scenarios only. (NEC, LG, Intel, Qualcomm, LG, Huawei, Xiaomi)
* Recommended WF

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| **Company** | **Comments** |
| Qualcomm | Option 3 as per the agreement below.  **Agreement on Network deployment scenarios assumption made in RF session in RAN4#98e meeting (R4-2103399)**   * There are no deployment restrictions (Non-co-located/co-located) for network to configure inter-band DL CA for CBM UEs.   UE RF requirements for CBM shall be derived based on co-located deployment scenario only. |
| Intel | Option 3. |
| LG Electronics | Support option 3. It needs to align with RF session’s agreement. |
| MTK | Option 3 as per the agreement in RF session. |
| OPPO | Option 3 as per the agreement in RF session. |
| Ericsson | Option 3. : Define MRTD and RRM requirements for CBM capable UEs based on co-located deployment scenarios only. |
| NEC | Option 3 |
| Nokia | We can agree to use the same assumptions as agreed for the RF requirements development in order to ensure that RF and RRM requirements are based on the same assumptions. Hence, there will be no deployment restrictions (co-located or non-co-located) for the network to configure inter-band CA for CBM capable UEs.  The RRM requirements for CBM will be developed based on co-location deployment scenario only. This does not mean any implicit MRTD assumptions (which is handled in other sub-topics). |

**Issue 1-1-2: UE assumption for IBM**

* Proposals
  + Option 1: For an IBM capable UE, with more than 1 panel, the UE is able to actively operate with multiple panels simultaneously. (Nokia)
  + Option 2: No further discussion is needed for inter-band IBM UE. (Qualcomm)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2. The following agreements were made in RF session in RAN4#98e. At to “multiple panels” in Option 1, the exact definition and whether it has any restriction on the applicability of the set of agreements can be further discussed in RF session as needed.  **Definition of IBM (Independent Beam Management):**   * A UE that supports inter-band CA with IBM selects its DL Rx beam(s) for all CCs in each configured band based on DL reference signals measurements made in that band.   **Network deployment scenarios assumption**   * Follow the agreements in Rel16 i.e. there is no restriction on deployment scenario i.e. network assumes IBM UE supports both co-located and non-co-located deployments.   **UE beam/panel assumptions**  IBM capable UE is assumed to be capable of receiving signals for FR2 inter-band CA with different beam directions at the same time |
| Intel | Issues on the number of panels should be discussed in RF session but not in RRM. |
| LG Electronics | Support option 2 for inter-band DL CA based on IBM UE. |
| Ericsson | Option 1: For an IBM capable UE, with more than 1 panel, the UE is able to actively operate with multiple panels simultaneously. |
| Nokia | We are fine not discussing number of panels further. Only aspect we would like to discuss as being common understanding is that an IBM capable UE is able to operate the independent beams independently and without panel restrictions. Meaning, assumption would be that an IBM capable UE would not be restricted in independent beam operations due to the potential active beams not being handled by same panel. |

### Sub-topic 1-2: MRTD for common beam management

*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 1-2-1: MRTD value for FR2 inter-band CA**

* Proposals
  + Option 1: Reuse FR2 intra-band MRTD i.e. 260ns (Vivo, Apple, Intel, OPPO, Xiaomi)
  + Option 2: 3us (NEC, Ericsson, Nokia, Huawei)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1. As per the agreement below, a set of requirements for CBM based inter-band FR2 CA shall be based on co-located deployment scenario for which “BS type 1-O” is applicable. TAE requirement for “BS type 1-0” is 260ns which coincides with intra-band FR2 MRTD.  **Agreement on Network deployment scenarios assumption made in RF session in RAN4#98e meeting (R4-2103399)**   * There are no deployment restrictions (Non-co-located/co-located) for network to configure inter-band DL CA for CBM UEs.   UE RF requirements for CBM shall be derived based on co-located deployment scenario only. |
| Intel | Based on the reviewed proposals we don’t see that agreement on MRTD value could be made.  The proposal of introducing the performance degradation is not acceptable – the RX beam switching is unpredictable and in the extreme case it can happen after each slot, which leads to severe upper bound of performance degradation.  The solutions proposed by Ericsson, NEC and Huawei to switch Rx beams only during UL-DL switch and during SSB/RSSI symbols may work. But Rx beam switching is implementation specific and, in general, we should assume that UE can switch its Rx beams at any time. Limiting implementations by spec is unlikely to be agreed.  At the same time the issue can also be resolved from the BS side. As we mentioned in our paper, current inter-band TAE was defined to support non-co-located deployments. We don’t see any technical reasons why TAE should be larger than 260ns for co-located deployment and within the same frequency band group. So, we believe that BS implementations with TAE<260ns are possible.  **We see the compromised solution in introducing UE capability which informs network whether UE can support 3us MRTD or 260ns MRTD. This will allow different implementations for both UE and BS not limiting to them.**  If the corresponding flag is 1, that means that UE implementation allows 3us MRTD by using, for instance, only UL-DL guard period or SSB/RSSI symbols for Rx beam switch during CA (or any other implementation specific solution). No problem for CBM inter-band CA in this case.  If the corresponding flag is 0 then it is up to network to decide. If it can support TAE<260ns then no problem for CBM inter-band CA. But if its implementation doesn’t allow that then it just doesn’t schedule that UE in inter-band CA.  The main drawback of this solution is that we can come to the situation when UE vendors will always set this field as false and network will always choose not to schedule such UEs in CA. In this case we will fall back to no worse than current situation. But we believe that good implementations are possible from both sides. |
| LG Electronics | Support Option 1. |
| MTK | Option 1. The Rx beam switching is up to UE implementation and we should assume that UE can switch its Rx beams at any time. It is not agreeable on limiting the switching time during RS symbols. |
| OPPO | Support Option 1. |
| Ericsson | Option 2: 3 µs. Applicable for UE which is only capable of common beam management for a band combination where common beam management is possible. The UE may, assume collocated site, in this case. |
| NEC | We support option 2. Our view is there exists a method using which UE can complete RX beam switch without any performance degradation.  However since the company’s position is same since Rel-16, to make progress we can consider supporting Intel’s suggestion of introducing new UE capability. |
| Nokia | We support option 2. As discussed, we see that the MRTD consist of the TAE and the propagation time. For the current scenarios defined for inter-band CA we can assume that the DL propagation delay will be the same on both bands and hence the difference will be ~0.  The impact on the UE reception from different DL reception in each band for the CBM capable UE will occur if the misalignment is larger than the CP.  But even for the case when the scenario when co-location is assumed for developing the RRM requirements the CBM UEs will be to receive on both bands even if the MRTD is larger than 260ns. In some situation, e.g. if the MRTD is significantly larger than 260ns (but lower than CP), the CBM UE will see some impact on the performance. However, such performance impact will be visible on the network side and network can take appropriate actions. Hence, in the end it will be the network configuration choice and network responsibility.  Inter-band CA is different from intra-band CA from network configuration. For inter-band CA, the default implementation is two remote radio heads. For intra-band CA, since we assume co-located scenarios, one RRH is applied. Too tight MRTD for example 260ns for inter-band FR2 CA will restrict the network deployment especially for not fully collocated deployment or multiple RRHs implementation, and it will be also difficult for operators to synchronize multiple RRHs. |

**Issue 1-2-2: Symbol level alignment assumption**

* Proposals
  + Option 1: Symbol level alignment should be with CP length (OPPO, Apple, Vivo)
  + Option 2: Symbol level alignment should be within MRTD value (3us) (NEC)
  + Option 3: RAN4 should focus on how to define MRTD requirements for CBM UE (Vivo)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1. We see no need for a separate discussion for this from MRTD. |
| Intel | Option 3. |
| LG Electronics | Support option 3. |
| MTK | Option 3. |
| OPPO | Option 1. |
| Ericsson | Option 2: Symbol level alignment should be within MRTD value |
| NEC | Option 2. |
| Nokia | we support option 2. Symbol level alignment should be within MRTD. We suppose the option 1 is derived from the applicability of intra-band CA, however it is different case for inter-band FR2 CA. For intra-band CA, single transmitter/receiver chain architecture is assumed, hence, same Tx beam is assumed for all CCs. For inter-band CA, there will have multiple transmitter/receiver chain architecture, there will have multiple Tx beams for all CCs. |

**Issue 1-2-3: How to derive MRTD for FR2 inter-band CA?**

* Proposals
  + Option 1: MRTD = TAE + Δ\_propagation\_time (Ericsson, NEC, Nokia, Huawei)
    - Option 1a: Any change in MRTD should not impact already defined BS TAE of 3 µs for FR2 inter-band CA; i.e. keep Rel-15 values for BS TAE unchanged.
  + Option 2: MRTD requirements for CBM UEs should not rely on FR2 inter-band TAE requirement as it was defined for Non-co-located deployments. (Intel)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2. In accordance with the agreement below, the requirement shall be based on “BS type 1-0” for which TAE requirement is 260ns.  **Agreement on Network deployment scenarios assumption made in RF session in RAN4#98e meeting (R4-2103399)**   * There are no deployment restrictions (Non-co-located/co-located) for network to configure inter-band DL CA for CBM UEs.   UE RF requirements for CBM shall be derived based on co-located deployment scenario only. |
| Intel | Option 2 as it is discussed in our paper. |
| LG Electronics | Support Option 2. |
| MTK | Option 2. |
| OPPO | Option 2. |
| Ericsson | Option 1: MRTD = TAE + Δ\_propagation\_time.  TAE for inter band CA has been 3 µs since release 15 and we prefer to keep TAE = 3 µs for inter band, since there exist existing transmission solutions assuming this. |
| NEC | Option 1. Whether UE supports it or not can be UE capability |
| Nokia | We support option 1. MRTD are derived from TAE, MRTD for intra-band CA also defined as this way. What this issue is raised is some companies think it is the similar case between inter-band FR2 CA for CBM UE and intra-band FR2 CA, however, from network point of view, they are different. From network configurations, the default implementation is two remote radio heads for inter-band CA, however one RRH is applied for intra-band FR2 CA with co-located deployment. FR2 inter-band TAE requirement is defined because of network configuration with multiple RRHs, it is not limited by non-collocated deployment. Too tight MRTD like less than TAE for inter-band FR2 CA will restrict the network deployment and configurations with multiple RRHs implementation, and it will be also difficult for operators to synchronize multiple RRHs. |

**Issue 1-2-4: Performance degradation due to Rx beam switch**

* Proposals (The options/sub-options are not mutually exclusive)
  + Option 1: UE can switch RX beams without major performance degradation even if MRTD is larger than CP length
    - Option 1a: UE can switch RX beams (for example if it can switch during start of UL to DL transition) without major performance degradation (NEC)
    - Option 1b: A beam switch could be performed safe within the DL2UL guard if properly performed (Ericsson)
  + Option 2: Any timing impacts should be identified and should need to be accounted in the UE requirements (Nokia).
    - Option 2a: If MRTD larger than CP length is defined for inter-band DL CA based on CBM, demodulation performance degradation should be noted due to Rx beam switch. If MRTD less than CP length is defined for inter-band DL CA based on CBM, reuse Rel-16 FR2 intra-band non-contiguous MRTD of 260ns (LG, OPPO)
    - Option 2b: For CBM UEs in FR2 inter-band CA, if MRTD is larger than CP length with respect to serving cell numerology, serving cell(s) shouldn’t expect the UE to be able to receive/detect PDCCH(s) on search spaces including at least the first or last OFDM symbol of slot in a band where beam management reference resource(s) it not configured. FFS on multiple numerologies. FFS on further scheduling restrictions on PDCCH and/or PDSCH. (Qualcomm)
    - Option 2c: 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)
  + Option 3: No additional scheduling restriction requirements are needed for Rx beam switching of intra-frequency measurement and layer 1 measurements, if the existing scheduling restriction requirements applied for FR2 intra-band CA are extended to FR2 inter-band CA with CBM type UE. (Huawei)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 2. And to us, Option 3 is not different from Option 2 in terms of performance degradation due to MRTD larger than CP if nothing is explicitly specified for CBM based inter-band FR2 CA.  As the first OFDM symbol of slot is typically used for PDCCH and/or front-loaded PDSCH-DMRS transmission, the impact of one OFDM symbol interruption will likely result in a significant performance loss.  For option 1, we don’t really follow what exactly it means. Does the UE beam switching during “UL-to-DL gap” and/or “DL-to-UL gap” mean that network will extend the each gap by, e.g. 3usec, to account for TAE between the two bands for CBM based inter-band CA UEs? If then, isn’t it at the expense of available UE resources? If this additional gap is provided implicitly by TDD pattern configuration, UEs not configured with CA in the two FR2 bands or UEs capable of IBM UEs can be unfairly penalized. Besides, RAN4 should keep in mind that UEs should be always allowed to switch Rx beams for BM/RRM/RLM purposes in any DL slots where relevant reference resources are configured. |
| Intel | Option 2c. In the worst case the performance loss can be too bad. Prefer not to allow it at all. |
| LG Electronics | Support option 2. |
| MTK | Option 2. |
| OPPO | Option 2 and 2c. |
| Ericsson | Option 1, 1b. We argue the following:   1. A Band combination where the inter band CA combination bands are not so well separated that the channel models and propagation are significantly different. 2. A Band combination that allows CBM (and where it would make sense to restrict to CBM). 3. A UE indicating only capable of CBM for the specific inter band CA band combination. 4. The network is deployed as co-located (a pre-requisite for supporting CA for CBM restricted UEs, refer to Section 3 for further details). 5. A beam switch or change is still needed, despite network deployed as co-located. 6. There will be no available time occasion in DL (or UL as well for that matter) where the UE could safely perform a beam switch within CP. If both carriers are not full then there might still exist opportunities to switch. What is the likelihood of both carriers full, at all times? Even if both carriers are active, there are possibilities to use the DL to UL guard. One such opportunity is developed in section 2.2 below. 7. If it is not possible to mitigate effects of the beam switch during actual transmission/reception, then consequences would be dependent on how frequent beam switch would occur. 8. If it is not possible to mitigate effects of beam switch during transmission/reception and if happens to frequent then consequences would be dependent beam switch time compared to symbol time   ***There are many options before scheduling restrictions are needed, like available time in UL and DL (if carriers not full) and DL to UL switch, where UE could safely switch beams.*** |
| NEC | Option 1a. Our understanding is as follows.  MTTD is more than MRTD value. If MRTD is agreed as 3us, MTTD can be in the order of 3.5us that means one CC (e.g. CC1) will start DL switch 3.5us ahead of other CC (e.g. CC2). If UE starts Rx beam switch immediately after UL to DL switch completion of CC1, since CC2 UL to DL switch complete only after 3.5us, and since RX beam switch value do not exceed CP, UE can perform DL RX switch on CC1 before the start of DL CP start on CC2. That means there may not be any performance degradation.  To Qualcomm, in this method there is no need to extend the UL to DL switching gap as the switch happens on one CC (e.g. CC1 in the above example) DL CP immediately after the UL to DL switch gap, and the other CC (e.g. CC2) would not have completed UL to DL switch by the time CC1 completed RX beam switch. |
| Nokia | We would support option 1 although it is not clear what ‘major’ really means. If option 1b is seen feasible from UE implementation point of view this is our preferred solution. We would be interested in understanding any technical reasonings on the feasibility of option 1b and in case unfeasible, what would be the reason?  As can be understood and seen from input from many companies, the potential performance impact from larger MRTD happens if the MRTD increases beyond the CP. If the misalignment at the UE side increases beyond the CP the UE may not be able to receive the impacted symbols. Hence, UE may have performance loss of typically 1 symbol (but could be more if SCS is large).  However, instead of forcing a common and very strict MRTD requirement, RAN4 should instead analyze the further the potential impact under the different scenario (as done in Qualcomm paper) to evaluate conditions under which performance may be impacted and how much we expect the impact to be.  Based on such evaluation RAN4 would be able to define UE requirements with larger MRTD like 3us than 260ns accounting both UE and network concerns. |

**Issue 1-2-5: reference signals for Rx beam switch**

* Proposals
  + Option 1: RX beam switch (measurements) should be based on CC configured with beam management RS (NEC)
  + Option 2: For FR2 inter-band CA with CBM, RAN4 needs to study whether the UE would be configured with RS resources on different FR2 bands for layer 1 measurement. (Huawei)
* Recommended WF

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| **Company** | **Comments** |
| Qualcomm | Option 1.  For Option 2, we do not see the need for the study and believe Huawei has the same understanding based on my reading of the contribution R4-2106944. |
| Intel | Option 1. |
| MTK | Option 1. |
| Ericsson | Option 1. |
| NEC | Option 1 |
| Nokia | We do not think either option 1 or 2 are clear enough and prefer additional discussion.  In last meeting following was agreed:   * A UE that supports inter-band CA with CBM selects its DL Rx beam(s) for all CCs in all configured bands based on DL measurements made in the only CC configured with the reference signal for beam management.   + In FR2 CA cases, requirements apply when the BM RS is provided in a CC with a configured UL BWP   First of all one should likely be clear that above agreement is for FR2 inter-band CA for CBM capable UE.  Secondly, RAN4 would need to agree what assumptions should be made related to DL RS for BM for the CBM UE in FR2 inter-band CA. E.g. if DL RS for BM is available in both bands? What would be the related UE requirements? Etc.  We would assume that the agreement made in last meeting means that the CBM UE in FR2 inter-band CA configuration, would only need to be configured with DL RS for BM in one CC. And this CC would be the CC with an UL BWP. We would assume that the UE at least perform BM related measurements at least on that CC in that band. Whether the UE additionally is required to perform other BM related measurements needs to be discussed. |

**Issue 1-2-6: Rx beam switch delay**

* Proposals
  + Option 1: RX beam switch value is 150ns (NEC)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | The value should be discussed and decided in RF session. |
| Intel | The value should be discussed in RF session. Based on the contribution from NEC it looks like we have different understanding of the Rx beam switch problem. Our understanding is that the problem is not only in missed samples during the beam switch but in using non-optimal beam in CC2 for the rest of the symbol. So, short Rx beam switch value will not help. |
| LG Electronics | Same view with QC. |
| MTK | The value should be discussed in RF session. And agree that short value will not help much on the degradation. |
| Ericsson | The value should be discussed in RF session. |
| NEC | We agree that value can be discussed in RF session. However unless the value is known, we may not be able to quantify the performance degradation. Can we make some working assumption for further discussion of performance degradation? |

### Sub-topic 1-3: MTTD for common beam management

*Sub-topic description:* This sub-topic discusses the MTTD requirements for common beam management.

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

**Issue 1-3-1: The MTTD value for FR2 inter-band CA with CBM**

* Proposals
  + Option 1: 3.5 µs (E///)
  + Option 2: 375 ns (Xiaomi)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Close to Option 2. We believe MTTD shouldn’t be in the order of micro-seconds. The exact value can be discussed later on. |
| Intel | MTTD is related to UL transmission but based on a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| LG Electronics | At first, MRTD needs to be decided. Postpone MTTD until MRTD is decided. |
| Ericsson | Ericsson shares Intel’s analysis of revised WID RP-210914 CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| Nokia | Once RAN4 has decided on the MRTD the MTTD should be defined based on the agreed MRTD. |

### Sub-topic 1-4: RRM requirements for common beam management

*Sub-topic description:* This sub-topic discusses the RRM requirements other than MRTD and MTTD in case of CBM for FR2 inter-band DL CA. Please note that not all the options/sub-options are mutually exclusive.

**Issue 1-4-1: RRM requirements baseline**

* Proposals
  + Option 1: Rel-15 RRM requirements can be re-used as baseline for Rel-17 FR2 inter-band CBM UE RRM requirements (Nokia)
    - Option 1a: Rel-15 CA requirements are applicable for Rel-17 FR2 inter-band CA for CBM even if the SCS different between the bands (Nokia)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | It is unclear about which specific RRM requirements Option 1 refers to. For example, as CBM UE doesn’t need to perform Rx beam sweeping on CCs in a band where BM resources are not configured, there can be RRM requirements that may not be developed based on Rel-15 even if MRTD is not larger than CP, e.g. SCell activation latency requirement. And it is also unclear what “baseline” exactly means here. It needs to be more specific. |
| Intel | Clarification on “baseline” is needed. |
| Ericsson. | Clarification on “baseline” is needed |
| NEC | We share same view as Intel and Ericsson. |
| Nokia | To clarify our proposal. We suggest that existing Rel-15 CA requirements can be applied as baseline for the FR2 RF CBM RRM requirements (excluding MRTD part). It can be further discussed whether there is a need for updates. |

**Issue 1-4-2: Interruption requirements**

* Proposals
  + Option 1: The interruption requirements applied for CBM based FR2 inter-band CA need to be introduced in Rel-17:
    - Option 1a: The existing interruption requirements of intra-band CA can be applied (OPPO, Xiaomi)
    - Option 1b: Existing non-IBM UE interruption requirements would be applicable (Nokia)
    - Option 1c: The existing interruption requirements for inter-band CA in R15/R16 can be reused for CBM type UE in R17 (Huawei)
    - Option 1c: Need RF inputs on the RF architecture of CBM type UE (Vivo)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1. By default, the existing interruption requirements of intra-band and inter-band CA are expected to be applied here, and there can be more depending on RF input and a conclusion on MRTD/MTTD. |
| Intel | Option 1c. Depending on implementation (shared RF chain or independent RF chains) either existing inter-band CA or existing intra-band CA interruption requirements can be applied. We are ok to wait for RF inputs if such discussion is expected there. Otherwise, if there will be no agreement on exact implementation, the most conservative requirement should be chosen which is the existing interruption requirements of intra-band CA – Option 1a. |
| MTK | Option 1a can be the starting point, and it can be revised up to RF input. |
| OPPO | Option 1a. More RF input may be needed. |
| Ericsson | Option 1c: The interruption requirements applied for CBM based FR2 inter-band CA need to be introduced in Rel-17, which need RF inputs on the RF architecture of CBM type UE |
| NEC | We can wait for further RF input. |
| Nokia | Accounting or proposal in Issue 1-4-1 and option 1b here, we see 1b and 1c as the same and we have same view as Huawei and option 1c. The requirements would need to capture the CBM capable UE requirements. |

**Issue 1-4-3: Scheduling restriction**

* Proposals
  + Option1: The scheduling availability requirements for FR2 inter-band CA scenario shall be introduced to clarify there is scheduling restriction on one FR2 band due to RLM/BFD/CBD/L1-RSRP measurements being performed on another FR2 band if UE uses common beam (Vivo, Qualcomm, Nokia):
    - Option 1a: The existing scheduling restriction requirements on FR2 shall be extended to serving cells in different bands. (Vivo, Qualcomm, Huawei)
    - Option 1b: Existing non-IBM UE scheduling restriction requirements would be applicable (Nokia)
    - Option 1c: In Rel-17, the existing scheduling restriction requirements applied for FR2 intra-band CA need to be extended to FR2 inter-band CA with CBM type UE, and the scheduling restriction requirements for CBM UE can be defined as below (Huawei):
      * When inter-band carrier aggregation in FR2 is configured, the scheduling restrictions on one serving cell apply to all serving cells in a different band on the symbols that fully or partially overlap with restricted symbols, provided that UE is capable of common beam management on this FR2 band pair.
  + Option 2: There is no need to introduce scheduling restrictions on other bands due to measurements performed on one band (NEC)
  + Option 3: If MRTD between the two bands is larger than CP length with respect to serving cell numerology, Measurement and/or Scheduling restriction to serving cell(s) on the other band should account for the MRTD, e.g. [x] slots before and after SSB symbols and/or CSI-RS symbol(s) (Qualcomm)
    - Option 3a: For CBM UEs in FR2 inter-band CA, if MRTD is larger than CP length with respect to serving cell numerology, serving cell(s) shouldn’t expect the UE to be able to receive/detect PDCCH(s) on search spaces including at least the first or last OFDM symbol of slot in a band where beam management reference resource(s) it not configured. FFS on multiple numerologies. FFS on further scheduling restrictions on PDCCH and/or PDSCH.
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 and Option 3. In our understanding, for the restriction, there are two factors that need to be taken into consideration. (1) Spatially separate beams for the two bands can’t be generated by the UE concurrently. (2) UE may not be able to always receive all OFDM symbols without any loss unless Time-difference-of-arrival between CCs in the two bands is less than or equal to CP length. For Option 3, if RAN4 concludes that MRTD is not larger than CP length, it can be delisted. |
| Intel | Option 1 |
| MTK | Fine with Option 1. |
| OPPO | Option 1 is fine. |
| Ericsson | Option 1a: The existing scheduling restriction requirements on FR2 shall be extended to serving cells in different bands |
| NEC | We feel that further RF input is needed. Information of common RF chain or separated RF chain for different bands may be needed.  May be a clarification question to other companies. Aren’t we discussing scheduling restriction on one band due to measurements performed on other band? Since there is only one RS for BM on one band, won’t it have effect on requirements discussed here? |
| Nokia | In general, there seems to be agreement to introduce scheduling availability requirements for FR2 inter-band CA scenario. then on the details how to capture the scheduling restriction on one FR2 band due to RLM/BFD/CBD/L1-RSRP measurements being performed on another FR2 band if UE uses common beam, there are different proposals.  From our view we see options 1a and 1b as being the same. How then to capture the inter-band CBM requirements the detailed proposals in option 1c and 3a needs further discussion. In one aspect we have a slight preference for the principle in option 3a as it defines more clearly the UE requirements and restrictions. |

**Issue 1-4-4: Measurement restriction**

* Proposals
  + Option 1: Measurement restriction requirements need to be defined for CBM capable UE for inter-band CA scenario.
    - Option 1a: Existing Measurement restriction requirements would be applicable (Nokia)
  + Option 2: RAN4 not to define any measurement restrictions for CBM operation in FR2 inter-band CA (NEC).
  + Option 3: If MRTD between the two bands is larger than CP length with respect to serving cell numerology, Measurement and/or Scheduling restriction to serving cell(s) on the other band should account for the MRTD, e.g. [x] slots before and after SSB symbols and/or CSI-RS symbol(s) (Qualcomm)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1 and Option 3. For Option 3, if RAN4 concludes that MRTD is not larger than CP length, it can be delisted. Please refer to the comment provided in Issue 1-4-3. |
| Intel | Option 1. |
| MTK | Fine with Option 1. |
| Ericsson | Option 1a: The existing scheduling/measurement restriction requirements applied for FR2 intra-band CA need to be extended to FR2 inter-band CA with CBM type UE. |
| NEC | Same comments as above |
| Nokia | Suggest taking same approach as for Issue 1-4-3. If companies can agree to use similar approach and re-use existing non-IBM requirements as baseline and make the necessary updates to capture the measurement restrictions for the CBM capable UE when configured with inter-band CA in FR2. |

**Issue 1-4-5: SCell activation delay**

* Proposals
  + Case 1: if PCell/PSCell and the target SCell are in a FR2 band pair with CBM and the target SCell is known,
    - Option 1: the existing SCell activation requirements can be readily be re-used for CBM capable UE in inter-band CA scenario (Nokia, Huawei).
    - Option 2: SCell activation delay for CBM operation in FR2 inter-band DL CA is 3ms (NEC).
  + 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: SCell activation delay would be reduced compared to the existing SCell activation delay requirements for FR1+FR2 CA (OPPO)
    - Option 2: the existing SCell activation requirements in Case 2 with removing L1-RSRP measurement delay can be used for CBM type UE (Huawei).
    - Option 3: the SCell activation delay requirements defined for the scenario where there is at least one active serving cell in the band, apply (Nokia)
    - Option 4: For CBM UEs, SSB samples for Rx beam sweeping shouldn’t be accounted for in SCell activation latency requirement. (Qualcomm)
    - Option 5: SCell activation delay for CBM operation in FR2 inter-band DL CA is 3ms (NEC).
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | For Case 1, Option 1.  For Case 2, Option 1. More specifically, Option 2 and Option 4. If MRTD is no larger than CP length, a further latency reduction can be considered, e.g. Option 3. |
| Intel | Case 1: Option 1  Case 2: Option 1 |
| MTK | Case 1: Option 1  Case 2: Option 1/2/4. |
| OPPO | Case 1: Option 1  Case 2: Option 1 |
| Ericsson | Case 1: Option 1. Case 2: For this scenario there is no need for UE Rx beam sweeping since the spatial downlink transmission filter already is set by spCell or by other already activate serving cell in the FR2 band combination. But some SSB detection for the purpose of timing acquisition may be needed when MRTD is larger than CP/2 ~ CP. So this would be some combination of Option 2 and Option 4, or Option 3, depending on MRTD. |
| NEC | May be we didn’t understand the agreement that beam management RS is present on only one band. Isn’t this assumption and co-location assumption means, SSB less SCell activation? Can companies clarify why this can’t be treated as SSB less SCell activation? |
| Nokia | For Case 1 it seems agreeable to re-use existing requirements while the conditions and final requirements needs more discussion.  For Case 2 our view is that based on the assumption of colocation the SCell activation delay can be reduced. As minimum we do not see any need for UE sweeping as the CBM capable UE would not benefit from identifying any/better DL in any other direction than the QCL source of the already active serving cell(s) in the other band.  The exact Tactivation\_time delay and UE need for measurement can be discussed further. |

Issue 1-4-6: CSSFoutside\_gap

* Proposals
  + Option 1: Existing R15 requirements for CSSFoutside\_gap can be used as the baseline for CBM UE (Nokia)
  + Option 2: If FR2 inter-band CA with two bands are only considered in Rel-17, then the existing requirements on scaling factor CSSFoutside\_gap in Rel-16 can be applied to Rel-17 (OPPO, Huawei)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Close to Option 2, but want to a further check. |
| Intel | Option 2. The requirements on scaling factor CSSFoutside\_gap need to be revised if FR2 inter-band CA with more than two bands will be introduced in Rel-17 |
| MTK | Option 2 because it is more specific in our view. |
| Ericsson: | Option 2: If FR2 inter-band CA with two bands are only considered in Rel-17, then the existing requirements on scaling factor CSSFoutside\_gap in Rel-16 can be applied to Rel-17 |
| Nokia | To clarify our proposal: As the WI only so far include inter-band CA in FR2 among 2 bands the existing CSSFoutside\_gap can be applied. Hence, options 1 and 2 are the same. |

Issue 1-4-7: Beam management

* Proposals
  + Option 1: The existing BFD/CBD requirements in Rel-16 can be applied for CBM type UE (Nokia, OPPO)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Is Option 1 similar to Issue 1-2-5? If it means BFD/CBD is performed on a CC where CBM resources are configured, we support Option 1. |
| Intel | Option 1. |
| MTK | Does it mean no spec change is needed? |
| OPPO | Option 1. |
| Ericsson | Option 1. |
| Nokia | We support option 1. |

### Sub-topic 1-5: RRM requirements for independent beam management

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

**Issue 1-5-1: RRM requirements baseline**

* Proposals
  + Option 1: For IBM UE, the existing R16 RRM requirements for FR2 inter-band CA can be applied in Rel-17. (Huawei)
* Recommended WF
  + TBA

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| **Company** | **Comments** |
| Qualcomm | Option 1. |
| Intel | Option 1. |
| MTK | A bit unclear the motivation of Option 1 because even without this agreement, the existing IBM requirement shall apply.  Option 1 is fine in general. |
| OPPO | Option 1. |
| Ericsson | Option 1. |

## 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.*

Moderator comments: According to Andrey’s email, the CR R4-2106394 will be postponed and not be discussed in the email discussion.

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| **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

*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** |
| [R4-2106945](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106945.zip) | Huawei, HiSilicon | Proposal 1: It is suggested to start the discussion on RRM requirements for FR2 inter-band CA based on CBM after the feasibility is confirmed in RF session.  Proposal 2: For IBM type UE, the existing interruption and delay requirements for UL carrier RRC reconfiguration in Rel-16 can be applied in Rel-17.  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 impact due to introducing FR2 inter-band UL CA.  Proposal 4: RAN4 investigates the interruption requirements for NR SRS carrier based switching applicable for inter-band SRS carrier switching in FR2. |
| [R4-2106531](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106531.zip) | OPPO | Proposal 1: Symbol level alignment should be with CP length.  Proposal 2: Demodulation performance degradation due to Rx beam switch should be noted in MRTD requirements for CBM UE if MRTD is larger than CP.  Proposal 3: For MRTD of FR2 inter-band CA with CBM, reuse FR2 intra-band CA MRTD, i.e. 260ns.  Proposal 4: For a FR2 inter-band CA with CBM, the existing interruption requirements of intra-band CA can be applied.  Proposal 5: As compromise, RRM discussion on DL interruption at NR SRS carrier-based switching can be hold until we have conclusion of FR2 inter-band UL CA in RF session.  Observation 1: The SCell activation requirements of CBM capable UE for case 2 depend on both RF architecture and MRTD requirements for CBM type UE.  Proposal 6: SCell activation delay would be reduced for the case provided that 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 7: If FR2 inter-band CA with two bands are only considered in Rel-17, then the existing requirements on scaling factor CSSFoutside\_gap in Rel-16 can be applied to Rel-17.  Proposal 8: The existing BFD/CBD requirements in Rel-16 can be applied for CBM type UE |

## Open issues summary

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

**Issue 2-1-1: General**

* Proposals
  + Option 1: It is suggested to start the discussion on RRM requirements for FR2 inter-band CA based on CBM after the feasibility is confirmed in RF session (Huawei, OPPO)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | As per a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. And the last sub-bullet below should be only for IBM based inter-band FR2 CA in our understanding, hence, no further discussion shall be pursued in Rel-17. |
| Qualcomm | Agree with Qualcomm’s comment. Based on a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| LG Electronics | For FR2 inter-band UL CA, objectives related to CBM were removed. Therefore, further discussion is not needed in Rel-17. |
| Ericsson | Based on a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| Nokia | Agree. No need to discuss UL CA for CBM unless agreements are reached in RF. The latest WI is no longer including this objective. |

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

* Proposals
  + Option 3: RRM discussion should be hold until we have conclusion of FR2 inter-band UL CA in RF session. (OPPO)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | The same comment as Issue 2-1-1. |
| Intel | Based on a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| Ericsson | Based on a revised WID (RP-210914) approved in RAN#91e, CBM-based FR2 inter-band UL is no longer in the scope of Rel-17. |
| Nokia | Same comments as Issue 2-1-1. |

### Sub-topic 2-2 RRM requirements for independent beam management

**Issue 2-2-1: Interruption due to UL carrier RRC reconfiguration**

* Proposals
  + Option 1: For IBM type UE, the existing interruption and delay requirements for UL carrier RRC reconfiguration in Rel-16 can be applied in Rel-17 (Huawei)
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | In principle, Option 1 is okay. However, we want to consult with RF session on the exact value. |
| Ericsson | Option 1. |
| Nokia | Referring to below texts in TS38.133, UL carrier RRC configuration is not necessarily dependent on UL CA. It is also applicable for single carrier. Why do we discuss it here?  *The requirements in this clause shall apply when a supplementary UL carrier or an UL carrier is configured or de-configured in NR standalone carrier aggregation as defined in TS 38.331 [2].* |

**Issue 2-2-2: DL interruption at UE Tx switching between two uplink carriers**

* Proposals
  + Option 1: 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 impact due to introducing FR2 inter-band UL CA. (Huawei)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Want to revisit the issue in the next meeting. We’re internally double checking the issue/spec. |
| Ericsson | Option 1. There is no switching between two uplink carriers in FR2. Therefore, this issue does not apply to FR2 inter-band UL CA. |
| Nokia | We also understood the interruption at Tx switching in current spec is only applicable to FR1. So it is natural the Rel16 interruption requirements for FR1 is still applicable in Re17. Just to confirm this is not intending to extend the applicability to FR2 inter-band UL CA. |

**Issue 2-2-3: DL interruption at NR SRS carrier based switching**

* Proposals
  + Option 1: RAN4 investigates the interruption requirements for NR SRS carrier based switching applicable for inter-band SRS carrier switching in FR2 (Huawei)
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Needs to consult with RF session on, e.g. RF switching time defined for FR2 inter-band CA. |
| Ericsson | Needs further discussion. |
| Nokia | It seems to propose discuss inter-band SRS carrier switching but this seems not to be part of this WI. In current spec, SRS carrier based switching only concerns intra-band and inter-band FR1. It is not clear if it is feasible to switch between carriers in different bands in FR2. In addition, the SRS carrier based switching is not necessarily dependent on UL CA, which seems better to be discussed in other WI. |

## 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”.*

# Topic #3: UL gaps for self-calibration and monitoring

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [R4-2106395](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106395.zip) | Nokia, Nokia Shanghai Bell | UL gaps for PA calibration:   1. If UL gaps for PA calibration are very infrequent, there is no need to define configurable UL gaps for this purpose. 2. If UL gaps for PA calibration gaps are very frequent there may be a need to define configurable UL gaps for this purpose. 3. Wait for input from RF session whether UL gaps for PA calibration is needed or not.   UL gaps for proximity detection:   1. UL gaps for proximity detection may be used for improving P-MPR. 2. UL gaps with a periodicity of 5% correspond to 1 slot every 2.5 ms which may have be a significant impact on system level performance. 3. Frequent UL gaps for proximity detection would lead to a need for defined UL gaps and likely UL gap pattern to be defined. 4. RAN4 need to agree on UL gap length and periodicity in order to define UL GP. 5. Agreement on the need for introducing UL gaps for proximity detection is still pending. 6. RAN4 would first agree on introduction of configurable UL gaps before detailed design is started. |
| [R4-2106946](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2106946.zip) | Huawei, HiSilicon | ***Proposal 1: RAN4 needs to investigate the pattern design of network configured UL gaps used for self-calibration and monitoring.***  ***Proposal 2: RAN4 study whether the network configured UL gaps is per-UE UL gap or per-FR UL gap.***  ***Proposal 3: RAN4 study whether to define the applicability for UL gap pattern configurations.***  ***Proposal 4: For network configured UL gap, RAN4 needs to define the scheduling restriction requirements during gap duration.***  ***Proposal 5: For UE specific UL gap, RAN4 study the conditions allowing UE self-calibration with autonomous UL gaps.***  ***Proposal 6: For UE specific UL gap, interruption requirements, including interruption length and interruption rate, to allow UE self-calibration with autonomous UL gaps.*** |
| [R4-2107078](file:///C:\DuLei2019\RAN4\RAN4%2398ebis\Docs\R4-2107078.zip) | vivo | **Observation 1 Uplink gaps that are already defined in TS 38.133 are mainly due to the unavoidable RF processing or the necessary requirements that UE has to follow.**  **Observation 2 Uplink duty cycle is defined in R16 to ensure RF performance. It is captured in RF specs and RAN2 specs.**  **Proposal 1 RAN4 further discuss whether uplink gaps are captured in RRM specs or in RF specs.** |

## Open issues summary

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

### Sub-topic 3-1 General

**Issue 3-1-1: General**

* Proposals
  + Option 1: RAN4 further discuss whether uplink gaps are captured in RRM specs or in RF specs (Vivo)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Can be discussed/decided later, if introduced. |
| Intel | Prefer to wait for RF session to decide on whether the performance gain identified. |
| MTK | whether to introduce uplink gaps should be discussed in the RF session. |
|  | It is premature to discuss the uplink gaps in RRM group at this stage.  RRM group should wait for discussing any uplink gaps until the RF group has concluded their work on UL gaps and corresponding use cases/scenarios. |
| Nokia | We see that would depend on which type of gaps RAN4 decide to introduce. If the gaps are rare (e.g. for PA calibration) and only happening infrequent there is likely no need to define any related RRM requirements and/or configurable UL gaps.  If on the other hand it is agreed to introduce gaps which are more frequent and thereby have significant impact on the overall scheduling and performance, there may be a need to define configurable gaps. Such gaps could resemble those known from DL gaps.  However, RAN4 has no decision yet to introduce any additional UL gaps compared to those in Rel-15. |

### Sub-topic 3-2 UL Gaps for PA calibration

**Issue 3-2-1: UL gaps for PA calibration**

* Proposals
  + Option 1: Wait for input from RF session how frequent UL gaps for PA calibration is needed (Nokia)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Option 1, and even for UL gaps for Proximity detection, it needs to be first studied in RF. |
| Intel | In the WID it is said that RRM requirements should be defined in Phase 2 based on the outcome of RF discussion in Phase 1. Prefer to wait for RF Phase 1 agreements first. |
| MTK | Option 1, wait for input from RF session |
| Ericsson | RRM group should wait for outcome/conclusion of RF group before discussing any issue related to the UL gaps in RRM session. |

### Sub-topic 3-3 UL Gaps for proximity detection

**Issue 3-3-1: Network configured UL gaps**

* Proposals
  + Option 1: RAN4 would first agree on introduction of configurable UL gaps before detailed design is started (Nokia)
    - Option 1a: RAN4 need to agree on UL gap length and periodicity in order to define UL GP (Nokia)
  + Option 2: RAN4 needs to investigate the pattern design of network configured UL gaps used for self-calibration and monitoring. (Huawei)
  + Option 3: RAN4 study whether the network configured UL gaps is per-UE UL gap or per-FR UL gap. (Huawei)
  + Option 4: RAN4 study whether to define the applicability for UL gap pattern configurations. (Huawei)
  + Option 5: For network configured UL gap, RAN4 needs to define the scheduling restriction requirements during gap duration.(Huawei)
* Recommended WF
  + TBA

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | Should start the discussion when NW-configured UL gap feature is justified based on a demonstration of the benefits and the scenarios where the benefit can be observed are identified in RF session. |
| Intel | In the WID it is said that RRM requirements should be defined in Phase 2 based on the outcome of RF discussion in Phase 1. Prefer to wait for RF Phase 1 agreements first.  However, we are ok to define such topics for discussion for next meetings. |
| MTK | wait for RF Phase 1 agreements |
| Ericsson | RRM group should wait for outcome/conclusion of RF group before discussing any issue related to the UL gaps in RRM session. |
| Nokia | Initially we see that there need to an agreement in RAN4 to introduce configurable UL gaps. If such agreement is reached, we agree that the aspect raised by Huawei would need to be addressed.  However, until there is an agreement to introduce configurable UL gaps RAN4 can focus the work on other open aspects in this WI. |

**Issue 3-3-2: UE specific UL gaps**

* Proposals
  + Option 1: For UE specific UL gap, RAN4 study the conditions allowing UE self-calibration with autonomous UL gaps.(Huawei)
  + Option 2: For UE specific UL gap, interruption requirements, including interruption length and interruption rate, to allow UE self-calibration with autonomous UL gaps. (Huawei)
* Recommended WF
  + TBA

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | In our understanding, “UE autonomous UL gap-based approach” is an implementation specific solution which doesn’t cause an interruption. If Option 1 and Option 2 propose to consider allowing UE to cause interruptions due to PA calibration and/or Proximity detection and such, its benefit and required interruption ratio need to be assessed and decided in RF session. |
| Intel | In the WID it is said that RRM requirements should be defined in Phase 2 based on the outcome of RF discussion in Phase 1. Prefer to wait for RF Phase 1 agreements first. |
| MTK | wait for RF Phase 1 agreements |
| Ericsson | RRM group should wait for the outcome/conclusion of the RF group before discussing any interruption requirements for any autonomous gaps. |
| Nokia | Both options are under discussion in the RF session and should not be discussed in parallel here. |

## 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 3.2.*

## 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