**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** |
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**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** |
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### 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: 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** |
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**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** |
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**Issue 1-2-3: 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** |
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**Issue 1-2-4: Performance degradation due to Rx beam switch**

* Proposals
  + Option 1: UE can switch RX beams without major performance degradation
    - 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** |
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**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** |
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**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** |
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### 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** |
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### 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.

**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** |
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**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** |
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**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)
* Recommended WF
  + TBA

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

**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** |
| XXX |  |

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** |
| XXX |  |

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** |
| XXX |  |

### 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** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

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

### CRs/TPs comments collection

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

1. [98e][230] NR\_RF\_FR2\_req\_enh2\_RRM
   1. 2 CRs submitted (R4-2101868, R4-2101869) by E///. No CR / Draft CR submissions allowed for this WI based on meeting agenda (“No CR / Draft CR submissions allowed except for AIs where it is explicitly allowed”). The CRs will be postponed and shall not be included 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.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

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

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

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

## Discussion on 2nd round (if applicable)

# Topic #2: Inter-band UL CA

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **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

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

**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

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

### 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** |
| XXX |  |

**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

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

**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** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

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

### CRs/TPs comments collection

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

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

### 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

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

### 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

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

**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** |
| XXX |  |

## Companies views’ collection for 1st round

### Open issues

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