**3GPP TSG-RAN WG4 Meeting #94-e R4-2002183**

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

**Agenda item:** 8.13.2

**Source:** Huawei, HiSilicon

**Title:** Email discussion summary for RAN4#94e\_#60\_NR\_RF\_FR1\_RRM

**Document for:** Information

# Introduction

This email thread discusses the RRM requirements for Tx switching between two uplink carriers in agenda 8.13.2 and the proposals on DL interruption in other papers in 8.13.1.6 are treated in this thread as well.

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

* 1st round: Invite companies to review the recommended WF in each sub-topic, and provide comments.
* 2nd round: TBA

# Topic #1: RRM requirements for Tx switching between two uplink carriers

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000065 | Huawei, HiSilicon | Observation 1: There is no need to consider DL interruption for SUL case when switching between 1Tx carrier and 2Tx carrier.Proposal 1: No DL interruption is considered for SUL case when switching between SUL carrier with 1Tx chain and UL carrier with 2Tx chains.Observation 2: The downlink interruption, which would impact the downlink performance, can be avoided.Proposal 2: For inter-band EN-DC case, no DL interruption is allowed for UE capable of switching between LTE uplink with 1Tx chain and NR uplink with 2Tx chains.Proposal 3: For UL CA case, no DL interruption is allowed for UE capable of switching between the uplink carrier with 1Tx chain and the uplink carrier with 2Tx chains. |
| R4-2000068 | Huawei, HiSilicon | LS out:- For SUL case, there is no DL reception interruption;- For UL CA case, no DL reception interruption is allowed;- For inter-band EN-DC case, no DL reception interruption is allowed.RAN4 also understands that if a UE has to cause interruptions during switching between the two uplink carriers, the UE is considered as not supporting the switching. |
| R4-2000135 | China Telecom | Proposal 1: Not define RRM interruption requirement.Observation 1: If additional RRM requirements will be defined to verify the same switching time for UE, the number of test cases will be doubled.Proposal 2: Not define RRM switching delay requirement. |
| R4-2000457 | MediaTek Inc. | Observation 1: Whether to introduce interruption requirements in RRM session is pending on the conclusion in RF session.Observation 2: Capturing interruption requirements in TS38.133 is better for spec consistency and maintenance in the future.Proposal 1: If interruption is agreed in RF session, the requirements are specified in TS38.133 with the starting time of the interruption and the interruption duration specified in the unit of OFDM symbol. |
| R4-2000640 | vivo | Proposal 1: Select option C among available options Proposal 2: The length of interruption should be less or equal to the switching delay and the location of the interruption is within the switching delay duration. |
| R4-2000991 | OPPO | Observation 1: Tx switching with interruption is more realistic implementation for UE. Proposal 1: RAN4 encourages to recognize the high-demand requests of band combination for Tx switching.Observation 2: Study the feasibility to define per band combination capability for UE to indicate if supporting Tx switching with interruption.Proposal 2: Consider RRM requirements of interruption and switching delay for MIMO layer adaption and SRS carrier switching as reference. |
| Proposals on DL interruption from papers in 8.13.1.6 are treated in this thread |
| R4-2000643 | CMCC | Proposal 2: it is proposed that: * + No DL reception interruption for the following duplex mode combinations: (carrier 1 + carrier 2)
		- SUL+TDD
		- TDD+TDD with the same UL-DL pattern
	+ Other band combinations: Define different capabilities for UEs with and without DL reception interruption. If UE does not report this capability, it means there is no DL reception interruption.
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| R4-2000793 | Apple Inc. | Proposal 2: DL interruption requirements due to Tx switching should be specified. The length of the interruption is TBD. The related UE capability can be specified as per band combination. |
| R4-2000113 | Qualcomm Incorporated | Proposal 4: For every switching occasion, UE is not required to receive the slot that overlaps with the switching time. |
| R4-2000131 | China Telecom | For DL reception interruption due to UL switching:Observation 6: For LTE carrier in EN-DC, since LTE PDCCH is transmitted from the first OFDM symbol of one TTI, DL reception interruption at the beginning of the TTI cannot be allowed.Observation 7: For NR carrier, if DL reception interruption at the beginning of the slot is allowed, NR PDCCH shall be started from symbol #n or later in slots with and without DL interruption.Observation 8: For NR UEs only supporting PDSCH mapping type A, 140 us and 250 us DL interruption would imply no concurrent PDCCH and PDSCH transmission in one slot for 30kHz SCS carrier, and 250 us DL interruption would imply no concurrent PDCCH and PDSCH transmission in one slot for 15kHz SCS carrier.Observation 9: For LTE carrier in EN-DC, since TTI-based PDSCH transmission is defined, DL reception interruption at the end of the TTI cannot be allowed.Observation 10: For NR carrier, if DL reception interruption in the middle or at the end of the slot is allowed, PDSCH can be transmitted in the slot with a shortened duration, i.e., decreased DL throughput. Moreover, if the DL interruption is in the middle of the slot, the OFDM symbols after the DL interruption may only be scheduled by PDSCH mapping type B.Observation 11: NR SSB should not be impacted by DL interruption by network scheduling.Proposal 3: Not allow downlink interruption reception during uplink switching. |
| R4-2000628 | CATT | Proposal 3: Only specify this feature for those combinations that can avoid DL interruption issue. |
| R4-2000810 | ZTE Corporation | Proposal 3: Downlink interruption is not allowed due to the switching between two uplink carriers.Proposal 4: No RRM interruption requirements defined for the switching between two uplink carriers. |
| R4-2001307 | MediaTek Inc. |

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| Scenario ID | Case 1 | Case 2 | Synchronized UL/DL | Interruption during switching |
| Carrier 1 | Carrier 2 | Carrier 1 | Carrier 2 |  | DL | UL |
| 1 | FDD | TDD |  | TDD 2xUL | N/A | Carrier 1 | All UL |
| 2 | FDD | FDD |  | FDD 2xUL | N/A | All DL | All UL |
| 3 | TDD | TDD |  | TDD 2xUL | Yes | No | All UL |
| 4 | TDD | TDD |  | TDD 2xUL | No | Carrier 1 | All UL |
| 5 | TDD | FDD |  | FDD 2xUL | N/A | Carrier 2 | All UL |
| 6 | SUL | TDD |  | TDD 2xUL | N/A | No | All UL |
| 7 | SUL | FDD |  | FDD 2xUL | N/A | Carrier 2 | All UL |

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| R4-2001430 | Nokia, Nokia Shanghai Bell | Proposal 2: No interruptions in DL reception are allowed due to UL switching. |

## Open issues summary

### Sub-topic 1-1 DL Interruptions due to UL TX switching

* Proposals
	+ Option 1: No downlink interruption is allowed due to the switching between two uplink carriers (China Telecom, ZTE, Nokia, Huawei).
	+ Option 2 (CMCC, vivo, MediaTek):

-No DL reception interruption for the following duplex mode combinations: (carrier 1 + carrier 2)

* + - SUL+TDD
		- TDD+TDD with the same UL-DL pattern

-Other band combinations: Define different capabilities for UEs with and without DL reception interruption. If UE does not report this capability, it means there is no DL reception interruption.

* + Option 3: Only specify this feature for those combinations that can avoid DL interruption issue(CATT)
	+ Option 4: Define different capabilities for UEs with and without DL reception interruption (Apple, MediaTek, Qualcomm)
* Recommended WF
	+ No DL reception interruption for the following duplex mode combinations: (carrier 1 + carrier 2)
		- SUL+TDD
		- TDD+TDD with the same UL-DL pattern
		- For the following band pairs of FDD+TDD CA/EN-DC, no DL reception interruption (carrier 1 + carrier 2):
			* Band (n)x + Band ny
			* < *To be added* >

*Note: band pairs for this bullet is discussed in RF session.*

* + - For the other duplex mode combinations and band pairs:
			* Carrier 1: define different capabilities for UEs with and without DL reception interruption. If UE does not report this capability, it means there is no DL reception interruption.
			* Carrier 2: no DL interruption

*Note: band pairs for this bullet is discussed in RF session.*

### Sub-topic 1-2: Where to capture the interruption requirements

* Proposals
	+ Option 1: RRM spec
	+ Option 2: RF spec
* Recommended WF
	+ Is option1 agreeable?

### Sub-topic 1-3: interruption granularity

* Proposals
	+ Option 1: in the unit of OFDM symbols (MediaTek)
	+ Option 2:in the unit of Slot (Qualcomm)
* Recommended WF
	+ Is option1 agreeable?

### Sub-topic 1-4: Whether delay requirement shall be specified

* Proposals
	+ Option 1:No
* Recommended WF
	+ Is option1 agreeable?

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| China Telecom | Sub topic 1-1: Ok with the recommended WF. Considering the tight timeline for Rel-16, RF and RRM discussions can be conducted in parallel.Sub topic 1-2:To reduce the standard impact, our original thinking was to simply add one sentence in the RF time mask requirements on whether DL interruption is allowed or not.In the offline discussion, a few companies suggested to introduce interruption requirements (the applicability of the requirements is a separate discussion). So we are ok to define the requirements in RRM spec instead of capturing it in RF spec. Option 1 is ok for us.Sub topic 1-3:Based on our deployment scenario, UL switching can happen very frequently, for example, up to 4 times per 5ms. So it is highly recommended to adopt option 1.Sub topic 1-4:Having switching time mask requirements defined in RF spec, we do not see the additional test point with RRM switching delay requirement, which just doubles the number of test cases. So option 1 is our preference. |
| OPPO | Sub topic 1-1: Generally we could support option 2/4, but prefer a new option that RAN4 study the feasibility to define UE capability as per band combination but not as per UE, since in RF session the high-demand requests of band combination for Tx switching are to be recognized.Sub topic 1-2: Support option1.Sub topic 1-3: Support option2.Sub-topic 1-4: Agree with China Telecom to simplify the test. Prefer to wait for the conclusion of switching time from RF session. |
| MTK | **Sub topic 1-1:** The WF is agreeable to us. But it seems the topic of whether to allow interruption is now discussed in #19\_NR\_RF\_FR1\_Part\_2. RRM session should wait for the conclusion of #19. **Sub topic 1-2:**Support Option 1.Prefer RRM spec for the consistency of the spec as well as easier maintenance in the future.**Sub topic 1-3:**Support Option 1 as a compromise for the progress. But there is no intention to revise other existing interruption requirements with a different granularity.**Sub topic 1-4:**Support Option 1. No delay requirement is required. This should be captured in the UE preparation time in RAN1 spec. |
| Huawei, HiSilicon | **Sub topic 1-1: DL Interruptions due to UL TX switching**Agree with the recommended WF. To OPPO, the capability may be as per band combinition if DL intteruption is identified for certain band pairs.**Sub topic 1-2: Where to capture the interruption requirements**Support option 1(RRM spec).**Sub topic 1-4: Whether delay requirement shall be specified**Support option 1.Switching time mask is defined in RF session. No need to define delay requirements in RRM. |
| Nokia, Nokia Shanghai Bell | Sub-topic 1-1: Recommended WF is not clear and therefore also not acceptable for us. It is open for different interpretations. Furthermore, DL interruption needs to be discussed as part of RF requirements first, not only as part of RRM requirements. RRM requirement implications can be discussed additionally. If DL interruptions are allowed, RAN4 has already agreed to request further analyses from RAN1 first. In our view the UE supports UL Tx switching only for those band combinations, for which UE does not need interruptions for DL reception. Thus, interruptions in DL receptions should not be allowed for UL Tx switching. Sub-topic 1-2: As discussed in the sub-topic 1-2 DL interruptions is not just RRM requirement matter but also RAN1 and RF matter. The impacted specifications can also be decided after it has been decided how to handle DL interruptions. The discussion would continue as part of RF requirements like done in the previous RAN4 meeting. Thus, the recommended WF is not acceptable for us. Sub-topic 1-3: interruption granularity should only be decided once the basic interruption decisions and lengths are decided. Sub-topic 1-4: Only after the basic minimum interruption time requirements and assumptions are agreed, it is possible to decide if additional RRM requirements need to be specified. RRM requirement analyses need to be done after agreeing the interruption time requirements and assumptions. |
| CMCC | Sub topic 1-1: There are three bullets in the recommended WF. We support the first bullet as below.* + No DL reception interruption for the following duplex mode combinations: (carrier 1 + carrier 2)
		- SUL+TDD
		- TDD+TDD with the same UL-DL pattern

For the other two bullets, it is not clear what is relation between this email discussion and RF email discussion. We prefer to define UE capability to give some flexibility, and on top of that, RAN4 can further discuss whether each band combination allow DL interruption or not* + - For the following band pairs of FDD+TDD CA/EN-DC, no DL reception interruption (carrier 1 + carrier 2):
			* Band (n)x + Band ny
			* < *To be added* >

*Note: band pairs for this bullet is discussed in RF session.** + - For the other duplex mode combinations and band pairs:
			* Carrier 1: define different capabilities for UEs with and without DL reception interruption. If UE does not report this capability, it means there is no DL reception interruption.
			* Carrier 2: no DL interruption

*Note: band pairs for this bullet is discussed in RF session.*Sub-topic 1-2: We are OK with both options.Sub-topic 1-3: We think option 1 is better. But before discussing the granularity of interruption, we should first discuss the interruption time itself.Sub-topic 1-4: We support option 1, no delay requirements is neededWe support  |
| QC | 1.2.1 Sub-topic 1-1The WF is not really clear to us, so with the current language not really agreeable. In order to define the length of interruptions, we would need to wait and see how long the RF delays are. This topic should follow the same procedure as any other topic. First, RF room decides what all the RF delays are, and what all re-tuning/switching is needed. Based on those agreements, RRM delegates will decide where all and how long are the interruptions needed. 1.2.2 Sub-topic 1-2Option 1: Interruption requirements are always captured in RRM spec. 1.2.3 Sub-topic 1-3Option 2: Interruptions in RRM have always been at slot level. 1.2.4 Sub-topic 1-4The delay should come from RF room.  |
| Apple | Sub-topic 1-1: we should take option 4 as baseline. Then, it can be further discussed if no interruption can be completely avoided for certain duplex mode combination based on the relatd RF agreement.Sub-topic 1-2: RRM specSub-topic 1-3: Considering NR scheduling is flexible in symbol level, option 1 makes more sense. Sub-topic 1-4: what delay requirements refer to here? |
| vivo | **Sub topic 1-1:** We prefer option 2.**Sub topic 1-2:**Prefer option 1. |

### 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.*

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| **CR/TP number** | **Comments collection** |
| XXX | Company A |
| Company B |
|  |
| YYY | Company A |
| Company B |
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## Summary for 1st round

### Open issues

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

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|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:*No tentative agreements. *Candidate options:*RF is discussing this topic in parallel. RRM can refer to the conclusion of RF.*Recommendations for 2nd round:* skip discussion of this sub-topic in RRM. |
| **Sub-topic #2** | Tentative agreements:No tentative agreements. Candidate options:- Option 1: RRM spec (China Telecom, OPPO, MediaTek, Huawei, CMCC, Qualcomm, Apple, vivo)- Option 2: The impacted spec can’t be decided now(Nokia)Recommendations for 2nd round: Further discussion |
| **Sub-topic #3** | Tentative agreements:No tentative agreements. Candidate options:- Option 1: in the unit of OFDM symbols (China Telecom, MediaTek, CMCC, Apple)- Option 2: in the unit of Slot (OPPO, Qualcomm)- Option3: the interruption granularity can’t be decided now(Nokia)Recommendations for 2nd round: Further discussion |
| **Sub-topic#4** | Tentative agreements:No tentative agreements. Candidate options:- Option 1: No (China Telecom, OPPO, MediaTek, Huawei, CMCC, Qualcomm, Apple, vivo)- Option2: can’t be decided now(Nokia)Recommendations for 2nd round: Further discussion |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
| #1 | WF on RRM requirements for Tx switching between two uplink carriers | Huawei, HiSilicon |

### CRs/TPs

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

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

## Discussion on 2nd round (if applicable)

**Sub-topic 1-2: Where to capture the interruption requirements**

- Option 1: RRM spec

- Option 2: The impacted spec can’t be decided now

**Sub-topic 1-3: interruption granularity**

- Option 1: in the unit of OFDM symbols

- Option 2: in the unit of Slot

- Option3: the interruption granularity can’t be decided now

**Sub-topic 1-4: Whether delay requirement shall be specified**

- Option 1: No

- Option2: can’t be decided now

### Companies views’ collection for 2nd round

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| **Company** | **Comments** |
| Company X | **Sub-topic 1-2: Where to capture the interruption requirements****Sub-topic 1-3: interruption granularity****Sub-topic 1-4: Whether delay requirement shall be specified** |

## 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*

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| **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”* |

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