**3GPP TSG-RAN WG4 Meeting #94-e R4-20xxxxx**

**Electronic Meeting, Feb.24th – Mar.6th 2020**

**Agenda item:** 8.15.1.4, 8.15.1.8, 8.15.1.9, 8.15.1.11

**Source:** Intel

**Title:** Email discussion summary for RAN4#94e\_#62\_NR\_RRM\_Enh\_RRM\_Part\_1

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion and provide some guidelines for email discussion if necessary.*

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round: TBA
* 2nd round: TBA

# Topic #1: BWP Switching on multiple CCs

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000155 | vivo | Proposal 1: For the simultaneous BWP switch on multiple CCs case, the type 2 switch delay requirement consists of two parts, the RF part and the baseband part. The value of RF related part is scaled by the number of total involved CCs and the value of baseband processing part is the same as the BWP switch delay on single CC.  Proposal 2: For a CC among involved CCs, if its BWP switch does not require related RF change, it does not need to be included in the scaling factor N.  Proposal 3: For the simultaneous BWP switch on multiple CCs case, if the BWP switch on multiple CCs results in the change of the SCS on any CC among involved CCs, the BWP switching delay should be expressed in the time unit of slots corresponding to the largest SCS among all involved SCS value of all involved CCs.  Proposal 4: For RRC based simultaneous BWP switch on multiple CCs, at least is not scaled by the number of involved CCs.  Proposal 5: Within the same frequency range, partial overlapping BWP switch is not allowed.  Proposal 6: For a UE is not capable of per-FR gap, the case where partially overlapping BWP switch happens over different frequency range is not allowed.  Proposal 7: For a UE is capable of per-FR gap, the case where partially overlapping BWP switch happens over different frequency range is allowed.  Proposal 8: For a UE is capable of per-FR gap, at each frequency range, each individual BWP delay requirement among all partial overlapping BWP switches can follow either the single or the simultaneously multiple BWP switch delay requirement, depending on whether that BWP switch happens on a single CC or simultaneous multiples CCs. |
| R4-2000156 | vivo | Proposal 1: For the interruption period of simultaneous BWP switch on multiple CCs case, its duration should be extended and the value could depend on the number of simultaneous BWP switches.  Proposal 2: For the simultaneous BWP switch on multiple CCs case, the interruption period due to BWP switch is determined by the smallest SCS among all the SCS before all BWP switches and all the SCS after all BWP switches.  Proposal 3: For per-FR capable UE with partial overlapping BWP at different frequency range, the interruption period of a particular BWP switch at any frequency range will either follow the already existing Rel-15 interruption period requirement, for BWP switch over single CC case or follow the interruption period requirement defined for simultaneous BWP switches over multiple CCs case, where all CCs are within the same frequency range. |
| R4-2000372 | Intel Corporation | Proposal 1: For NR-DC operation no requirements shall be defined for RRC based simultaneous BWP switching on multiple CCs  Proposal 2: The switching delay for simultaneous timer and DCI based, BWP switching delay on multiple CCs is defined as:  Proposal 3: The switching delay for RRC based BWP switch on multiple CCs is defined as:  Proposal 4: For simultaneous BWP switching on multiple CCs, the interruption is defined as:  Proposal 5: BWP switching with partial overlap triggering on multiple CCs is only defined when BWP switching on each CC doesn’t cause interruption on other CCs  Proposal 6: The BWP switching requirements for partial overlap triggering on multiple CCs is the same as that of single CC |
| R4-2000459 | MediaTek inc. | Proposal 1: The definition for simultaneous RRC triggering in NR-DC is not considered. Once the RRC processing time of 2 RRC messages overlap fully or partially in time, UE is allowed to conduct the required BWP switch sequentially.  Proposal 2: For simultaneous DCI-based or timer-based BWP switch, the delay requirement for BWP switch in multiple CCs is sum of R15 single-CC delay requirement and , where N is the total number of CCs of which the BWPs are switched simultaneously.  Proposal 3: For simultaneous DCI-based or timer-based BWP switch, the interruption requirement BWP switch in multiple CCs is considered for each CC separately.  Proposal 4: For non-simultaneous BWP switch, except for those scenarios that are already precluded in RAN1 spec, UE should be allowed to conduct the BWP switch for different request sequentially in a first-come-first-serve manner.  Proposal 5: For non-simultaneous BWP switch, the interruption requirement BWP switch in multiple CCs is considered for each CC separately. |
| R4-2001013 | NEC | Proposal 1: BWP switch on multiple CC (simultaneous) is BWP switch delay of 1 CC + D \* ceil ((N÷K) -1). Where, D= BWP switching delay without processing delay of DCI or RRC and N is the number of CCs and K= [4].  Proposal 2: RAN4 to confirm DCI based non-simultaneous BWP switching is not considered for NR-DC.  Proposal 3: In NR-DC, BWP switch delay on each CG should be independent for simultaneous or non-simultaneous BWP switch triggering.  Proposal 4: Timer based BWP switch delay on multiple CC (non-simultaneous) = M× BWP switch delay on multiple CC (simultaneous) + M × Interruption due to each BWP switch.  Proposal 5: RRC based BWP switch delay on multiple CC (non-simultaneous) for each CG is equal to BWP switch delay on multiple CC (simultaneous). |
| R4-2001548 | Huawei, HiSilicon | Observation 1: The implementation and the capability for parallel processing may different.  Proposal 1: Define the BWP switching delay by counting the extra process delay of each additional CC.  Proposal 2: It is suggested to calculate the total absolute time delay regardless of SCSs of each CCs and then transforming the delay to the number of slots according to the SCSs of each CCs.  Proposal 3:  *For DCI and timer triggered BWP switching:*  For Type 1 UE, the incremental delay for each additional CC is 100 us. The BWP switching delay of a CC where there are simultaneous triggered BWP switching delay on other CCs is: 600 + 100 (N-1) us, where N ≤8 is the total number of CCs where the BWP switching is triggered by the same method (DCI or timer).  For Type 2 UE, the incremental delay for each additional CC is 200 us. The BWP switching delay of a CC where there are simultaneous triggered BWP switching delay on other CCs is: 2000 + 200 (N-1) us, where N ≤8 is the total number of CCs where the BWP switching is triggered by the same method (DCI or timer).  *For RRC-based switching:*  The existing delay requirements for single CC can be reused for on each individual CC when the BWP switching is simultaneously triggered on multiple CCs by 1 RRC command in each CG provided that the total number of CCs is less than 8.  Proposal 4: For the requirements of interruptions, for BWP switching on multiple CCs, the existing interruption requirements for a single CC shall apply for each BWP switching separately.  Proposal 5: It is suggested that the existing delay requirements for single CC can be reused for on each individual CC when the BWP switching is non-simultaneously triggered on multiple CCs by 1 RRC command in each CG for NR-DC provided that the total number of CCs is less than 8.  Proposal 6: The total delay for non-simultaneous DCI-based BWP switching on multiple CC for NR-DC is defined as:  Where ­ is the total BWP switching delay of a CC; is the existing delay requirements for BWP switching on a single CC. N is the total number of the non-simultaneous DCI-based BWP switching processes in different CG which overlap with . D is the incremental delay which is same as the simultaneous case.  Proposal 7: The total delay for non-simultaneous Timer-based BWP switching on multiple CC for CA and NR-DC is defined as:  Where ­ is the total BWP switching delay of a CC; is the time delayed by ongoing timer-based BWP switching with in the same frequency range. is the existing delay requirements for BWP switching on a single CC. N is the total number of the non-simultaneous timer-based BWP switching processes in different frequency range which overlap with . D is the incremental delay which is same as the simultaneous case.  Proposal 8: For the requirements of interruptions, for BWP switching on multiple CCs, the existing interruption requirements for a single CC shall apply for each BWP switching separately. |
| R4-2002090  R4-2001851 | Ericsson | *For simultaneous triggering*  Proposal 1: For DCI-based triggering, the requirements shall assume that reception of PDCCH and parsing of DCI can be carried out fully in parallel on the monitored component carriers.  Proposal 2: For software reconfiguration, i.e. CPU providing new configurations to hardware accelerators and DSPs at BWP change, requirements may consider additional time proportional to the number of component carriers for which a change is carried out. We may further discuss whether it is needed for type1, type2, or both.  Proposal 3: For radio reconfiguration, the requirements may consider additional time proportional to the number of component carriers for which BWP change is carried out, as writing to registers may be serial.  Observation 1: The point in time at which the UE detects that BWP changes are triggered simultaneously on multiple component carriers differ between Timer-based and DCI-based triggering, resulting in a tighter timeline for the latter.  Observation 2: In mixed numerologies and DCI-based triggering, the point in time at which the UE detects whether BWP changes are triggered on multiple component carriers simultaneously via DCI-based depends on the lowest numerology among the component carriers. The lower the numerology, the later the DCI parsing is completed.  Proposal 4: Separate requirements shall be introduced for Timer-based and DCI-based BWP change on multiple component carriers, as the margins in the respective timelines differ.  Observation 3: In Timer-based or DCI-based triggering, the location of the interruption window depends on the numerology of the carrier for which BWP change is carried out. If not accounted for when defining BWP change delay requirements for simultaneous triggering in mixed numerologies, it may lead to undesirable performance degradation on component carriers for which switching is not carried out.  Proposal 5: Performance impact by interruptions on other component carriers shall be taken into account when defining Timer-based and DCI-based BWP change delay requirements for simultaneously triggered BWP change of multiple component carriers.  *For partial overlap triggering*  Observation 1: Serving cells in different CGs can independently perform DCI based BWP switching and coordination between CGs may not be possible.  Proposal 1: BWP switching requirements are also specified for partial overlap triggering of DCI-based BWP switching on multiple CC.  Observation 2: When the BWP switching is non-simultaneously triggered on multipe CCs over partially overlapping time, then the ongoing BWP switching on one CC can be interrupted due to the BWP triggering on the other CC(s).  Observation 3: When numerologies of CCs involved in BWP switching are different then BWP switching on CC with larger SCS may cause interruption on CC with smaller SCS spanning across successive slots.  Proposal 2: UE shall trigger the BWP switching on a CC at slot boundary of the other CC with the smallest SCS where there is an ongoing BWP switching for CA and synchronous DC.  Proposal 3: For the case when BWP switching does not cause any interruption then the total BWP switching delay for one serving cell shall be the same as defined in section 8.6 of TS 38.133.  Proposal 4: For the case when BWP switching causes interruption, then the existing BWP switching delay defined in section 8.6 of TS 38.133 needs to be extended, in order to account for the interruption caused by the triggering of BWP switching on one or more CCs on the ongoing BWP switching on another CC.  Proposal 5: In proposal # 4, the total BWP switching delay for one serving cell can be expressed by:  Where:  : It is the total time to switch BWP on a serving cell.  : It is the BWP switching delay specified in section 8.6.2 for timer or DCI-based BWP switching, or in section 8.6.3 for RRC-based BWP switching.  : It is the interruption on a serving cell while switching its BWP due to the BWP switching on another *i*th serving cell. It is expressed in slots. CC where interruption occurs. The interruption defined in sections 8.2.2.2.5 for CA and 8.2.4.2.5 for NR-DC can be reused.  N (2 ≤ N≤ TBD): It is the maximum number of serving cells supported by the UE. |
| R4-2002047 | Nokia, Nokia Shanghai Bell | 1. For SA and NR-DC, interruption requirements in SA and NR-DC defined for single CC case can be reused for each BWP switch in multiple CC case. 2. In EN-DC and NE-DC, BWP switch on multiple carriers means that among the victim cells there are always both NR and E-UTRA cells, if the UE does not support per-FR gap or if the BWP switching involves SCS changing.   When the UE supports per-FR gap, the victim cells may also be only E-UTRA cells if other NR cells are on different FR than the aggressor cell.   1. For EN-DC and NE-DC, interruption requirements in EN-DC and NE-DC defined for single CC case can be reused for each BWP switch in multiple CC case, and the clarification has to be made in both TS 38.133 and TS 36.133. |
| R4-2002054 | Qualcomm Incorporated | Proposal 1: BWP switching delay for N cells would be *BWP switching delay 1 CC + D∗(N−1),* where D is 450us for Type1 and 1.5 ms for Type 2.  Proposal 2: For timer based simultaneous switch, same requirements as simultaneous DCI based switch to apply.  Proposal 3: For simultaneous BWP switch triggered via RRC, the delay would be composed of two components and , where remains the same as that for single CC and would scale with number of CC’s.  Proposal 4: For a timer based BWP switch on Cell2 when another timer based BWP switch is already ongoing on Cell1, the Cell2 timer based switch to start when the BWP switch on Cell1 is complete and the time for BWP switch on Cell 2 to be 450us for Type1 and 1.5 ms for Type 2 |

## 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 1-1: Simulataneous BWP switch on multiple CCs

*Sub-topic description: Requirements for simultaneous BWP switch on multiple CCs*

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

**Issue 1-1-1: RRC based simultaneous triggering for NR-DC operation**

* Proposals
  + Option 1 (Intel, MediaTek): Not considered
* Recommended WF
  + RRC based simultaneous triggering for BWP switch on multiple CCs for NR-DC operation is not considered

**Issue 1-1-2: Delay requirements for DCI/timer based BWP switch**

* Proposals
  + Option 1 (Intel): ; N: Number of CCs with simultaneous BWP switch; K: Number of CCs that can be processed simultaneously
  + Option 2 (MediaTek, Qualcomm, Huawei, NEC): ; N: Number of CCs with simultaneous BWP switch
    - Options 2-1
      * D=250 us (MediaTek)
      * D=100us for Type 1; 200 us for Type 2 (Huawei)
      * D = 450us for Type 1; 1.5ms for Type 2 (Qualcomm)
    - Options 2-2
      * K=1 (Huawei)
      * K=2 (MediaTek)
      * K=4 (NEC)
  + Option 3 (vivo) Ttotal = Tbaseband + D\*N
    - D = 500us for Type 2
    - N (BWP switchs within the same FR and need RF parameters updates: SCS, bandwidth, central frequency change etc.)
* Recommended WF
  + TBA

**Issue 1-1-3: Delay requirements for RRC based BWP switch**

* Proposals
  + Option 1a ( Intel, Vivo): ; N: Number of CCs with simultaneous BWP switch; K: Number of CCs that can be processed simultaneously
  + Option 1b (MediaTek, NEC, Qualcomm) : ; D= BWP switching delay without processing delay of RRC
    - Options 1b-1
      * K=4 (NEC)
  + Option (Huawei): on each individual CC

Notes: If it is assumed that D = , Option 1a and 1b are the same.

* Recommended WF
  + ; K=1

**Issue 1-1-4: Interruption requirements for simultaneous BWP switch**

* Proposals

For interruption length

* + Option 1(Huawei): Use same interruption requirements as single CC case on each CC
  + Option 2 (Vivo): Extend interruption compared to single CC case; Extension depends on number of CCs undergoing simultaneous BWP switch
  + Option 3a (Vivo): Interruption length is determined by smallest SCS among all CCs before and after BWP switch
  + Option 3b (Intel):

For interruption definition

* + Option 1 (MediaTek): Consider interruption on each CC separately
* Recommended WF
  + Consider interruption on each CC separately

### Sub-topic 1-2: Partial overlap BWP switch on multiple CCs

*Sub-topic description : Requirements for partial overlap BWP switch on multiple CCs*

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

**Issue 1-2-1: DCI based partial overlap BWP switch for NR-DC**

* Proposals
  + Option 1 (NEC): Not considered
  + Option 2 (Huawei, Ericsson): Considered
* Recommended WF
  + TBA

**Issue 1-2-2: Conditions when requirements for partial overlap BWP switch are defined**

* Proposals
  + Option 1 (Vivo, Intel): When UE is capable of per FR gap and BWP switch is on different FR/When BWP switch on one CC doesn’t cause interruption on other CCs (with partial overlap BWP switch)
* Recommended WF
  + When BWP switch on one CC doesn’t cause interruption on other CCs (with partial overlap BWP switch)

**Issue 1-2-3: Delay requirements for DCI/Timer/RRC based BWP switch**

* Proposals

Applicable to all types of switching

* + Option 1 (Intel): Same as single CC
  + Option 1a (Vivo): Same as simultaneously triggered on multiple BWPs if the trigger on a group of CCs is simultaneous
  + Option 2 (MediaTek): UE processes BWP switch sequentially on each CC
  + Option 3 (Ericsson):

: It is the total time to switch BWP on a serving cell.

: It is the BWP switching delay specified in section 8.6.2 for timer or DCI-based BWP switching, or in section 8.6.3 for RRC-based BWP switching.

: It is the interruption on a serving cell while switching its BWP due to the BWP switching on another *i*th serving cell. It is expressed in slots. CC where interruption occurs. The interruption defined in sections 8.2.2.2.5 for CA and 8.2.4.2.5 for NR-DC can be reused.

N (2 ≤ N≤ TBD): It is the maximum number of serving cells supported by the UE.

DCI Based

* + Option 1 (Huawei): For NR-DC Where ­ is the total BWP switching delay of a CC; is the existing delay requirements for BWP switching on a single CC. N is the total number of the non-simultaneous DCI-based BWP switching processes in different CG which overlap with . D is the incremental delay which is same as the simultaneous case.

Timer based

* + Option 1 (Huawei):  Where ­ is the total BWP switching delay of a CC; is the time delayed by ongoing timer-based BWP switching with in the same frequency range. is the existing delay requirements for BWP switching on a single CC. N is the total number of the non-simultaneous timer-based BWP switching processes in different frequency range which overlap with . D is the incremental delay which is same as the simultaneous case.
  + Option 2 (NEC): M× BWP switch delay on multiple CC (simultaneous) + M × Interruption due to each BWP switch
  + Option 3 (Qualcomm): when another timer based BWP switch is already ongoing on Cell1, the Cell2 timer based switch to start when the BWP switch on Cell1 is complete and the time for BWP switch on Cell 2 to be 450us for Type1 and 1.5 ms for Type 2

RRC based

* + Option 1 (NEC): Same as simultaneous trigger on multiple CCs
  + Option 2 (Huawei): Same as single CC when multiple CCs are triggered by 1 RRC command in each CG for NR-DC
* Recommended WF

**Issue 1-2-4: Interruption requirements for partial overlap BWP switch**

* Proposals
  + Option 1 (Intel, Huawei)): Same as single CC, considered on each CC separately
  + Option 1a (Vivo): Same as simultaneously triggered on multiple BWPs if the trigger on a group of CCs is simultaneous
* Recommended WF
  + Same as single CC, considered on each CC separately

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Sub topic 1-1:  Issue 1-1-1: we are also fine with option 1.  Issue 1-1-2: Support Qualcomm proposal on D value since SW processing needs to be considered as well. We support K=1 with the worst case for UE implementation.  Issue 1-1-3: In the worst case we assume D = , and we support Option 1a with K=1.  Issue 1-1-4: UE may have different timing to adjust the RF, and therefore we support to consider interruption on each CC separately, and therefore the total interruption in worst case is Option 3B with K=1.  Sub topic 1-2:  Issue 1-2-2: Agree with Intel and Vivo  Issue 1-2-3: Since the processing capability is UE implementation and the requirement shall be defined based on the worst case, so we support MediaTek proposal of “UE processes BWP switch sequentially on each CC”.  Issue 1-2-4: we agree to consider on each CC separately and the total interruption during multiple BWP switching could be up to N\*Tinterrption\_single\_CC |
| QC | Sub topic 1-1:  Issue 1-1-1:  We are fine with not defining requirements for NR-DC simultaneous switch.  Issue 1-1-2  We obviously support our proposal.  Issue 1-1-3:  We would agree with K=1 in this case too.  Issue 1-1-4:  Interruptions happened when UE switches its RF. Since that may happen at different points for different CC’s there would need to be different interruptions.  Sub topic 1-2:  Issue 1-2-1:  Agree with NEC on Option 1. Non-simultaneous DCI is precluded by RAN1.  Text from 38. 213 “A UE does not expect to detect a DCI format 1\_1 indicating an active DL BWP change or a DCI format 0\_1 indicating an active UL BWP change for a scheduled cell within FR1 (or FR2) in a slot other than the first slot of a set of slots for the DL SCS of the scheduling cell that overlaps with a time duration where the UE is not required to receive or transmit for an active BWP change in a different cell from the scheduled cell within FR1 (or FR2).”  Issue 1-2-2:  Precluded by RAN1  Issue 1-2-3:  There are three cases for which we need to define requirements   1. Simultaneous DCI: Delay discussed in Issue 1-1-2 2. Timer based: Simultaneous would be the same as simultaneous DCI. Partial would be done sequentially 3. RRC based: Single command in a CG, follows the same timeline as single CC.   Issue 1-2-4:  Separate interruptions due to each CC |
| Mediatek | **Issue 1-1-1: RRC based simultaneous triggering for NR-DC operation**:  Support Option 1  It is not always guaranteed that the PHY, MAC and RRC processing of 2 CGs can be finished at the same time for a UE operating in DC. Simultaneous RRC triggering does not make sense to UE.  **Issue 1-1-2: Delay requirements for DCI/timer based BWP switch**  Support Option 2  Huawei’s proposal is also agreeable to us. One minor comment is that it will be better to have D equals a multiple of the slot duration of 120KHz SCS. If so, the spec can be even simpler and clearer. Since simultaneous BWP switch on multiple CC is one key feature for FR2 power saving, it is desired to finish this as early as possible. D ≥ 250us with K=1 (or other equivalent/longer proposals) is not desirable.  **Issue 1-1-3: Delay requirements for RRC based BWP switch**  Support Huawei’s proposal <Option ?>.  We removed ourselves from Option 1b (with track change)  **Issue 1-1-4: Interruption requirements for simultaneous BWP switch**  Support Option 1 for interruption length and interruption definition  The interruption duration on multiple CC caused by 1 CC should be the same Rel-15. When considering multiple CCs, each CC should be allow to cause independent and separated interruptions. In other words, the interruptions caused by multiple CCs can be fully, partially, or fully non-overlapped in time domain.  **Issue 1-2-1: DCI based partial overlap BWP switch for NR-DC**  Support Option 1 for same FR and Option 2 for cross FR  Since RAN1 spec is generic and NR-DC has already been introduced in Rel-15, we believe that RAN1 spec already covers NR-DC. Following RAN1 spec, UE does not expect DCI-based BWP requests during BWP switch on another CC in the same FR. RAN4 can consider to send an LS to RAN1 for confirmation.  **Issue 1-2-2: Conditions when requirements for partial overlap BWP switch are defined**  Support Option 1  There should be no problem on this agreed Rel-15 principle.  **Issue 1-2-3: Delay requirements for DCI/Timer/RRC based BWP switch**  We need to discuss this issue for DCI, Timer and RRC cases separately.   * For timer, we should follow RAN1 spec that UE will postpone the BWP switch which comes late. We believe that network doesn’t really have to care about the switch delay here because there is no data transmission to this UE. * For RRC, as we commented in Issue 1-1-1, UE processing for 2 CGs are independent. Therefore, it is not guaranteed that only extending the delay by the interruption duration could be feasible. * For DCI, Ericsson’s proposal (Option 3) could be the starting point. But we need more time to check.   **Issue 1-2-4: Interruption requirements for partial overlap BWP switch**  Support Option 1  Same comment as Issue 1-1-4 |

### 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:* |

*Recommendations on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### CRs/TPs

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

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

## Summary on 2nd round (if applicable)

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

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

# Topic #2: UL Spatial Relation Info Switching

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000373 | Intel Corporation | Observation #1: The spatial relation info for SRS, PUCCH or PUSCH could be associated with a DL RS – SS/PBCH or CSI-RS or with a UL RS – an SRS  Observation #2: The network could configure the spatial relation info for SRS using RRC or MAC CE, for PUCCH using RRC or MAC CE and for PUSCH using DCI  Observation #3: The network could indicate a spatial relation switch to the UE by MAC-CE (for PUCCH and SP-SRS) or via RRC reconfiguration – for SRS or PUCCH configured with only 1 resource spatialRelationInfoToAddModList.  Observation #4: The TCI state of the DL RS associated with spatial relation info should be known to the UE in order to transmit SRS or PUCCH or PUSCH with the configured TX beam  Proposal #1: When UL transmission is configured with spatial relation info associated with DL RS and the TCI state of the DL RS is unknown, the UE shall (1) drop UL transmission until TCI state is known or (2) use best known beam or (3) use arbitrary beam for UL transmission  Observation #5: The spatial relation info switching delay for UL transmission associated with DL RS would depend DL command decoding time and UE processing time  Proposal #2: The UE shall select arbitrary TX beam for UL transmission if the TX beam for SRS associated with spatial relation info is not known.  Observation #5: The spatial relation info switching delay for UL transmission associated with SRS would depend DL command decoding time  Observation #6: For SP-SRS MAC CE is configuring the spatial relation info rather than switching. For PUCCH MAC CE could switch the spatial relation info  Proposal #3: Define MAC CE based spatial relation switch requirements for PUCCH  Observation #7: MAC CE based spatial relation switch requirements could be defined like MAC CE based TCI state switching requirements when spatial relation info is associated with DL RS  Proposal #4: MAC CE based spatial relation info switching delay when associated with DL RS is defined as: THARQ +3ms for known TCI state ; THARQ + 3ms + TL1-RSRP for unknown TCI state  Proposal #5: MAC CE based spatial relation info switching delay when associated with SRS is defined as: THARQ +3ms  Proposal #6: No requirements are defined for RRC based spatial relation info switching |
| R4-2001036 | MediaTek inc. | Observation 1: When active spatial relation is configured to switch to a SRS, it means after some QCLed links, the spatial relation shall be QCLed with SRS with its usage configured as ‘beamManagement’.  Observation 2: The spatial relation of PUSCH will follow PUCCH when configured by DCI format 0\_0 or follow SRS when configured by DCI format 0\_1.  Observation 3: The time interval between DCI command and aperiodic SRS transmission is very short and hasn’t considered the additional beam sweeping time in RAN1 specification.  Proposal 1: When active spatial relation is configured to switch to a DL RS, the known and unknown condition shall be defined.  Proposal 2: When active spatial relation is configured to switch to a DL RS, Rx beam sweeping shall be also considered in unknown condition.  Proposal 3: For unknown spatial relation switch, UE is allowed to transmit signals with previous spatial domain transmission filter during the Rx beam training phase.  Proposal 4: When active spatial relation is configured to switch to a SRS, the UE will directly follow the same beam with this uplink SRS without the differentiation between known and unknown condition.  Proposal 5: RAN4 shall define the MAC based active spatial relation switch for PUCCH.  Proposal 6: For PUSCH spatial relation switch RAN4 either does not define the requirement or directly refers to the requirements for SRS and PUCCH.  Proposal 7: RAN4 shall define   * the RRC based active spatial relation switch for periodic SRS. * the MAC based active spatial relation switch for semi-persistent SRS. * the DCI based active spatial relation switch for aperiodic SRS.   Proposal 8: If the SRS-SpatialRelationInfo is configured as srs, the spatial relation switch is always in known condition.  Proposal 9: When network configures the periodic/semi-persistent SRS transmission and the SRS-SpatialRelationInfo with DL RS, both known and unknown requirement shall be defined.  Proposal 10: Only define the delay requirement of aperiodic SRS spatial relation switch in known condition. |
| R4-2001667 | Huawei, HiSilicon | Proposal 1: The MAC-CE based PUCCH spatial relation switching delay can be specified as below,   * If the spatial relation associated downlink RS is known and the fine timing of the downlink RS is acquired or the associated RS is SRS, upon receiving MAC-CE activation command indicating a value of pucch-SpatialRelationInfoId in slot n, UE shall be able to transmit a PUCCH with target spatial relation no later than in slot n+ THARQ +3 ms/ NR slot length. * If the spatial relation associated downlink RS is unknown, there is no requirement.   Downlink known condition refers to section 8.10(active TCI state switching delay).  Proposal 2: No requirements are defined for PUCCH spatial relation switching if UE is not provided PUCCH-SpatialRelationInfo.  Proposal 3: There is no need to define the PUSCH spatial relation switching requirement.  Proposal 4: Aperiodic SRS spatial relation switching delay is specified in RAN1 and no unknown case is considered.  Proposal 5: Periodic SRS spatial relation switching delay is specified as below,   * When the spatial relation associated RS is SSB/CSI-RS, if the associated DL RS is known and the fine timing of the downlink RS is acquired, the periodic SRS spatial relation switching delay is TRRC\_processing, otherwise no requirements are specified. * When the spatial relation associated RS is SRS, the spatial relation switching delay is TRRC\_processing.   Proposal 6: Semi-persisitent SRS spatial relation switching delay can be specified as below,   * If the spatial relation associated downlink RS is known and the fine timing of the downlink RS is acquired or the associated RS is SRS, upon receiving MAC-CE command indicating triggering a new semi-persistent SRS in slot n, UE shall be able to transmit semi-persistent SRS with target spatial relation no later than in slot n+ THARQ +3 ms/ NR slot length. * If the spatial relation associated downlink RS is unknown, there is no requirement.   Downlink known condition refers to section 8.10(active TCI state switching delay). |
| R4-2002060 | Qualcomm Incorporated | Proposal 1: RAN4 to define requirements for spatial relation switch for PUCCH, PUSCH and SRS.  Proposal 2: RAN4 to prioritize defining requirements for the case where the spatial relation is QCL’d to (or the QCL chain contains) SSB or CSI-RS.  Proposal 3: Re-use the known state definition for TCI state for known spatial relation.  Proposal 4: RAN4 to define requirements for PUCCH spatial relation switch via MAC-CE. The PDCCH TCI switch timeline to be used as baseline.  Proposal 5: For PUSCH spatial relation switch, no new requirements need to be defined. RAN4 to refer to RAN1 requirements.  Proposal 6: RAN4 to define requirements for RRC based switch for P SRS and MAC based activation for SP SRS. |
| R4-2002088 | Ericsson | Proposal 1: Introduce spatial relation switching delay requirement for RRC-based reconfiguration of the spatial relation for a single active SRS resource.  Proposal 2: Introduce the following spatial relation switching delay requirements for PUCCH:  RRC-based reconfiguration of a single spatial relation for PUCCH  MAC-based switching of spatial relation for PUCCH  Proposal 3: No spatial relation switching delay requirements are introduced for PUSCH, as delays would be secondary effects from switching of spatial relation for SRS resource or PUCCH.  Proposal 4: Use requirements for MAC-CE based TCI state switch delay (TS 38.133 clause 8.10.3) as starting point for delay requirements for MAC-CE-based switching to spatial relations with DL reference signal (SSB or CSI-RS). Address known/unknown condition. Address assumptions on whether DL reference signal needs to be part of tracked TCI state list for PDSCH. For MAC-CE based switching to spatial relation with UL reference signal (SRS), refer to RAN1 requirement.  Proposal 5: Use requirements for RRC-based TCI state switch delay (TS 38.133 clause 8.10.5) as starting point for delay requirements for RRC-based switching of single active spatial relation. Address known/unknown condition for the case of DL reference signal (SSB, CSI-RS). Address assumptions on whether DL reference signal needs to be part of tracked TCI state list for PDSCH. |

## 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 2-1 : MAC CE based spatial relation info switch

*Sub-topic description: Requirements for MAC CE based spatial relation switch for DL-RS and SRS*

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

**Issue 2-1-1: Applicability of MAC CE based spatial relation info switching delay**

* Proposals
  + Option 1 (Intel, Ericsson): PUCCH
  + Option 2 (MediaTek, Qualcomm, Huawei): PUCCH, SP-SRS
* Recommended WF

**Issue 2-1-2: MAC CE based spatial relation info switching associated with DL-RS**

* Proposals

For known TCI state

* + Option 1 (Intel): THARQ +3ms
  + Option 1A (Huawei): THARQ +3ms, if the fine timing of the downlink RS is acquired. Otherwise, no requirement.
  + Option 2 (Qualcomm, Ericsson): THARQ +3ms + time for time tracking if applicable

For unknown TCI state

* + Option 1 (Intel): THARQ + 3ms + TL1-RSRP
  + Option 2 (Qualcomm, Ericsson): THARQ + 3ms + TL1-RSRP + time for time tracking if applicable
  + Option 3 (Huawei): No requirement
* Recommended WF

**Issue 2-1-3: MAC CE based spatial relation info switching associated with SRS**

* Proposals
  + Option 1 (Intel): THARQ +3ms
  + Option 2 (Qualcomm): Deprioritize
  + Option 3 (Ericsson): Refer to RAN1 requirement
* Recommended WF
  + Define MAC CE based spatial relation info switching delay associated with SRS as THARQ +3ms

### Sub-topic 2-2: RRC based spatial relation info switch

*Sub-topic description: Requirements for RRC based spatial relation switch for DL-RS and SRS*

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

**Issue 2-2-1: Applicability of RRC based spatial relation info switching delay**

* Proposals
  + Option 1 (Qualcomm, Huawei, MediaTek): P-SRS
  + Option 2 (Ericsson): PUCCH
* Recommended WF
  + RRC based spatial relation info switch requirements are defined for P-SRS

**Issue 2-2-2: RRC based spatial relation info switching associated with DL-RS**

* Proposals

For known TCI state

* + Option 1 (Ericsson): Define delay based on RRC based TCI state switching requirements
  + Option 2 (Huawei): TRRCprocessing (timing is acquired)
  + Option 3 (Intel): No requirements

For unknown TCI state

* + Option 1 (Ericsson): Define delay based on RRC based TCI state switching requirements
  + Option 2 (Intel, Huawei): No requirements
* Recommended WF

**Issue 2-2-3: RRC based spatial relation info switching associated with SRS**

* Proposals
  + Option 1 (Huawei): TRRCprocessing
  + Option 2 (Intel): No requirements
* Recommended WF

### Sub-topic 2-3: DCI based spatial relation info switch

*Sub-topic description: Requirements for DCI based spatial relation switch*

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

**Issue 2-3-1: Applicability of DCI based spatial relation info switching delay**

* Proposals
  + Option 1 (MediaTek): A-SRS
* Recommended WF
  + DCI based spatial relation info switch requirements are defined for A-SRS

**Issue 2-3-2: DCI based spatial relation info switching**

* Proposals

For known TCI state for DL RS /SRS

* + Option 1 (MediaTek, Huawei): Refer to RAN1 requirement

For unknown TCI state for DL RS

* + Option 1 (MediaTek, Huawei): No requirements
* Recommended WF
  + For DCI based spatial relation info switch: No requirements for unknown TCI state; refer to RAN1 requirement for known TCI state

### Sub-topic 2-4: General

*Sub-topic description: Requirements for DCI based spatial relation switch*

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

**Issue 2-4-1: Spatial relation info switching for PUSCH**

* Proposals
  + Option 1 (Most companies): No requirements
* Recommended WF
  + No requirements are defined for spatial relation info switching for PUSCH

**Issue 2-4-2: When PUCCH-SpatialRelationInfo is not configured**

* Proposals
  + Option 1 (Huawei): No requirements
* Recommended WF
  + No requirements are defined for spatial relation info switching for PUCCH when PUCCH-SpatialRelationInfo is not configured

**Issue 2-4-2: When configured spatial relation info is unknown**

* Proposals
  + Option 1 (Intel): UE transmits with previous TX beam/ arbitrary beam
* Recommended WF
  + The UE shall select arbitrary or previous TX beam for UL transmission if the TX beam for SRS associated with spatial relation info is not known or TCI state of DL-RS is unknown

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Apple | Sub topic 2-1:  Issue 2-1-1: MAC CE based SP-SRS activation is like a SP-SRS activation rather than a spatial relation change, so we may only focus on the MAC CE based spatial relation change for PUCCH. Support option 1.  Issue 2-1-2: for known case, we also think it’s necessary to consider fine time tracking for UE to switch to apply the target spatial relation for UL transmission, support option 2.  Issue 2-1-2: for unknown case, if the DL-RS is available for L1-RSRP for Rx beam refinement and the TCI of L1-RSRP RS is known to UE, we agree with option 2. Otherwise, we suggest to not define the requirement.  Issue 2-1-3: fine with Option 1.  Sub topic 2-2:  Issue 2-2-1: support option 1.  Issue 2-2-2: For known case, we think this requirement could be similar as RRC based TCI switching, but the condition of TOk shall be changed, here we may assume TOk is always as 1 for the worst case. For unknown case, we don’t understand the use case and motivation of network, so we prefer option 2.  Issue 2-2-3: fine with option 2.  Sub topic 2-3:  Issue 2-3-1: either no requirement or option 1 is fine to us, because DCI based A-SRS transmission is mostly like a SRS transmission triggering activity rather than a spatial relation change.  Issue 2-3-2: agree with the recommended WF.  Sub topic 2-4:  Issue 2-4-1: agree with the recommended WF.  Issue 2-4-2: agree with the recommended WF.  Issue 2-4-3: For SRS if the spatial relation info is unknown, we need to further consider more options before making the decision, e.g. using the last available spatial relation for SRS or the PL-RS TCI could be used for SRS transmission in this case.  For PUCCH, UE will keep using the last spatial relation before the delay of the PUCCH spatial relation change. |
| QC | Sub topic 2-1:  Issue 2-1-1:  We are fine with defining requirements only for PUCCH too and down prioritize SP\_SRS  Issue 2-1-2:  Issue 2-1-3:  Our preference here is to down-prioritize. If we do want to define these requirements, we need a new definition of known/unknown and need to consider UL beam sweeping.  Sub topic 2-2:  Issue 2-2-1:  Issue 2-2-2:  Can be similar to RRC based TCI state switching. Exact numbers may need more work. Agree to formulate the same way.  Issue 2-2-3:  Don’t define requirements.  Sub topic 2-3:  Issue 2-3-1:  Either no requirements or refer to RAN1  Issue 2-3-2:  No requirement or refer to RAN1  Sub topic 2-4:  Issue 2-4-1:  No requirements  Issue 2-4-2:  No requirements  Issue 2-4-3:  This should be an error case where UE behavior is undefined. |
| Mediatek | **Issue 2-1-1:**  Option 2.  The spatial relation of SP SRS is also activated by MAC CE. There is no reason not to define SP SRS requirement.  **Issue 2-1-2:**  For known TCI state   * Option 2. We don’t see any difference with TCI state processing flow when spatial relation is QCLed with DL RS. UE still need fine timing tracking time.   For unknown TCI state   * Option 2. We don’t see any difference with TCI state processing flow when spatial relation is QCLed with DL RS, but we’re also fine with option 3.   **Issue 2-1-3:**   * Option 1. It should clarify that associated to SRS means the source QCL of spatial relation is SRS.   **Issue 2-2-1:**   * Option 1.   **Issue 2-2-2:**  For known TCI state,   * We don’t see any difference with TCI state processing flow when spatial relation is QCLed with DL RS. UE still need fine timing tracking time. It should be TRRC\_processing +TOk\*(Tfirst-SSB + TSSB-proc).   For unknown TCI state, we think firstly we should agree whether to define unknown requirement. If yes, we don’t see any difference with TCI state processing flow when spatial relation is QCLed with DL RS.  **Issue 2-2-3:**   * Option 1.   **Issue 2-3-1:**   * Option 1. Similar as DL PDSCH, we can define the requirement for A-SRS followed with RAN1 spec and only in known scenario.   **Issue 2-3-2:**   * Agree with the potential WF. For DCI based spatial relation info switch: No requirements for unknown TCI state; refer to RAN1 requirement for known TCI state.   **Issue 2-4-1:**   * Agree   **Issue 2-4-2:**   * Agree   **Issue 2-4-3:**  As discussed in our paper, we think UE should transmit with previous TX beam when UE doesn’t finish the active spatial relation switching because this is the only beam both UE and network know. |

### 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:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 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)

## Summary on 2nd round (if applicable)

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

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

# Topic #3: Non-simultaneous UL carrier operation in FR2

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2002163 | Apple | **Observation 1: BWP switching framework is more efficient in terms of switching delay. However the feasible is subject to further study.**  **Observation 2: SCell activation framework should be feasible to enable NSU. The related activation/deactivation delay should be further investigated.**  **Observation 3: SCell configuration framework will result in long switching delay to make NSU less efficient in terms of switching delay. However, compared to Alt. 2, Alt. 3 can be more power efficient.**  As a result, it is proposed that  **Proposal: RRM related work should be kicked off to investigate**   * **the feasibility of extending BWP switching framework to NSU** * **the SCell activation framework based NSU switching delay and how to fit it into NSU time frame.** |

## 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 : RRM plan

*Sub-topic description: Requirements for MAC CE based spatial relation switch for DL-RS and SRS*

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

**Issue 3-1-1: RRM plan**

* Proposals
  + Option 1 (Apple):

RRM related work should be kicked off to investigate

* + - the feasibility of extending BWP switching framework to NSU
    - the SCell activation framework based NSU switching delay and how to fit it into NSU time frame.
* Recommended WF

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Mediatek | Sub topic 3-1:          Whether BWP switch framework can be used should involve RAN1 discussion. Based on Rel-15 BWP framework, BWP switch is always within one CC, rather than switch across CCs.                         It is unclear to us on the definition of NSU time frame. |

### 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:* |

*Suggestion on WF/LS assignment*

|  |  |  |
| --- | --- | --- |
|  | **WF/LS t-doc Title** | **Assigned Company,**  **WF or LS lead** |
| #1 |  |  |

### 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)

## Summary on 2nd round (if applicable)

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

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