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

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

**Agenda item:** 8.13.1.6

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for RAN4#94e\_#19\_NR\_RF\_FR1\_Part\_2

**Document for:** Information

# Introduction

This email thread discusses the RF requirements for Tx switching between two uplink carriers in agenda 8.13.1.6.

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 (if any) in section 1.3, 2.3 and 3.3.
* 2nd round: TBA

# Topic #1: Length of uplink switching period

## Companies’ contributions summary

|  |  |  |
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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000064 | Huawei, HiSilicon | Proposal 1: Specify 35us and 140us as the only two options from which a UE choose to report its capability of the switching period for SUL case, which is Option B: {35us, 140 us} or {1, 4} OFDM symbols for 30kHz SCS.Proposal 2: Consider 35us and 140us as the only two options from which the UE choose to report its capability of supporting length of the switching period for inter-band EN-DC case, which is also Option B. |
| R4-2000113 | Qualcomm Incorporated | We discussed the meaning and impact of the “switching period” and made the following observations. Observation 1: According to existing requirements, 140 usec PLL retuning time overlaps with three symbolsObservation 2: Assuming even the tighter intra-band requirements, three symbols are affected by 140 usec PLL retuning time And to clarify the applicability of the switching period, we made following proposalsProposal 1: Define switching time as outage time how many symbols are affected and communicate this to RAN2Proposal 2: Allow 210 usec as one of the switching time options And to optimise the impact of the switching or outage period, we made the following proposal:Proposal 3: Reference for the switching time is RX |
| R4-2000125 | vivo | Observation 1: overall gain/loss of switching depends on UL MIMO gain. The performance can be improved by activating the Tx switching function for UE with high UL MIMO gain which can be handled be BS scheduling.Observation 2: overall gain/loss also depends on the frequency of switching. Lower frequency can reduce the switching overhead and achieve high gain.Proposal: switching time up to 250us/250+10us can be considered if it is justified by capability of certain UE implementation.  |
| R4-2000131 | China Telecom | For non-zero switching period:Observation 1: To make more UEs get benefits from Tx switching, it is important to allow different UE implementations for different band pairs in the spec.Observation 2: With multiple non-zero values defined in 3GPP spec, BS complexity is not an issue in some cases and for some BS implementations.Observation 3: How much gain can be achieved with different lengths of switching period depends on the many other factors. In the WI, it is straightforward to focus on defining UE requirements but not studying system performance.Observation 4: Uplink performance gain by Tx switching in term of available REs:* Tx switching can achieve significant gain in almost all the scenarios excepting when a switching period of 250us is placed in carrier 2 of scenario 2.
* In scenario 1 and scenario 2, when the switching period is placed in carrier 1, the decrease of the gain by Tx switching is negligible when the switching time increases; when the switching period is placed in carrier 2, the decrease of the gain by Tx switching is obvious when the switching time increases.
* In scenario 3, since the switching happens during the downlink OFDM symbols, the gain by Tx switching is unchanged for different switching time.

Proposal 1: Select option A or option B for the non-zero switching period for defining UE RF requirement and capability reporting:* Option A: {35us, 140 us, 250us} or {1, 4, and 7} OFDM symbols for 30kHz SCS
* Option B: {35us, 140 us} or {1, 4} OFDM symbols for 30kHz SCS

For zero switching period:Observation 5: For switching with 0 us, it is different from the Rel-15 UL CA/EN-DC, since maximum two concurrent Tx is allowed due to power consumption, heat dissipation and/or baseband capability issues.Proposal 2: Define 0 us switching period from forward compatibility point of view. |
| R4-2000628 | CATT | Proposal 1: It is proposed to adopt Option B: {35us, 140us} for non-zero value.Proposal 2: 0 us switching period can be kept. |
| R4-2000643 | CMCC | Proposal 1: Define 0us, 35us, 140us as the length of the UL switching period. |
| R4-2000793 | Apple | Proposal 1: Length of switching period should be defined as in a unit of symbol duration

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| Capability of switching period  | SCS=15kHz | SCS=30kHz | SCS=60kHz |
| 35us | 1 symbol | 1 symbol | 2 symbols |
| 140us | 2 symbols | 4 symbols | 8 symbols |
| 250us | [4] symbols | 7 symbols | 14 symbols |

 |
| R4-2000810 | ZTE Wistron Telecom AB | Proposal 1: 250us switching period is redundant to UE capability signalling, so it can be removed from the value set.Proposal 2: Include 0us into the value set for none hand-held devices and future proof, and not define requirements corresponding to 0us within Rel-16. |
| R4-2001307 | MediaTek Inc. | Proposal 1: For non-zero value, it is proposed to adopt option B and reported by UE per uplink band combination. 0us shall be removed in Rel-16. Keep FFS on whether to define 0us switching period for Rel-17 or later release.Proposal 2: Uplink interruption shall be allowed on both UL carriers. Proposal 3: For SA CA and SUL, the location of Tx switching period should be semi-statically configured by RRC on either case 1 or case 2. |
| R4-2001430 | Nokia, Nokia Shanghai Bell | Proposal 1: Define minimum requirements with only one value for the UL switching period (i.e. no UE capability) |

## Open issues summary

### Sub-topic 1-1: non-zero value

**Issue 1-1: Non-zero switching period for defining UE RF requirements and capability reporting**

* Proposals
	+ Option 1: {35us, 140 us, 210us} or {1, 4, and 6} OFDM symbols for 30kHz SCS ([Qualcomm], vivo, China Telecom, Apple)
	+ Option 2: {35us, 140 us} or {1, 4} OFDM symbols for 30kHz SCS (Huawei, China Telecom, CATT, CMCC, ZTE, MediaTek, CMCC)
	+ Option 3: only one value (Nokia)
* Recommended WF
	+ For SUL and UL CA
		- {35us, 140 us, 210us} or {1, 4, and 6} OFDM symbols for 30kHz SCS
	+ For EN-DC
		- {35us, 140 us} or {1, 4} OFDM symbols for 30kHz SCS
		- *Note:* As agreed in R4-1913041 at RAN4 #92bis, for EN-DC, the switching period can only be located in NR carrier

### Sub-topic 1-2: zero value

**Issue 1-2: Whether to define 0us switching period for RF requirements and capability reporting**

* Proposals
	+ Option 1: Yes (China Telecom, CATT, CMCC)
	+ Option 2: No (Huawei, Apple, MediaTek)
	+ Option 3: Only define capability, not define requirements in Rel-16 (ZTE)
* Recommended WF
	+ For 0 us switching period:
		- Define capability reporting in Rel-16
			* Design on its capability signalling is up to RAN2
		- Not define RF requirements in Rel-16 for UL CA and EN-DC

### Sub-topic 1-3: UL timing

**Issue 1-3: Assumption on UL transmission timing of the two carriers**

* *Two notes in the WID (RP‑192282)*
	+ *Note 1: Only addressing the case of co-located and synchronized network deployment for the two UL carriers*
	+ *Note 2: Only addressing the case of single TAG for the two UL carriers for SUL and for UL CA*
* Observations from the two notes in the WID:
	+ For UL CA and SUL
		- Option 1: The same uplink timing for the two carriers ([Qualcomm], Huawei, China Telecom)
	+ For EN-DC
		- Option 1: no more than 5.21 us timing difference (Huawei, [Qualcomm])
* Recommended WF
	+ Observations on UL transmission timing of the two carriers based on the WID
		- For UL CA and SUL: the same uplink timing
		- For EN-DC: no more than 5.21 us timing difference

### Sub-topic 1-4: UL outage

**Issue 1-4: Impact on UL transmission during UL switching time**

* *Agreement in RAN4 #92bis (R4-1913041)*
	+ *Applicable carrier(s) of UL outage due to switching*
		- *Both carrier 1 and carrier 2*
* Proposals
	+ Proposal 1 (Qualcomm):
		- Define switching time as outage time
		- Reference for the switching time is RX
	+ Proposal 2 (MediaTek):
		- Uplink interruption shall be allowed on both UL carriers.
* Recommended WF
	+ Uplink outage in both carrier 1 and carrier 2 are allowed during uplink switching period

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| China Telecom | Sub topic 1-1: This issue has been discussed for more than half year. Based on previous discussions, we have further analyzed the UE implementation, BS implementation and performance aspects in our contribution R4-2000131. Agree with the recommended WF as a compromise to move forward.Sub topic 1-2: Prefer option 1. As 3Tx is not a typical implementation in Rel-16, ok with the recommended WF for forward compatibility.Sub topic 1-3: Agree with the observationSub topic 1-4: ok to add the clarification on top of previous agreement |
| Nokia, Nokia Shanghai Bell | Sub topic 1-1: We do not agree with the recommended way forward. RAN4 should focus on getting the minimum requirements specified rather than creating number of UE capabilities for the features, which is intended for relaxing UE requirements rather than enhancing UE requirements. Furthermore, RAN4 has been discussing FR1 improved transient period with capability far longer than this topic (long before this topic had even been proposed in RAN4) but no conclusions have been reached despite clear majority of the companies in RAN4 see the improvement feasible improvement and it was even agreed to be optional for the UE. Now in R4-2001757 FR1 improved transient period work is requested to be postponed to Rel-17 with an argument that testing aspects have not been sufficiently studied and according to that company different transient period cannot be distinguished although other companies have shown that it is feasible to differentiate performance for different transient period. For this UL switching no testing related analyses have been presented. Furthermore, in our view UE capabilities should rather be defined when improving UE capabilities compared to the earlier releases rather than defining number of capabilities for relaxations. Sub topic 1-2: We do not agree with the recommended WF. What is even justification to define UE capability for 0 us switching period without defining RF requirements? RAN4 should focus on defining requirements not capabilities. There is no issue with future-proofness if non-zero minimum requirements are defined as 0 us switching period also meets non-zero switching time requirements.Sub topic 1-3: Before we can commented on the feasibility of the recommended WF we would like that the recommended WF would be clarified further including implications on the deployments. Is it feasible to assume intra-band EN-DC deployment assumptions for inter-band EN-DC? Are there any constraints for the frequency bands that could be supported with the proposed WF?Sub topic 1-4: We do not agree with the recommended WF as it is against the earlier RAN4 agreements and LS sent to RAN2. RAN4 requested signaling to indicate on which carrier the UL switching is located. If both carriers are impacted, no signaling would be needed. Furthermore, the recommended WF would degrade the system performance even further. |
| OPPO | Sub topic 1-1: Generally, we agree to introduced different values according to UE capabilities and prefer option 1. About the proposed WF, for EN-DC we would like to understand better the reason of removing 210us.Sub topic 1-2: It is well known that 0 us switching period requires UE to implement with 3Tx chains which has big challenge to UE implementation and has never been implemented up to now, therefore, our preference is not introduce the 0us capability. About the proposed WF, we can further discuss. |
| MediaTek | Sub topic 1-1: Agree with Recommended WFSub topic 1-2: Cannot agree with Recommended WF since 0us is not feasible in Rel-16. Keeping 0us may create inconsistency in Rel-16 since concurrent two uplink chain is common understanding. For Rel-17, it is FFSSub topic 1-3: Agree with Recommended WF since co-located and synchronized is baseline.Sub topic 1-4: Agree with Recommended WF |
| CMCC | Sub topic 1-1: we support to define 35us and 140us. Sub topic 1-2: we support to define 0us capability reporting for future proof. We are OK with the recommended WF. |
| ZTE | Sub topic 1-1: We slightly prefer to one set of values applicable to all three scenarios (SUL/UL CA/EN-DC).Sub topic 1-2: The recommended WF is acceptable to us.Sub topic 1-3: The recommended WF is acceptable to us.Sub topic 1-4: The recommended WF is acceptable to us. |
| Qualcomm | Sub topic 1-1: We prefer option 1 and option 3 is also preferred with the condition that minimum requirement is 210 usec allowance for outage.  Sub topic 1-2: We mildly prefer not to define 0 usec (option 2) time since the complication of the specification and at least initially redundant capability. Sub-topic 1-3: Our understanding on the interpretation of the note in the WID is the option 1 for ULCA and SUL which is also according to RAN1 specifications (even very unclearly there). For EN-DC, we are ok with the option 1 but this should be written somewhere since it not specified anywhere currently. Note is that for all case, MRTD in 38.133 still holds. Sub-topic 1-4: We support confirming the agreement in WF i.e. outage is in all UL carriers. However, not clear is the switching time aligned with TX or RX is not clear since it is not in any of the options.  |
| CHTTL | Sub topic 1-1: Though we prefer option 2, we think the recommend WF is a reasonable compromise. Sub topic 1-2: we support to define 0us capability reporting for future proof. We are OK with the recommended WF.Sub\_topic 1-3: we are fine with the recommend WF, but it seems like an observation, not sure if we need to address something in the RF spec. |
| vivo | Sub topic 1-1: we prefer option1. And we are fine with the recommended WF as compromise. |
| Huawei | Sub topic 1-1: For SUL and UL CA, our preference is defining two values {35us and 140us}. Since only single TAG is assumed, it means no timing difference between two uplink carriers. As given in the paper, 140us comes from PLL retuning time. We don’t see why 210us should apply for SUL and UL CA cases.Additionally, for all the cases it is preferred to have the periods defined in microsecond rather than in number of symbols since the switching period can be configured to be at any one of the carriers with all kinds of possible data SCS.Sub topic 1-2: 0us is difficult to support based on the current assumption that only two con-current uplink transmissions can be assumed in the WID. Sub topic 1-3: we agree with the observations. But the group do not need to re-agree on the agreement captured in WID NOTE2. In our understanding, NOTE1 and NOTE2 in the WID shall be captured in the specification.Sub topic 1-4: we agree with the clarifications. But there has already been the agreement. Maybe we can skip this discussion. Company can refer to the previous agreement. |
| CATT | Sub topic 1-1: We would accept values not exceeding 140us as proposed in our paper. Sub topic 1-2: In relation to sub topic 1-1, if the switching period cannot be down selected to single value in the end, then anyway signaling will be needed. We can keep 0 us as an option for future. 0 us will have no impact to the current UE since it is UE capability based.Sub topic 1-3: Ok with the proposed WF but need to have clear limitation on deployment scenario, e.g. the time alignment between E-UTRA and NR frame should be no larger than 3us for inter-band co-located EN-DC.  |
| Apple | Sub topic 1-1: Prefer to option 1 but can compromise to option 2Sub topic 1-2: Option 2. It seems there is no vendor claiming to achieve 0us switching time. Meanwhile, we have inform RAN2 that up to three switching time will be specified. If option 1 in 1-1 is adopted, we have ran out of space. Sub topic 1-3: For UL CA and SUL, what the same uplink timing means, e.g. 0us or 2.47us ?Sub topic 1-4: the proposed WF is OK |
| Intel | Sub topic 1-1: Support option 1 which allows more implementation choice.Sub topic 1-2: Not agree with WF and support option 2. 0 uS switching implicates 3-TX which never been assumed in RAN4 even in Rel-16. Sub topic 1-3: Support option 1 for UL CA and SUL. However, we would like to understand better the background for EN-DC. Currently RAN4 defines MTTD for intra-band synchronous EN-DC, which is 5.21 uS. Option 1 here seems repeat the existing RRM requirement. Is this correct or something else?Sub topic 1-4: The proposed WF is acceptable but as Qualcomm shown in the paper, we see a benefit to align reference time with RX. |
| XXX | Sub topic 1-1: Sub topic 1-2:Sub topic 1-3:Sub topic 1-4:….Others: |

## Summary for 1st round

### Open issues

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

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

*Recommendations on WF/LS assignment*

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

## 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*

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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”* |

# Topic #2: Applicability of DL interruption

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000113 | Qualcomm Incorporated | Regarding DL interruptions, we made the following proposal: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. |
| R4-2000643 | 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.
 |
| R4-2000793 | Apple | 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.  |
| R4-2000810 | ZTE Wistron Telecom AB | Proposal 3: Downlink interruption is not allowed due to the switching between two uplink carriers. |
| R4-2001307 | MediaTek Inc. | Proposal 2: For EN-DC without SUL, inter-band UL CA and standalone SUL in case 1, it is proposed to adopt option A.  |
| R4-2001430 | Nokia, Nokia Shanghai Bell | Proposal 2: No interruptions in DL reception are allowed due to UL switching. |

## Open issues summary

### Sub-topic 2-1: Applicability of DL interruption

**Issue 2-1: Applicability of DL interruption requirements**

* Proposals
	+ Option 1: Define different capabilities for UEs with and without DL reception interruption ([Qualcomm], Apple, MediaTek)
		- If UE does not report this capability, it means there is no DL reception interruption.
	+ Option 2: DL reception interruption is not allowed. (Huawei, China Telecom, ZTE, Nokia, CATT)
	+ Option 3: Only specify this feature for those combinations that can avoid DL interruption issue. (CATT)
	+ Option 4 (CMCC, vivo):
		- 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.
* Recommended WF
	+ Discuss DL interruption requirements in RRM session.
	+ Discuss the applicability of DL interruption requirements (i.e., whether or not the interruption requirements can be applied for some band pairs for some UE implementations) in RF session.
	+ Proposal on the applicability of DL interruption requirements
		- For the following duplex mode combinations, no DL reception interruption (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* >
		- 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

## Companies views’ collection for 1st round

### Open issues

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| **Company** | **Comments** |
| China Telecom | Sub topic 2-1: Propose to add n1+n78 and n3+78 as FDD+TDD CA/EN-DC band pairs with no DL reception interruption, i.e.,* + - For the following band pairs of FDD+TDD CA/EN-DC, no DL reception interruption (carrier 1 + carrier 2):
			* Band (n)1 + Band n78
			* Band (n)3 + Band n78
 |
| Nokia, Nokia Shanghai Bell | Sub topic 2-1: Recommended WF is not clear to us. DL interruption needs to be discussed as part of RF requirements, not only RRM requirements. RRM requirement implications can be discussed additionally. Furthermore, if DL interruptions were allowed, RAN4 has agreed to request further analyses from RAN1 first. In our view the UE supports the feature only for those band combinations, for which UE does not need interruptions for DL reception. |
| KDDI | Sub topic 2-1: Propose to add n1+n78 and n3+78 as FDD+TDD CA/EN-DC band pairs with no DL reception interruption* Band (n)1 + Band n77 or n78
* Band (n)3 + Band n77 or n78
* Band (n)18 + Band n77 or n78
* Band (n)28 + Band n77 or n78
 |
| China Unicom | Sub topic 2-1: We agree with the proposal that for (n)1+n78 and (n)3+n78 band pairs, DL reception interruption is not required as suggested by China Telecom. |
| OPPO | Issue 2-1: Ok with the proposal, but for the band combinations proposed it should be justified that no interruption can really happen. |
| MediaTek | Sub topic 2-1: For FDD+TDD, we can accept no DL interruption only for listed and agreed CA/EN-DC combinations as long as frequency separation of TDD band is large enough to FDD DL band. Ex:FGAP>200MHz separation when TDD band <=2GHz. FGAP >400MHz when 2GHz <=TDD band <=4GHz. FGAP >800MHz when TDD band >=4GHz.We can accept above combinations mentioned by China Telecom, KDDI and China Unicom with no DL interruption applied. |
| CMCC | Sub topic 2-1: According to the email discussion guidance, interruption should be discussed in another email discussion. It seems that companies start adding band combinations to the list for band pairs with no DL reception interruption. Is the way forward to ask operator to request for their band combinations, and then companies check whether DL reception interruption is allowed or not? At this moment, we would like to propose the following band combinations.* Band (n)3 + Band n41 or n79
* Band (n)8 + Band n41 or n79

But we have concern on this approach to list band combinations. The number of band combinations will be increased very soon if operators start to add their band combinations. In order to complete the work, we should have general solution first. For example, agree on introducing UE capability for DL interruption, and then RAN4 can discuss whether DL interruption is allowed for each band combination or not.  |
| ZTE | Sub topic 2-1: It seems difficult to reach consensus on a generic principle for DL interruption. In this case, we are ok to go for an agreement that DL interruption is not allowed for some specific band combinations, in which there is no DL interruption by nature. |
| Qualcomm | Sub topic 2-1: WF seems a bit unclear. We are ok if we can define DL interruption in RF spec and make it a per band capability. There should not be mandatory non DL interruption per spec but it should be left for implementation discussions.  |
| CHTTL | Sub topic 2-1: We are also interested in the band combinations proposed by China Telecom, but consider there will be other potential combinations proposed in the future, we think it will be good if RAN4 can agree on some general rule, the suggestion from Mediatek seems good to consider. And it seems that the proposed combos so far can achieve no DL interruption, then probably we don’t need to discuss the case when DL interruption is allowed at this stage. |
| vivo | Sub topic 2-1: we prefer option4 i.e. for each FDD+TDD combination, UE report capabilities of DL reception interruption. |
| SoftBank | Sub topic 2-1: In addition to the band combinations already proposed, we are interested in the following combinations at this moment.  Band (n)8 + Band n77 or n78 Band 11 + Band n77 or n78And as already pointed out from some companies, I also have the concern about the treatment of upcoming band combinations. To make the general rule is desirable. |
| Huawei | Sub topic 2-1: It is the consensus that for SUL and TDD + TDD sync cases, as proposed by companies, the switching imposes no DL interruption. For other cases, our view is not to allow any DL interruption for switching capable UE. It is ok to declare not supporting the feature if a UE is not capable of switching without DL interruption.However in the case that DL interruption is allowed by RAN4 on certain band combinations, capability signaling and RRM requirements should be introduced. |
| CATT | Sub topic 2-1: We think option 3 is the same meaning as option 2. We changed the summary a little bit. Propose to consider not allowing interruption or just allowing this feature for band combinations that can avoid interruption for the first step. |
| Apple | Sub topic 2-1: We should firstly have a generic agreement that UE is allowed to have different capability to introduce/avoid the interruption for different band combinations. Secondly, we can further discuss if the interruption is not allowed for certain band combinations. |
| XXX | Sub topic 2-1: Others: |

## Summary for 1st round

### Open issues

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

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

*Suggestion on WF/LS assignment*

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|  | **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*

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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)

## 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”* |

# Topic #3: RF requirements and CR structure

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2000066 | Huawei, HiSilicon | CR to 38.101-1 on UE requirements for switching between 1Tx carrier and 2Tx carrier |
| R4-2000067 | Huawei, HiSilicon | CR to 38.101-3 on UE requirements for switching between 1Tx carrier and 2Tx carrier |
| R4-2000132 | China Telecom | CR to TS 38.101-1: Switching time mask between two uplink carriers in UL CA and SUL |
| R4-2000133 | China Telecom | CR to TS 38.101-3: Switching time mask between two uplink carriers in EN-DC |
| R4-2001428 | Nokia, Nokia Shanghai Bell | CR to TS 38.101-1: Time mask requirements for switching between 1Tx and 2Tx transmissions for inter-band UL CA |
| R4-2001429 | Nokia, Nokia Shanghai Bell | CR to TS 38.101-3: Time mask requirements for switching between 1Tx and 2Tx transmissions for inter-band EN-DC without SUL |

## Open issues summary

### Sub-topic 3-1: CR structure

**Issue 3-1: CR structure**

* Proposals
	+ Option 1: Add the time mask requirements for UL CA and SUL in sub-clause 6.3.3, as seen in R4-2000066 and R4-2000132 (Huawei, China Telecom)
	+ Option 2: Add the time mask requirements for UL CA in sub-clause 6.3A.3, and add the time mask requirements for SUL in sub-clause 6.3C.3, as seen in R4-2001428 (Nokia)
* Recommended WF
	+ FFS based on the inputs from more companies

### Sub-topic 3-2: rank adaptation

**Issue 3-2: Capture of RAN4 agreement on rank adaptation**

* *Agreement in RAN4 #93(R4-1916084)*
	+ *Type of new RF requirement*
		- *Define requiremnet for switching period and transient period, and verify that UE supports switching period being located on either one of the NR FR1 UL carriers (i.e., for UL CA and SUL)*
			* *Define time mask requirement, and no other RF requirements will be defined. RAN1 feedback will be taken into account when defining UE RF requirements.*
	+ *For UE supporting UL Tx switching, it is mandated to support 2-layer UL-MIMO transmission and single-layer transmission on carrier 2 following the BS scheduling and rank adaptation (if rank adaptation is applicable).*
* Proposals
	+ Option 1: Add the support of rank adaptation in RF time mask requirements, as seen in R4-2001428/9 (Nokia)
	+ Option 2: Not add rank adaptation related description in RF time mask requirements (Huawei, China Telecom)
		- Rank adaptation is a Rel-15 baseband feature.
		- No enhancement on rank adaptation is introduced for Tx switching.
* Recommended WF
	+ FFS based on the inputs from more companies

### Sub-topic 3-3: power class

**Issue 3-3: Capture of RAN4 agreement on power class**

* *Agreement in RAN4 #93(R4-1916084)*
	+ *Power class declaration will NOT be changed between case 1 and case 2.*
	+ *Rel-16 power class singling will be followed for Tx switching between case 1 and case 2.*
* Proposals
	+ Option 1: Add the following text in RF time mask requirements, as seen in R4-2001428/9 (Nokia)
		- The UE power class shall be the same for the simultaneous single-layer transmissions with one antenna port on both of the uplink carriers configured on different NR bands and when switching between single-layer transmission with one antenna port and two-layer transmission with two antenna port between the two uplink carriers configured on different NR bands.
	+ Option 2: Not add power class related text in RF time mask requirements (Huawei, China Telecom)
* Recommended WF
	+ Discuss how and where to capture the agreement on power class, including:
		- Whether it is suitable to capture power class in time mask requirements.
		- Suggestions on the wording

## Companies views’ collection for 1st round

### Open issues

|  |  |
| --- | --- |
| **Company** | **Comments** |
| China Telecom | Sub topic 3-1: Either option is ok.Sub topic 3-2: Rank adaption is a fundamental baseband feature in Rel-15. We don’t see the test point by adding rank adaptation in RF CR. To us, signal quality before and after the Tx switching is the main test point here, and adding more aspects in time mask requirements could make the main test point unclear. But since RAN4 #93 made the following agreement related to rank adaptation, we may consider to add the agreement as a note in the time mask requirements.* + *For UE supporting UL Tx switching, it is mandated to support 2-layer UL-MIMO transmission and single-layer transmission on carrier 2 following the BS scheduling and rank adaptation (if rank adaptation is applicable).*

Sub topic 3-3: Ok to add some “clarification” on power class to make the spec clearer. |
| Nokia, Nokia Shanghai Bell | Issue 3-1: UL CA and SUL do not have the same assumptions and same requirements and therefore it is not possible to define common requirements. For UL CA simultaneous UL transmission on both of the two UL carriers has to be possible when there is no UL switching and 2-layer UL MIMO transmission. However, in case of SUL simultaneous UL transmission on both of the carriers is not possible. Furthermore, in case of UL CA UL MIMO could be supported on either of the carriers depending on UE capabilities. However, UL MIMO is not supported for SUL carriers.Issue 3-2: After lengthy discussion in the last RAN4 meeting #93 RAN4 agreed for the UE requirements that “For UE supporting UL Tx switching, it is mandated to support 2-layer UL-MIMO transmission and single-layer transmission on carrier 2 following the BS scheduling and rank adaptation (if rank adaptation is applicable)”. The previous RAN4 requirement related agreement should be respected and this critical requirement should be included to the CR. If the requirement is not captured as normative UE requirements, some UEs may not support 2-layer UL-MIMO with UL switching and without 2-layer UL-MIMO support UL switching would only create significant system performance losses. Furthermore, it is important that signal quality with UL switching is within the requirement performance limits with and without UL-MIMO. Otherwise, system performance would be negatively impacted. Informative note does not ensure any behavior and performance and therefore, we do not see it as a solution for the agreed UE requirements.Issue 3-3: The definition of the UE power class with two port UL-MIMO transmission and EN-DC have been extensively discussed in RAN4 and companies have had different views and understanding. Therefore, we see it important that this requirement as agreed in the WF is captured the UE requirements. Otherwise, it is not possible to know how the UE behaves and performs. |
| OPPO | Issue 3-2: Agree with option 2. No need to add rank adaptation related description in RF time mask requirements since Rel-15 UE RF does not considered this requirement either. If added we need to understand better on how it affects UE RF performance.Issue 3-3: Clarify the power class in spec is ok, but our understanding of the agreement is that there is no new power class signaling introduced for this feature and UE will follow normal power class reporting like one power class for case 1 (EN-DC/CA) and another power class for case 2 (NR UL MIMO). These power classes will not be changed due to the switching. It does not mean case 1 power class shall be same as case 2. For example, in case 1 the typical power capability is LTE 23 + NR 23 and report PC3, while in case 2 the power capability could be NR 23+23 and report PC2. Power class between case 1 and case 2 apparently is not same. Therefore, if clarifications are needed in spec then the common understanding on the agreements shall be achieved first. |
| MediaTek Inc. | Sub topic 3-1: Option 2 is preferred. If option 1 is adopted, time chart for NR UL CA and For NR SUL shall be separated to avoid confusion.Sub-topic 3-3:Option 1 is preferred. Power class not changed between case 1 and case 2 is important agreement. It is suggested to be captured in RF time mask requirements or in the table discussed for listed combinations in Sub topic 2-1. |
| ZTE | Sub topic 3-1: For CRs, we think it would be preferable to have a whole package at a time to introduce the feature into specs, not piece by piece. Sub topic 3-2: We agree with option 2.Sub topic 3-3: We think it is important to explicitly capture the agreement in the specs, and option 1 is preferable. |
| Qualcomm | Issue 3-1: Option 2 is preferred and furthermore after studying the CR’s there maybe be justification for a dedicated suffix for this feature. In any case, it should be clearly written that the requirements are for UE that declares this capability. Issue 3-2: The fundamental motivation for this feature and work is to enable switching between 1Tx and 2Tx so it should be written somewhere that UE that supports this feature (and gets a relaxation compared to existing requirements) shall support UL MIMO for one of the carriers that is part of a band configuration where UE indicates support. Issue 3-3: Option 1 is the one agreed in WF. We should be carefull since some other discussion is proposing to add UL MIMO dedicated power class for rel-16. Also eMIMO work item output is not clear.  |
| CHTTL | Sub topic 3-3: OK to have some clarification text in the spec. |
| Huawei | Sub topic 3-1: Either option is ok.Sub topic 3-2: We prefer Option2.We don’t see a clear and rational justification of having rank adaption mentioned in the time mask requirements. The agreement in R4-1916084 as given under Issue 3-2 is relevant with the UE capability rather than putting any restriction on BS operation in real life. It is not necessary to put rank adaption in anywhere in the spec for the switching requirements in our view.In R4-2001428, it reads that *in addition to the requirements in clause 6.3A.3.3, the time mask requirements in this clause apply for the UE indicating support for the switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on two uplink carriers configured in different NR bands.* On carrier 2, network can configure two ports but use only rank-1. We do not understand why the proponent put such restrictions that only rank-2 is allowed to be configured on carrier 2, i.e., switching between single-layer … and two-layer transmission with two antenna ports on two uplink carriers. In the followed text in R4-2001428, there are a lot of similar statements. It is seen as imposing additional restrictions on the network side.In another paragraph of R4-2001428, it reads that *the UE shall follow the BS scheduling and rank adaptation for switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on the two uplink carriers configured in different NR bands and for transmitting simultaneously with single-layer transmission with one antenna port on both of the two uplink carriers configured in different NR bands*. That is the common UE behaviour specified in RAN1 specifications. Why should we put this redundancy in RAN4 specification?Sub topic 3-3: Group consensus is that it is natural the power class declarations should apply per UE and remain the same between case 1 and case 2. We don’t see why it should be mentioned in the spec.Power class is defined for UE working in single carrier mode, CA, SUL and EN-DC. The Tx switching feature is based on CA, SUL and EN-DC. Is there any particular reason why we should add such clarification in Tx switching section other than in some general section?  |
| Apple | Sub topic 3-1: Option 2 seems more clear since UL CA and SUL may not have the same requirements. Sub topic 3-2: No strong opition. However, if companies believes it is important to clarify, we can have a simple description paragraph on the motivation of this feature. As agreed previously, rank2 UL-MIMO support can be mentioned in that paragraph. Sub topic 3-3: Option 1 is preferred to clarify the power class assumption.  |

### 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 tdoc number** | **Comments collection** |
| R4-2000066, Huawei, HiSilicon | Company A |
| Company B |
|  |
| R4-2000067, Huawei, HiSilicon | Company A |
| Company B |
|  |
| R4-2000132, China Telecom | China Telecom: we will revise our CRs based on the 1st email discussion.  |
| Huawei: it is ok to use this one as the baseline for 38101-1. |
|  |
| R4-2000133, China Telecom | China Telecom: we will revise our CRs based on the 1st email discussion. |
| Huawei: it is ok to use this one as the baseline for 38101-3. |
|  |
| R4-2001428, Nokia, Nokia Shanghai Bell | Huawei: In R4-2001428, it reads that *in addition to the requirements in clause 6.3A.3.3, the time mask requirements in this clause apply for the UE indicating support for the switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on two uplink carriers configured in different NR bands.* On carrier 2, network can configure two ports but use only rank-1. We do not understand why the proponent put such restrictions that only rank-2 is allowed to be configured on carrier 2, i.e., switching between single-layer … and two-layer transmission with two antenna ports on two uplink carriers. In the followed text in R4-2001428, there are a lot of similar statements. It is seen as imposing additional restrictions on the network side.In another paragraph of R4-2001428, it reads that *the UE shall follow the BS scheduling and rank adaptation for switching between single-layer transmission with one antenna port and two-layer transmission with two antenna ports on the two uplink carriers configured in different NR bands and for transmitting simultaneously with single-layer transmission with one antenna port on both of the two uplink carriers configured in different NR bands*. That is the common UE behaviour specified in RAN1 specifications. Why should we put this redundancy in RAN4 specification?Do not need the UE power class clarification in this section, because it should be specified in a general section that when CA, SUL, EN-DC features are used with UL-MIMO or 2Tx the power class applies in every slot, unless there is new RAN4 agreement in the other RF topic which conflict with the agreement in RAN4#93 on UE power class. |
| Company B |
|  |
| R4-2001429, Nokia, Nokia Shanghai Bell | Huawei:Same comments as for previous one. |
| 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”* |