3GPP TSG RAN WG1 #104bis-e R1-21xxxxx

**e-Meeting, April 12th – 20th, 2021**

**Agenda item: 7.2.12**

**Source: Moderator (China Telecom)**

**Title: [104b-e-NR-Rel16-TxSwitching-01] Summary of email discussion on maintenance of Rel-16 uplink Tx switching**

**Document for: Discussion and Decision**

# Introduction

In [1], maintenance issues are summarized for Rel-16 uplink Tx switching. As per the guidance of Chairman, following issues are identified for email discussion/approval during RAN1 #104b e-meeting:

[104b-e-NR-Rel16-TxSwitching-01] Email discussion/approval regarding potential CRs for the following issues

* Issue#1: Correction on RRC parameter “uplinkTxSwitchRequest” in TS 38.214
* Issue#2: Clarification on SRS carrier switching
* Issue#3: Clarification on SRS antenna switching
	+ Whether it is a valid case should be clarified first.
* Issue#4: Clarification on UCI mapping

till 4/16 – Jianchi (China Telecom)

This contribution is the summary of email discussion/approval on maintenance of Rel-16 uplink Tx switching.

# Email discussion (1st round)

## Issue #1: Correction on RRC parameter “*uplinkTxSwitchRequest*” in TS 38.214

R1-2102377 mentioned that the RRC parameter “*uplinkTxSwitchRequest*” is misused in section 6.1.6 in TS38.214.

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| 6.1.6 Uplink switching**< unchanged text omitted>**The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap is indicated by UE capability *uplinkTxSwitchingPeriod*: - If a UE indicated a capability for uplink switching with *~~uplinkTxSwitchRequest~~* *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination- Configured with a MCG using E-UTRA radio access and with a SCG using NR radio access (EN-DC), or- Configured with uplink carrier aggregation, or- Configured in a serving cell with two uplink carriers with higher layer parameter *supplementaryUplink*. the conditions under which the switching gap may be present and the location of the switching gap are defined for each of the cases in clauses 6.1.6.1, 6.1.6.2, and 6.1.6.3 respectively.**< unchanged text omitted>** |

Companies are encouraged to provide views on the above TP.

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| **Company** | **Comments** |
| Huawei, HiSilicon | OK. |
| ZTE | Seems fine.Alternatively, if there is no other approved TP for 38.214, this can be captured in the chairman notes as an editorial change and ask editor to handle this. |
| CATT |  We are fine with FL proposal |
| Intel | We are fine with FL proposal |
| Qualcomm | We are fine with FL proposal |

## Issue #2: Clarification on SRS carrier switching

SRS carrier switching was intensively discussed in RAN1 #104e. Companies acknowledged that some clarification is needed, but no consensus has been achieved. R1-2102491, R1-2103149, R1-2103746 proposed to further discuss this issue in this meeting.

There are two UE behaviours for SRS carrier switching in the spec, i.e., dropping rule and suspension. R1-2102491 stated it is clear that the suspension is only applicable to the source carrier and target carrier. However, it is not clear whether the current dropping rule is applicable to the carrier other than source carrier and target carrier. R1-2102491 proposed the TP to clarify the UE behaviour.

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| **6.2.1.3 UE sounding procedure between component carriers**< -------------------- Other parts are omitted -------------------- >A UE can be configured with SRS resource(s) on a carrier *c1* with slot formats comprised of DL and UL symbols and not configured for PUSCH/PUCCH transmission. For carrier *c1*, the UE is configured with higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier* the switching from carrier *c2* which is configured for PUSCH/PUCCH transmission. During SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR*), the UE temporarily suspends the uplink transmission on carrier *c2*. If the UE is configured with uplink switching with parameter *uplinkTxSwitching* for carrier *c2* and carrier *c3*, during 2-port SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR*), the UE temporarily suspends the uplink transmission on carrier *c3*.< -------------------- Other parts are omitted -------------------- > |

R1-2103746 proposed to clarify the UE behaviours for both dropping rule and suspension and proposed the TPs.

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| **<Unchanged parts are omitted – 38.214>**6.2.1.3 UE sounding procedure between component carriersA UE can be configured with SRS resource(s) on a carrier *c1* with slot formats comprised of DL and UL symbols and not configured for PUSCH/PUCCH transmission. For carrier *c1*, the UE is configured with higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier* the switching from carrier *c2* which is configured for PUSCH/PUCCH transmission. During SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR*), the UE temporarily suspends the uplink transmission on carrier *c2*, and also the uplink transmission on carrier *c3* if the UE is configured with *uplinkTxSwitching-r16* for uplink switching between uplink carrier *c2* and *c3*.**<Unchanged parts are omitted – 38.214>** |

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| **<Unchanged parts are omitted – 38.214>**6.2.1.3 UE sounding procedure between component carriersFor a carrier of a serving cell *d* with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission, denote as the corresponding carrier of a serving cell whose UL transmissions are temporarily suspended as signalled by higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier*. Define the set as the set of carriers of serving cells that meet all the following conditions:- are in the same TAG as .- are in the different band as , and are both configured with *uplinkTxSwitching-r16*.The following prioritization rules shall be applied in case of collision between a transmission of SRS over carrier and transmission of a physical signal/channel over a carrier of a serving cell in set :- the UE shall not transmit SRS whenever SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell and PUSCH/PUCCH transmission carrying HARQ-ACK/positive SR/RI/CRI/SSBRI and/or PRACH on a carrier of a serving cell in set happens to overlap in the same symbol.- the UE shall not transmit a periodic/semi-persistent SRS whenever periodic/semi-persistent SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell and PUSCH transmission carrying aperiodic CSI on a carrier of a serving cell in set happens to overlap in the same symbol.- the UE shall drop PUCCH/PUSCH transmission carrying periodic CSI comprising only CQI/PMI/L1-RSRP/L1-SINR, and/or SRS transmission on a carrier of a serving cell in set configured for PUSCH/PUCCH transmission whenever the transmission and SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell *d* happen to overlap in the same symbol.- the UE shall drop PUSCH transmission carrying aperiodic CSI comprising only CQI/PMI/L1-RSRP/L1-SINR on a carrier of a serving cell in set whenever the transmission and aperiodic SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR)* on the carrier of the serving cell *d* happen to overlap in the same symbol.**<Unchanged parts are omitted>** |

R1-2103149 proposed the following proposals and provided the corresponding TPs.

Proposal 1: In the prioritization for SRS switching considers the state of carriers configured with UL Tx switching jointly. As an example, if SRS switching is configured between CC2 and CC3 then in the prioritization the state of CC1 also needs to be considered if CC1 and CC2 are configured with UL Tx switching.

Proposal 2: Define requirements allowing dropping transmissions on a CC due to SRS transmission on another CC, even if this CC is not configured with SRS switching, as long as the CC is configured with UL Tx switching.

Proposal 3: Choose one of the following options:

* During the SRS transmission on CC3 and the interruption time caused by RF tuning, UE is not expected to be scheduled or configured with other transmission requiring UL Tx switching
* Define rules on the order in which the UE state vs. dropping decisions are being made

Proposal 4: During SRS transmission, CC3 is always treated as two ports, even if one-port SRS resource is configured.

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| 6.1.6.2 Uplink switching for carrier aggregation**<Unchanged parts are omitted>** - The UE is not expected to be scheduled or configured with uplink transmissions that result in simultaneous transmission on two antenna ports on one uplink carrier, and any transmission on another uplink carrier.- If the UE is configured with *SRS-CarrierSwitching,* the UE is not expected to be scheduled or configured with any uplink transmission (including a preceding or succeeding duration ) overlapping with an SRS transmission on a serving cell not configured for PUSCH/PUCCH transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR*), whenever the uplink transmission would be preceded or succeeded by a duration .- In all other cases the UE is expected to transmit normally all uplink transmissions without interruptions.**<Unchanged parts are omitted>** |

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| **<Unchanged parts are omitted>**6.2.1.3 UE sounding procedure between component carriersFor a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission, the UE shall not transmit SRS whenever SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR)* on the carrier of the serving cell and PUSCH/PUCCH transmission carrying HARQ-ACK/positive SR/RI/CRI/SSBRI and/or PRACH happen to overlap in the same symbol and that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]. In evaluating whether the transmission can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability, the UE may assume uplink transmission occurring in all carriers configured for PUSCH/PUCCH transmission, except for the carrier indicated by *srs-SwitchFromCarrier*, and if that carrier is configured with parameter *uplinkTxSwitching*, also the other carrier configured with *uplinkTxSwitching*, for which the UE assumes the actual configured transmissions. For a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission, the UE shall not transmit a periodic/semi-persistent SRS whenever periodic/semi-persistent SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR)* on the carrier of the serving cell and PUSCH transmission carrying aperiodic CSI happen to overlap in the same symbol and that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]. In evaluating whether the transmission can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability, the UE may assume uplink transmission occurring in all carriers configured for PUSCH/PUCCH transmission, except for the carrier indicated by *srs-SwitchFromCarrier*, and if that carrier is configured with parameter *uplinkTxSwitching*, also the other carrier configured with *uplinkTxSwitching*, for which the UE assumes the actual configured transmissions.For a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission, the UE shall drop PUCCH/PUSCH transmission carrying periodic CSI comprising only CQI/PMI/L1-RSRP/L1-SINR, and/or SRS transmission on another serving cell configured for PUSCH/PUCCH transmission whenever the transmission and SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR)* on the serving cell happen to overlap in the same symbol and that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]. In evaluating whether the transmission can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability, the UE may assume uplink transmission occurring in all carriers configured for PUSCH/PUCCH transmission, except for the carrier indicated by *srs-SwitchFromCarrier*, and if that carrier is configured with parameter *uplinkTxSwitching*, also the other carrier configured with *uplinkTxSwitching*, for which the UE assumes the actual configured transmissions. For a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission, the UE shall drop PUSCH transmission carrying aperiodic CSI comprising only CQI/PMI/L1-RSRP/L1-SINR whenever the transmission and aperiodic SRS transmission (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133]) as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR)* on the carrier of the serving cell happen to overlap in the same symbol and that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]. In evaluating whether the transmission can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability, the UE may assume uplink transmission occurring in all carriers configured for PUSCH/PUCCH transmission, except for the carrier indicated by *srs-SwitchFromCarrier*, and if that carrier is configured with parameter *uplinkTxSwitching*, also the other carrier configured with *uplinkTxSwitching*, for which the UE assumes the actual configured transmissions.For an aperiodic SRS triggered in DCI format 2\_3 and if the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeA', and given by *SRS-CarrierSwitching,* without PUSCH/PUCCH transmission, the order of the triggered SRS transmission on the serving cells follow the order of the serving cells in the indicated set of serving cells configured by higher layers, where the UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'. For an aperiodic SRS triggered in DCI format 2\_3 and if the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeB' without PUSCH/PUCCH transmission, the order of the triggered SRS transmission on the serving cells follow the order of the serving cells with aperiodic SRS triggered in the DCI, and the UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'. A UE can be configured with SRS resource(s) on a carrier *c1* with slot formats comprised of DL and UL symbols and not configured for PUSCH/PUCCH transmission. For carrier *c1*, the UE is configured with higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier* the switching from carrier *c2* which is configured for PUSCH/PUCCH transmission. During SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR*), the UE temporarily suspends the uplink transmission on carrier *c2*. If the UE is configured with *uplinkTxSwitching-r16* for uplink switching between *c2* and a third carrier *c3*, the UE may temporarily suspend the uplink transmission on carrier *c3* during the SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR*).If the UE is not configured for PUSCH/PUCCH transmission on carrier *c1* with slot formats comprised of DL and UL symbols, and if the UE is not capable of simultaneous reception and transmission on carrier *c1*and serving cell *c2*, the UE is not expected to be configured or indicated with SRS resource(s) such that SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *srs-SwitchingTimeNR*) would collide with the REs corresponding to the SS/PBCH blocks configured for the UE or the slots belonging to a control resource set indicated by *MIB* or *SIB1* on serving cell *c2*.**<Unchanged parts are omitted>** |

Companies are encouraged to provide views on the proposals in R1-2103149 and proposed TPs in R1-2102491, R1-2103149 and R1-2103746.

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| **Company** | **Comments** |
| Huawei, HiSilicon | Regarding the first change about suspended uplink carrier, we prefer a concise TP like our TP proposed in R1-2103746.Regarding the change about prioritization rules, the “switch-from” carrier is surely involved in prioritization rules together with the “switch-to” SRS carrier, **as shown in the latest LTE specification TS 36.213 for SRS carrier switching and shown in CR R1-1721095.** Therefore, we prefer to keep the same UE behaviour instead of excluding the “switch-from” carrier as the TP proposed in R1-2103149. Additionally, for the intra-band case where the same UE hardware PA shared between the “switch-from” carrier and the intra-band carrier, **the prioritization rules in LTE SRS carrier switching has been extended to the intra-band carrier as in R1-1721095**, and the following agreement,RAN1#90:***Agreement in Principle:****Capture the following in 36.213:** *The “same PA” is implicitly identified by the following. Two “CC with the same PA” are those that:*
	+ *Are in the same band*
	+ *Are in the same TAG*
	+ *Have the same CP*
* *Adopt the following solution for the cases of collision between SRS switching and victim CC:*
	+ *Extend collision rules to victim CC (i.e., the transmission of SRS depends on the information transmitted in the source CC and the victim CC).*

*CR to be prepared for RAN1#90bis.* Similar to the intra-band case, UE hardware are shared between the uplink carrier configured with ULTxswitching, the situation is the same regarding to the prioritization rules, i.e. the uplink carrier sharing the same UE hardware with “switch-from” carrier is also a victim carrier. Therefore, we propose our TP in R1-2103746 with the same text structure as the latest LTE spec for SRS carrier switching. |
| ZTE | We are supportive to clarify this issue. However, as we analysed in our contribution R1-2102491, there are two UE behaviours for SRS carrier switching in the spec, i.e., dropping rule and suspension. It is clear that the suspension is only applicable to the source carrier and target carrier. However, it is not clear whether the current dropping rule is applicable to the carrier other than source carrier and target carrier. Different understandings on this may lead to different TPs. For example, * If the dropping rule (section 6.2.1.3 of TS38.214) can be applied to carriers other than the “source carrier” and “target carrier”, then it seems the current dropping rule can cover the current issue now.
* However, if the dropping rule can NOT be applied to carriers other than the “source carrier” and “target carrier”, namely it can only be applied to “source carrier” and “target carrier”, then TP may be needed. Even in this case, the current spec seems to be conflict with each. Because dropping rule tends to compare the priority between transmissions on “source carrier” and “target carrier”, while suspension seems to say that transmission on “target carrier” is always prioritized and transmission on “source carrier” is always suspended.

We understand that this is not the place to update Rel-15 spec, but we would prefer to clarify this issue and reach common understanding at least for Rel-16 UL Tx switching for this issue here.  |
| CATT | It seems that it is easy way to apply the dropping rule to carriers other than the “source carrier” and “target carrier”. |
| Qualcomm | In response to ZTE’s comments, yes, we do think current spec can’t provide direct & clear guidance on dropping beyond source and target carrier. We need multiple changes other than suspending rules proposed by some other companies, while the example wordings are listed in the annex of R1-2103149.We made some explanation on the issue in our paper but seems other companies may miss some details. We pasted the detailed explanation below for convenience. In general, we think the current text in the spec (below) is ambiguous, and we propose to clarify it at least for UL Tx switching together with SRS carrier switching.

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| TS38.214 - 6.2.1.3The following text is repeated by several times in the same section.“… that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]”.  |

In the following, we give an example where the ambiguity arises.The original intent of the text is to cover cases as the following example: The UE indicates the following CA band combination capabilities: * Band Combination 1:
	+ Band X + Band Y DL CA together with Band X + Band Y UL CA, with 1 UL port in Band X and 2 UL ports in Band Y
* Band Combination 2:
	+ Band X + Band Y DL CA with no UL CA, together with SRS carrier switching with Band X being source and Band Y being target for the switching.

Assume that this UE is being configured with CA and SRS carrier switching according to Band Combination 2. This UE will not require a switching gap for SRS carrier switching, since the simultaneous transmission doesn’t exceed the UEs UL CA capability as indicated in Band Combination 1. On the other hand, another UE that indicates Band Combination 2 capability but not Band Combination 1 capability would require a switching gap. Now consider the following case. The UE indicates the following CA band combination capabilities: * Band Combination 1:
	+ Band X + Band Y DL CA together with Band X + Band Y UL CA, with 1 UL port in Band X and 2 UL ports in Band Y
* Band Combination 3:
	+ Band X + Band Y + Band Z DL CA together with Band X + Band Z UL CA with 1 UL port in Band X and 2 UL ports in Band Z, together with SRS carrier switching with Band X being source and Band Y being target for the switching.

Now assume that this UE is being configured with DL and UL CA according to Band Combination 3. Suppose at a particular time instance, the UE is not configured to transmit in Band Z but is required to transmit PUSCH in Band X and SRS in Band Y at the same time. Strictly speaking, this instance would not exceed the UEs indicated UL CA capability as indicated in Band Combination 1. However, obviously this UE is not capable of simultaneous transmission in Band X and Band Y, since transmit chain(s) are committed to Band Z, even if there is no Band Z transmission is configured at the given instance. Therefore, there is an ambiguity in how to interpret what is exceeding a UEs UL CA capability. We propose to clarify this by adding an explanation that for the purposes of evaluating what exceeds the UEs UL CA capability, transmission on all configured UL CCs need to be assumed, irrespective of whether actual transmission is taking place at a given instance or not. We note that this clarification would be useful for the general case of CA with more than two CCs, but at least it should be clarified for the case of UL Tx switching together with SRS carrier switching involving three carriers. A further discussion point is how many ports should be counted as used for SRS transmission in SRS carrier switching. Obviously, when two-port SRS transmission is performed on CC3, the UE cannot transmit on either CC1 or CC2. It is a further question whether the UE is expected to transmit on CC1 or CC2 when one-port SRS transmission is performed on CC3. We note that when transmitting single-port SRS on CC3, the UE needs to retain the flexibility to transmit SRS from the better antenna port in CC3, where the determination of which port is better is made based on the observation by the UE of the DL signal on CC3. Since the UE must be able to switch relatively dynamically between the CC3 DL antenna ports, neither of the CC3 antenna ports should be considered as flexible, i.e. available for transmission in CC1 or CC2. Therefore, we propose during SRS transmission CC3 is always treated as 2 ports even 1 port SRS resource is configured. |

## Issue #3: Clarification on SRS antenna switching

SRS antenna switching was discussed in RAN1 #104e. Companies have different understandings whether the proposed issue is a valid case.

UL

SRS

SRS and UL

DL

Y symbol

CC1 UL

CC2

DL

Potential conflict w/o clarification

R1-2103149 raised the issue that there is potential conflict due to SRS antenna switching illustrated in the above figure and have following proposal:

* In the Y-symbol gap between SRS transmissions defined by Table 6.2.1.2-1 in 38.214, the UE is assumed to operate with the same number of ports as before and after the gap.

Companies are encouraged to provide views on whether the above issue is a valid case.

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| **Company** | **Yes/No** | **Comments** |
| Huawei, HiSilicon | No | As commented before, we hope the proponent could take our previous comments into consideration, copied below as well.“Regarding issue#3, we don’t agree the case shown in Figure 2 in R1-2103149 is a valid case simply because it has been precluded by current specification either the text about “no more than 1 UL Tx switching per slot” or the text about switching gap much larger than Y=1 symbol. Additionally, the TP proposed in R1-2103149 seems not relevant to the figure and not necessary simply because the SRS resource set of SRS antenna switching has been already restricted with the same number of SRS ports. Without this TP, it has been the same number of ports anyway. Therefore, we don’t feel issue#3 should be discussed again in this meeting. We are open for it if a reasonable TP is provided in future meeting.” |
| ZTE |  | From our perspective, the SRS together with its switching gap are considered as a transmission as a whole. In this sense, this issue can be divided into two sub-cases.Sub-case-1) 2-port SRS on CC2, UE is not expected to be configured/scheduled any UL transmission on CC1 that may be overlapping with this 2-port SRS together with its Y-symbol gap. Sub-case-2) 1-port SRS on CC1, UE can be configured/scheduled 1-port UL transmission on CC1 that may be overlapping with this 2-port SRS together with its Y-symbol gap.It seems one conclusion in the chairman notes could solve this issue, e.g.,*If CC1 and CC2 are configured with UL Tx switching, UE is not expected to be configured/scheduled any UL transmission on CC1 that may be overlapping with 2-port SRS on CC2 together with its Y-symbol gap.*  |
| CATT | No | It isn’t clear to us that why gNB need schedule UL transmission in CC 1 during Ygap in CC2.  |
| Qualcomm | Yes | Thanks for ZTE’s compromise proposal, we agree with the principle.We think this wording is ok for R16 1Tx-2Tx switching but may have issue for R17 2Tx-2Tx case. E.g. 2Tx scheduling on CC1 will cause conflict on CC2 even with 1-port SRS. We understand this is still within R16 scope, but we do want to leave enough flexibility to R17 as we don’t want to have another round discussion on the same issue for R17. From this point, we still prefer our original proposal and leave the dropping rule to the main part of UL Tx switching.In response to Huawei and CATT, we have pasted some parts of our paper to explain the motivation and issue.In the current specification it is not an error case for the gNB to schedule the above scenario. The gNB can schedule transmission overlapping with transients, and the UE is mandated to handle this case (e.g. with cancelling the overlapping transmission). Due to this fact, it is irrelevant whether this is thought to be a “valid case” or “not a valid case”. The only relevant fact is that it is not an error case in the current specification, therefore the gNB can freely schedule transmissions overlapping with the gap and the UE would be required to handle such scheduling events, e.g. by cancelling overlapping transmissions, unless the specification is changed. Furthermore, and more importantly, the UE can be configured with transients to be on CC2, in which case this is not only a valid scenario, but the UE would be required to actually transmit the overlapping transmission in the gap. In our view, it is not appropriate to assume any possible transient within the gap to begin with because the UE in reality still uses the same number of Tx chains in the gap as before and after. Therefore, this overlapping scheduling needs to be treated as an error case, the same as any overlapping transmissions requiring 3 Tx chains. It should not be the UE’s responsibility to filter grants requiring transmissions within the gap.  |

## Issue #4: Clarification on UCI mapping

R1-2103149 raised the issue that UE behaviour is not clear for UCI mapping in the case illustrated in the following figure:



R1-2103149 proposed two options to clarify the UE behaviour:

* Option 1: Error case
* Option 2: Do multiplexing first: multiplex the UCI in CC2, then drop CC2.

Companies are encouraged to provide views on the above issue and proposed options.

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| **Company** | **Comments** |
| Huawei, HiSilicon | Option 2. Because in current spec, as long as the timeline conditions for UCI multiplexing are met, UCI multiplexing is performed. The impact from UL Tx switching has been reflected by increased timeline conditions. If any conclusion would be made, the wording of Option 2 would be better to be rephrased a bit to describe the concerned case more precisely. |
| ZTE | If we understand this issue correctly, the issue is as following, a PUCCH was intended to be multiplexed in PUSCH on CC2. However, the PUSCH needs to be dropped (or partially cancelled) to accommodate the UL Tx switching gap on CC2. In this case, it is not clear whether the PUCCH should still multiplex on this PUSCH.From our perspective, either option is ok. But it seems no spec change is needed. Maybe a clarification in the chairman notes is enough. |
| CATT | We want to clarify this issue. In our understanding, it is possible way that UL Tx switching gap is executed before UCI transmission in CC1 and then UCI needn’t be dropped. In this case, PUSCH in slot#9 needs to be dropped (or partially cancelled). |
| Intel | We think the determination for PUCCH/PUSCH multiplexing should be done without consideration of potential dropping symbols by other criteria.  |
| Qualcomm | From UE perspective, Option 1 would be our first preference as UE can avoid unnecessary check. We are also ok with Option 2 as long as the group can have consensus on Option 2. On CATT’s proposal, our understanding this early switching behaviour is not supported by current specification. By following current spec, UE needs multiplex UCI on PUSCH as the PUCCH resource overlaps with a PUSCH on CC2 (SCC), and UE should not be expected to check any potential drop and make early switching. We propose the WG can clarify the understanding by one of the options above. |

# Email discussion (2nd round)

**FL comments: It seems everyone is fine with proposal 1.**

**Proposal 1:** Adopt the following TP to TS 38.214

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| 6.1.6 Uplink switching**< unchanged text omitted>**The UE may omit uplink transmission during the uplink switching gap if the conditions defined in this clause are met and the UE is configured with *uplinkTxSwitching*. The switching gap is indicated by UE capability *uplinkTxSwitchingPeriod*: - If a UE indicated a capability for uplink switching with *BandCombination-UplinkTxSwitch* for a band combination, and if it is for that band combination- Configured with a MCG using E-UTRA radio access and with a SCG using NR radio access (EN-DC), or- Configured with uplink carrier aggregation, or- Configured in a serving cell with two uplink carriers with higher layer parameter *supplementaryUplink*. the conditions under which the switching gap may be present and the location of the switching gap are defined for each of the cases in clauses 6.1.6.1, 6.1.6.2, and 6.1.6.3 respectively.**< unchanged text omitted>** |

**FL comments: It seems companies have the common understanding that clarification on UE behavior of suspension is needed, while for prioritization/dropping rules, companies still have different understandings on whether the prioritization/dropping rule (section 6.2.1.3 of TS38.214) can be applied to carriers other than the “source carrier” and “target carrier”. FL suggests to focus on clarification on UE behavior of suspension and align the understandings on the prioritization/dropping rule first.**

**Proposal 2:** Adopt the following TP to TS 38.214

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| **<Unchanged parts are omitted – 38.214>**6.2.1.3 UE sounding procedure between component carriersA UE can be configured with SRS resource(s) on a carrier *c1* with slot formats comprised of DL and UL symbols and not configured for PUSCH/PUCCH transmission. For carrier *c1*, the UE is configured with higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier* the switching from carrier *c2* which is configured for PUSCH/PUCCH transmission. During SRS transmission on carrier *c1* (including any interruption due to uplink or downlink RF retuning time [11, TS 38.133] as defined by higher layer parameters *switchingTimeUL* and *switchingTimeDL* of *SRS-SwitchingTimeNR*), the UE temporarily suspends the uplink transmission on carrier *c2*, and also the uplink transmission on carrier *c3* if the UE is configured with *uplinkTxSwitching-r16* for uplink switching between uplink carrier *c2* and *c3*.**<Unchanged parts are omitted – 38.214>** |

Companies are encouraged to provide views on the above proposal.

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| **Company** | **Comments** |
| CATT | We are fine with FL proposal. |
| ZTE | We are generally fine with this TP.  |
| Qualcomm | Thanks for the FL to make the comprise proposal, but I think the target is to enable the combination of UL Tx switching and SRS carrier switching. We would not agree with this particular proposal as the agreement as the important issues below are not identified. Without them, we can’t declare UL Tx switching could work together with SRS carrier switching. Which is even worse is that other people who doesn’t closely follow this topic would think these two features can work together. * According to the current procedures for SRS carrier switching, when the source carrier has PUCCH or PUSCH with UCI transmission, then that transmission is prioritized over periodic SRS. If we wanted to have SRS carrier switching feature supported then this requirement should be maintained, unlike in this proposal. We would not prefer to start to define a different carrier switching procedure just for UL Tx switching.
* There is an ambiguity in how to interpret what is exceeding a UEs UL CA capability as we identified in the Band Combination example. We propose to clarify this by adding an explanation that for the purposes of evaluating what exceeds the UEs UL CA capability, transmission on all configured UL CCs need to be assumed, irrespective of whether actual transmission is taking place at a given instance or not. We note that this clarification would be useful for the general case of CA with more than two CCs, but at least it should be clarified for the case of UL Tx switching together with SRS carrier switching involving three carriers.
* Another point is how many ports should be counted as used for SRS transmission in SRS carrier switching. Obviously, when two-port SRS transmission is performed on CC3, the UE cannot transmit on either CC1 or CC2. It is a further question whether the UE is expected to transmit on CC1 or CC2 when one-port SRS transmission is performed on CC3. We note that when transmitting single-port SRS on CC3, the UE needs to retain the flexibility to transmit SRS from the better antenna port in CC3, where the determination of which port is better is made based on the observation by the UE of the DL signal on CC3. Since the UE must be able to switch relatively dynamically between the CC3 DL antenna ports, neither of the CC3 antenna ports should be considered as flexible, i.e. available for transmission in CC1 or CC2. Therefore, we propose during SRS transmission CC3 is always treated as 2 ports even 1 port SRS resource is configured.
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| Huawei, HiSilicon | support |
| FL | Considering that there is some relevant discussion in [104b-e-NR-7.1CRs -02], FL suggests to wait for the relevant issues are addressed in [104b-e-NR-7.1CRs -02]. |
| Huawei, HiSilicon | In our understanding, the issues listed by Qualcomm is not specific to UL Tx switching but a general issue of SRS carrier switching, therefore, no matter what outcome could be to address those issues, the proposed TP is true. Could Qualcomm please clarify whether the TP is necessary in all cases? |
| CATT3 | We are fine with waiting for the relevant issues are addressed in [104b-e-NR-7.1CRs -02] |
| Qualcomm | Thanks for the FL’s proposal, but we think the thread [104b-e-NR-7.1CRs -02] would only solve intra-band CA case if it got agreed. It would not solve the issue how to evaluate whether the transmission can result in UL transmission beyond the specific UE’s indicated UL capability. We would need at least the following change in Annex of R1-2103149 when SRS switching together with UL Tx switching.* "In evaluating whether the transmission can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability, the UE may assume uplink transmission occurring in all carriers configured for PUSCH/PUCCH transmission, except for the carrier indicated by *srs-SwitchFromCarrier*, and if that carrier is configured with parameter *uplinkTxSwitching*, also the other carrier configured with *uplinkTxSwitching*, for which the UE assumes the actual configured transmissions."

Beyond this and the suspending part, we also propose other two points which would be necessary to enable the feature of SRS carrier switching together with UL Tx switching* During SRS transmission, CC3 (no PUSCH/PUCCH only with SRS) is always treated as 2 ports even 1 port SRS resource is configured.
* UE is not expected to be scheduled or configured with any uplink transmission overlapping with an SRS transmission on CC3 (no PUSCH/PUCCH only with SRS)
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| FL | From FL perspective, it’s pretty good if companies can be flexible and we can make progress. But it seems not the case. For suspension, it seems less controversial and companies tend to converge, but one company has concern. For the dropping rules, it seems quite controversial, companies still have different understandings and there is also some relevant discussion in [104b-e-NR-7.1CRs -02]. So from FL understanding, there can be two choices:Alt 1: focus on clarification on UE behavior of suspensionAlt 2: wait for the relevant issues addressed in [104b-e-NR-7.1CRs -02]. |

Companies are encouraged to answer the following questions:

* Whether the prioritization/dropping rule (section 6.2.1.3 of TS38.214) can be applied to carriers other than the “source carrier” and “target carrier” in current specification?
* Whether the issue of prioritization/dropping rule is a common issue or specific to uplink Tx switching?

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| **Company** | **Comments** |
| CATT | From our perspective, the dropping rule should be applied for carriers other than the “source carrier” and “target carrier” in order to resolve uplink Tx switching issue on multiple carriers.It isn’t clear to us why the dropping rule can’t be applied for carriers other than the “source carrier” and “target carrier”. |
| ZTE | Our understanding is that, the prioritization/dropping rule (section 6.2.1.3 of TS38.214) can be applied to “source carrier” and other carriers as well. In this sense, current specification requires the UE to 1) Perform prioritization/dropping rule between “source carrier” and “target carrier”, and2) Perform suspension on the “source carrier”. The above two UE behaviours seem to conflict with each other. 1) may end up with **prioritizing UL transmission on “source carrier”** while 2) always ends up with suspending transmission on “source carrier” (i.e., **prioritizing UL transmission on “target carrier”**). Is this the common understanding?We are open to hear other companies’ views/understandings on this. If we can reach consensus here, we think it is ok to clarify this issue here at least for UL Tx switching.Besides, we notice that companies are discussing similar issue under [104b-e-NR-7.1CRs -02] in this meeting. It is also fine to wait for the discussion out from that email thread first. |
| Qualcomm | No to first one and yes to second one. More detail explanation could be found in the above response.  |
| Huawei, HiSilicon | As commented before, the dropping rules should cover all victim carriers, as **shown in the latest LTE specification TS 36.213 for SRS carrier switching and shown in CR R1-1721095.**The issue here is specific to uplink Tx switching because the carrier configured with UL Tx switching together with its paired uplink becomes a victim uplink when its paired uplink is also configured with “switch-from” for SRS carrier switching. Here, suggest to discuss first whether it is a victim carrier regardless the outcome of [104b-e-NR-7.1CRs -02].@ZTE the suspension is conditional on the SRS transmission as a winner of the prioritization rules. |
| ZTE | Thanks @Huawei for the further clarification. Then, it is clear that companies have different interpretations on the prioritization/dropping rule for Rel-15 spec now. From our perspective, we can wait for the outcome of [104b-e-NR-7.1CRs -02] first. |
| CATT3 | Ok for waiting for the outcome of [104b-e-NR-7.1CRs -02] |
| Qualcomm | Please refer to the above input. |

**FL comments:** **Regarding SRS antenna switching, companies are encouraged to check whether it is a valid case after Qualcomm’s explanation.**

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| **Company** | **Comments** |
| CATT | Based on Qualcomm’s explanation, the intention is to avoid UE executing filtering grants requiring transmissions within the gap.In this case, one chair note as ZTE mentioned is enough. |
| ZTE | Ok to clarify this issue. Qualcomm’s previous proposal is also fine for us (copied below). In fact, we think our previous proposed conclusion is in line with the following proposal from Qualcomm.* *In the Y-symbol gap between SRS transmissions defined by Table 6.2.1.2-1 in 38.214, the UE is assumed to operate with the same number of ports as before and after the gap.*
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| Qualcomm | Yes. Our 1st preference is our former proposal listed by ZTE above, we are also ok with ZTE’s clarification and the only issue is we would need to re-discuss this for R17. |
| Huawei, HiSilicon | Following Qualcomm’s response, we have read Qualcomm’s paper many times, but we still don’t understand why the current spec is not sufficient to preclude the case,“*It has been precluded by current specification either the text about “no more than 1 UL Tx switching per slot” or the text about switching gap much larger than Y=1 symbol. Additionally, the TP proposed in R1-2103149 seems not relevant to the figure and not necessary simply because the SRS resource set of SRS antenna switching has been already restricted with the same number of SRS ports. Without this TP, it has been the same number of ports anyway.*” |
| CATT2 | From our perspective, proposed TP from ZTE is a little bit different with QC’s proposed TP. Proposed TP from ZTE mentions for CA scenarios, gNB can’t configured/scheduled any UL transmission on CC1 that may be overlapping with 2-port SRS on CC2 together with its Y-symbol gap. Proposed TP from QC mentions UE need operate with the same number of ports as before and after the gap.In addition, HW has a valid point on *It has been precluded by current specification either the text about “no more than 1 UL Tx switching per slot”* (refer to section 6.1.6 of TS38.214)Based on current spec, gNB won’t schedule any UL transmission on CC1 that may be overlapping with 2-port SRS on CC2 together with its Y-symbol gap so this case doesn’t happen. All in all, current spec is clear and proposed TP is unnecessary. |
| FL | It seems there is still no consensus on whether it is a valid case. Could Qualcomm and ZTE clarify the concerns from Huawei and CATT? Otherwise, we may not need to discuss it further. |
| ZTE | @CATT, based on our understanding, if the UE is assumed to operate with the same number of ports as before and after the gap on CC2, then network won’t schedule anything on CC1 that exceeds UE’s Tx capability because this will break/cancel the transmission on CC2. That’s why we think it is the same to say “NB can’t configured/scheduled any UL transmission on CC1…”.But overall, seems majority companies prefer the following potential conclusion. Maybe we can have to try on it.*If CC1 and CC2 are configured with UL Tx switching, UE is not expected to be configured/scheduled any UL transmission on CC1 that may be overlapping with 2-port SRS on CC2 together with its Y-symbol gap.* |
| Huawei, HiSilicon | Don’t see majority of support on ZTE’s proposed conclusion, based on only two companies supporting it. Our questions have never been answered by proponents. Thus the proposed TP or conclusion is not necessary. |
| CATT3 | From our perspective, because this case doesn’t happen based on current spec, the proposed conclusion is not necessary. |
| Qualcomm | We would like to ask CATT and Huawei yet again to kindly indicate which part of the specification prevents the gNB to schedule an SRS that overlaps with the gap. 1. Currently the gap means no transmission, which means 0P and 0T, therefore any overlapping transmission can be scheduled, putting the burden on the UE to filter out and drop the scheduled overlapping transmissions.
2. There is no language in the specification that would prevent the gNB to schedule a transmission that will be damaged by transient periods or gaps. As a matter of fact, there was an explicit agreement made to allow such scheduling and putting the burden on the UE to filter out such transmissions when they occur. We think this is unnecessary and should be prevented for the antenna switching gap case.
3. There are no two switches per slot. Even if a hypothetical presence of switches were to be assumed, the SRS with antenna switching can be on a 15kHz CC in the middle of the 15kHz slot, wherein the two hypothetical switches would fall in two different 30kHz slots, and the overlapping scheduled transmission is on a 30kHz CC. The two hypothetical switches would occur in two different 30kHz slots, therefore nothing in the current specification prevents this scenario.

We don’t understand why we need to spend time on debating hypothetical reasons of saying something is ‘invalid’ when RAN1 made a very explicit agreement to allow scheduling overlapping transmissions in an UL Tx switching gap with putting the burden on the UE to cancel such transmissions. What we propose is to make this an error case, so that the UE doesn’t need to check. Since Huawei and CATT keep saying that there is specification language that says that the UE is not expected to be configured with a transmission overlapping with the antenna switching gap, we again ask Huawei and CATT to point out that language. In particular for the case of 140us gap between two 15kHz SRSs that crosses the boundary of two 30kHz slots, and with a UE having 35us switching gap capability. So far CATT mentioned 38.214 Section 6.1.6, but the two UL Tx switches would be in two different 30kHz slots, therefore 38.214 Section 6.1.6 doesn’t say anything about this case. |

**FL comments: For clarification on UCI mapping, it seems majority companies can accept option 2. Option 2 is rephrased as follows:**

**Proposal 3:**

* For inter-band UL CA, if uplink Tx switching is configured, and if UE is scheduled or configured PUCCH transmission on carrier 1 and 2-port PUSCH transmission on carrier 2 simultaneously, UCI is multiplexed on PUSCH on carrier 2 and the UE is not expected to transmit on any of the two carriers in the switching period.

Companies are encouraged to provide views on the above proposal.

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| **Company** | **Comments** |
| CATT | We are fine with FL proposal. |
| ZTE | Ok with this proposed conclusion. |
| Qualcomm | We are ok with Option 2 and make some revision below.* For inter-band UL CA, if uplink Tx switching is configured and if UE is in Case 2, and if UE is to transmit PUCCH on a PUCCH resource on carrier 1 which is overlapped with PUSCH transmission on carrier 2, UCI is multiplexed on PUSCH on carrier 2 and the UE is not expected to transmit on any of the two carriers in the switching period.
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| Huawei, HiSilicon | The proposal should cover EN-DC and SUL cases, and generic to both carrier 1 and carrier 2. Therefore, we suggest,***Proposal***:*For a UE configured with uplink Tx switching on two uplinks, the determination of UCI multiplexing onto PUSCH between the two uplinks, if any, does not take into account any potential uplink interruption during the switching gap of uplink Tx switching while the determination of triggering an uplink Tx switching takes into account the result of the UCI multiplexing onto PUSCH, if any.* |
| CATT2 | For HW’s proposal, we want to clarify how to implement this proposal for EN-DC case. |
| FL | From FL understanding, there is no UCI multiplexing issue for EN-DC. Regarding “*the determination of triggering an uplink Tx switching takes into account the result of the UCI multiplexing onto PUSCH*” in Huawei’s proposal, UCI multiplexing may have impact on the decision of uplink Tx switching, which seems not aligned with the original issue. FL suggests the revised proposal as follows, including SUL, and both case 1 and case 2.**Proposal 3:*** For inter-band UL CA and SUL, if uplink Tx switching is configured and if the state of Tx chain is 0Tx on carrier 1 and 2Tx on carrier 2, and if UE is to transmit PUCCH on a PUCCH resource on carrier 1 which is overlapped with PUSCH transmission on carrier 2, UCI is multiplexed on PUSCH on carrier 2 and the UE is not expected to transmit on any of the two carriers in the switching period.
* For inter-band UL CA option 1 and SUL, if uplink Tx switching is configured and if the state of Tx chain is 1Tx on carrier 1 and 1Tx on carrier 2, and if UE is to transmit PUCCH on a PUCCH resource on carrier 2 which is overlapped with PUSCH transmission on carrier 1, UCI is multiplexed on PUSCH on carrier 1 and the UE is not expected to transmit on any of the two carriers in the switching period.
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| ZTE | The latest proposal 3 from FL seems ok to us. Our understanding is that this is just a conclusion in chairman note, which has no spec impact. |
| Huawei, HiSilicon | As commented before, the issue to be clarified is independent of the state of Tx chain and which carrier the PUCCH/PUSCH is on. Our proposal has resolved these concerns. So we are not OK with the FL proposal.Regarding “*the determination of triggering an uplink Tx switching takes into account the result of the UCI multiplexing onto PUSCH*”, it is sourced from the original Option 2, the “multiplexing first” and “then drop” in “*• Option 2: Do multiplexing first: multiplex the UCI in CC2, then drop CC2*.” We feel the key message from the Option 2 is the order of two concerned UE processing. If the outcome of UCI multiplexing were not taken into account by UL Tx switching, then concurrent transmissions on two uplinks would have been assumed and caused an error case or error switching of case1-case2. So we don’t see an issue for our proposed text@CATT, we agree with you, EN-DC case is not relevant with NR UCI multiplexing here. Sorry for any confusion. But the text “if any” in our proposal has precluded EN-DC. Hope it could resolve your concern. |
| CATT3 | We are fine with FL proposal#3 |
| Qualcomm | We are supportive to FL’s proposal 3 above. We can’t agree with Huawei’s proposal listed by FL. In option 2 of this issue, we are proposing to keep current UCI mapping rules which doesn’t and would not take UL Tx switching into consideration. In response to “If the outcome of UCI multiplexing were not taken into account by UL Tx switching, then concurrent transmissions on two uplinks would have been assumed and caused an error case or error switching of case1-case2.”, we don’t think concurrent transmission on both UL should be assumed even the UCI mapped to the 2-ports carrier would be dropped due to overlapped with switching period.  |
| FL | To address Huawei’s concern, proposal 3 is revised as follows. **Revised Proposal 3:*** For inter-band UL CA and SUL, if uplink Tx switching is configured, and if UE is to transmit PUCCH on a PUCCH resource on one carrier which is overlapped with PUSCH transmission on the other carrier, UCI is multiplexed on PUSCH on the other carrier first and then the UE is not expected to transmit on any of the two carriers in the switching period.
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# References

1. R1-2103502, Summary of Rel-16 uplink Tx switching, Moderator (China Telecom), RAN1#104bis-e, April 12th – 20th, 2021.
2. R1-2102377, Text Proposals for Tx Switching between Two Uplink Carriers, OPPO, RAN1#104bis-e, April 12th – 20th, 2021.
3. R1-2102491, Remaining Issues of Rel-16 UL Tx Switching, ZTE, RAN1#104bis-e, April 12th – 20th, 2021.
4. R1-2103149, Remaining issues for 1Tx-2Tx switching, Qualcomm Incorporated, RAN1#104bis-e, April 12th – 20th, 2021.
5. R1-2103746, Discussion on the remaining problems of supporting Tx switching between two uplink carriers, Huawei, HiSilicon, RAN1#104bis-e, April 12th – 20th, 2021.