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

**e-Meeting, January 25th – February 5th, 2021**

**Agenda item: 7.2.12**

**Source: Moderator (China Telecom)**

**Title: [104-e-NR-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 #104 e-meeting:

[104-e-NR-TxSwitching-01] Email discussion/approval on corrections regarding – till 1/29, Jianchi (China Telecom)

* Issue#1: Clarification on the ambiguity issue on SCS in TS 38.214
* Issue#2: Align the RRC parameters in TS 38.214 with TS 38.331
* Issue#3: Clarification on the Maximum data rate in TS 38.306
* Issue#4: Clarification of Tswitch in TS 38.213
* Issue#6: Clarification on the state of Tx chains for SRS antenna switching

and how to handle the following proposal (as a conclusion in Chairman’s notes?)

* For Rel-16 inter-band UL CA, SUL and EN-DC, if uplink Tx switching is configured on two uplinks, the case where SRS carrier switching is configured on a third uplink is not supported.
  + No spec impact.

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

# Discussion

## Issue#1: Clarification on the ambiguity issue on SCS in TS 38.214

This issue has been discussed for several meetings, but no progress has been made.

The last version of TP in RAN1#103e is as follows:

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| 6.1.6 Uplink switching  **< unchanged text omitted>**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max (*µUL,1, µUL,2*), where the *µUL,1* corresponds to the subcarrier spacing of the active UL BWP of one uplink transmitted before the switching gap and the *µUL,2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink transmitted after the switching gap.  **< unchanged text omitted>** |

In this meeting, R1-2100087 provided two alternatives:

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| **TP Alt.1**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier. |

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| **TP Alt.2**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier after the switching gap and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier after the switching gap. |

Companies are invited to provide views on the above TPs.

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| **Companies** | **Comments** |
| CATT | Ok with TP Alt.1, but not TP Alt.2. |
| QC | We are ok with the proposal, slightly preferring Alt.1 |
| ZTE | Currently, the spec is ambiguous due to the following two reasons.  (1) The “subcarrier spacing of the uplink transmitted before the switching gap” or “subcarrier spacing of the uplink transmitted after the switching gap” refer to the SCS of the uplink transmission. In case of PRACH, the SCS of uplink transmission can be different from the SCS of the active UL BWP.  (2) For CA Option2, there can be 1-port transmissions on both carrier1 and carrier2 simultaneously before the switching gap (or after the switching gap). In this case, it is not clear whether the “the subcarrier spacing of the uplink transmitted before the switching gap” (or “the subcarrier spacing of the uplink transmitted after the switching gap”) refers to SCS of carrier1 or SCS of carrier2.  TP Alt.1 can solve all the ambiguity issues, which is our preference.  TP Alt.2 can further clarify whether SCS before BWP switching or after BWP switching is applied if the DCI triggers an UL Tx switching and BWP switching at the same time. Take Figure 2 as an example, assuming currently UE is in Case1 (i.e., the preceding transmission is a 1-port transmission on carrier1), UE receives a DCI scheduling a 2-port PUSCH, which triggers UL Tx switching from case1 to case2 and triggers active UL BWP change with numerology change from u1 to u2. In this example, if we delete “transmitted before the switching gap” and “transmitted after the switching gap” in the spec, it is not clear how to determine *µUL* = max(*µUL, 1, µUL, 2*).    **Figure2**. A DCI triggers UL Tx switching and UL BWP switching simultaneously.  Note that TP Alt.2 doesn’t change legacy SUL and CA Option1 behaviour. Take Figure2 as an example, the calculation result of the current spec and TP Alt.2 are the same. |
| Huawei, HiSilicon | Not OK with TP Alt.2 because it changes the UE behavior quite much by changing “before” to “after”.  TP Alt.1 has been discussed for long time, it seems still unclear why the TP is essential. The propoent seems to find one issue only for the case of UL-CA Option 2 which is illustrated in figure 1 of R1-200087. However, the subcarrier spacing of carrier 1 is still unchanged before and after the switching gap because of no transmission on carrier 1 and thus the current spec text is clear enough.  Additionally, just remind that the TP Alt.1 does not highlight all changes, and have more changes as it shows now, e.g. “after the switching gap” is deleted.  Therefore, sorry to say we are not OK with the change. |
| Ericsson | OK with Alt 1. |
| FL | This issue has been discussed for several meetings. It seems the majority can accept TP Alt. 1 from R1-2100087 and FL understands the ambiguity may happen in some cases. Thus, FL proposes to adopt TP Alt. 1 from R1-2100087 to TS 38.214.  **< unchanged text omitted>**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier.  **< unchanged text omitted>** |
| ZTE2 | We support the FL proposal.  Regarding Huawei’s comments above on TP Alt.2, we don’t think the UE behavior has been changed. If the UE behavior has been changed, could you please give an example case to shown in which case the calculation result of*µUL* = max(*µUL, 1, µUL, 2*) would change because of TP Alt.2 compared with the existing specification?  Anyway, it seems most companies support the FL proposal. Regarding Huawei’s comment for TP Alt.1, if I recall correctly, we have discussed the ambiguity issue of the current specification clearly in last meeting. I don’t understand why you are claiming the spec is clear enough now. But anyway, I would try to clarify this issue again as below.  For CA Option2, for the left figure below, 1P+1P (Case1) 🡪 0P+2P (Case2), it is ambiguous which transmission is the “uplink transmitted before the switching gap”? For the right figure below, 0P+1P (Case1) 🡪 0P+2P (Case2), the SCS of the “uplink transmitted before the switching gap” and SCS of the “uplink transmitted after the switching gap” refers to the SCS of the same carrier, is this the intention of our previous agreements? **Could you please provide your understandings for the two questions if you are claiming the current spec is clear?**    **Figure1**. Ambiguity issues of current spec description.  The existing spec.   |  | | --- | | The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the uplink transmitted before the switching gap and the *µUL, 2* corresponds to the subcarrier spacing of the uplink transmitted after the switching gap. |   Regarding your comment “*Additionally, just remind that the TP Alt.1 does not highlight all changes, and have more changes as it shows now, e.g. “after the switching gap” is deleted.* ”, I checked our TP Alt.1 again and we didn’t notice which part we forgot to highlight in our TP. “after the switching gap” is deleted and is clearly showed in our TP. |
| Huawei, HiSilicon | We cannot agree on FL’s proposal for the reasons explained above. We could reiterate them as below.  Firstly, could we suggest that we start with what we left before in order to avoid repeated discussion like the questions you raised above? To be specific, since RAN1#102e meeting, after we discussed the same TP Alt1 above, we have converged to your proposal copied below. We believe it can resolve your concern. Unfortunately, every meeting, you brought back the exact TP alt1 to start from scratch, which make us miss what has not been solved.  **Revised proposal 3: (Updated by ZTE)**    Adopt the following TP to TS 38.214.   |  | | --- | | 6.1.6   Uplink switching  **< unchanged text omitted>**  The UE does not expect to perform more than one uplink switching in a slot withµUL= max(µUL,carrier1, µUL,carrier2),where theµUL,carrier1 corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier ~~uplink transmitted~~before the switching gap and the µUL,carrier2 corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier~~uplink transmitted~~after the switching gap.  **< unchanged text omitted>** | |
| ZTE3 | Thanks Huawei for providing the previous discussed CR. We keep bring new TPs here since companies keep objecting the previous discussed TPs.  But anyway, if you are fine with the “**Revised proposal 3: (Updated by ZTE)**” cited in your response, we are also fine with it. |

**FL proposes to make down selection on the following two alternative TPs.**

**Proposal 1:** Make down selection on the following two alternative TPs.

* Alt 1: adopt the following TP to TS 38.214

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| 6.1.6 Uplink switching  **< unchanged text omitted>**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier.  **< unchanged text omitted>** |

* Alt 2: adopt the following TP to TS 38.214

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| 6.1.6 Uplink switching  **< unchanged text omitted>**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max (*µUL,1, µUL,2*), where the *µUL,1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier ~~transmitted~~ before the switching gap and the *µUL,2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier ~~transmitted~~ after the switching gap.  **< unchanged text omitted>** |

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| Huawei, HiSilicon | We are fine with Alt 2. But don’t see necessity of additional changes that Alt 1 got on top of Alt 2. |
| ZTE | Thanks FL for the effort. Although our preference is Alt.1, we can also accept Alt.2. |
| QC4 | If Alt 2 doesn’t delete two “transmitted”, We are fine with both alternatives. We made similar comments in RAN1 103e and I paste below for your convenience.  Strictly speaking, Alt 2 also works but it is expected to raise questions what a carrier before the gap or carrier after the gap are once the word “transmitted” is deleted. Both UL carriers (or more than two UL carriers for UL CA with >2 UL CCs) are by definition both before and after the gap. Therefore, the way of selecting one or another is unclear. |

## Issue#2: Align the RRC parameters in TS 38.214 with TS 38.331

R1-2100117 proposed the following TP to align the RRC parameters of TS 38.214 and TS 36.331.

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| 1. 6.1.6.1 Uplink switching for EN-DC   **< unchanged text omitted>**  - when the UE is configured with *tdm-PatternConfig-r15* or by *~~tdm-PatternConfig-r16~~ tdm-PatternConfig2*  - for the E-UTRA subframes designated as uplink by the configuration, the UE assumes the operation state in which one-port E-UTRA uplink can be transmitted.  - for the E-UTRA subframes other than the ones designated as uplink by the configuration, the UE assumes the operation state in which two-port NR uplink can be transmitted.  **< unchanged text omitted>** |

Companies are invited to provide views on the above TP.

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| **Companies** | **Comments** |
| QC | We think this could be moved to the NR-DC maintenance A.I. |
| ZTE | Ok with the change. According to chairman’s guidance, company can directly indicate this alignment change to editor. |
| Huawei, HiSilicon | OK |
| Ericsson | Agree with QC as the update may be needed in other places in the spec. |
| FL | It seems this is a generic issue for EN-DC. Suggest the proponent to bring up this TP to the NR-DC maintenance A.I. or to the editor. |

## Issue#3: Clarification on the Maximum data rate in TS 38.306

R1-2101445 proposed to adopt the following revision of the note for the maximum data rate.

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| NOTE 2:  For UL Tx switching ~~between carriers in cell(s)~~, only the supported MIMO layer combination ~~across carriers~~ that results in the highest combined data rate is counted for the cell(s) in the supported maximum UL data rate. |

R1-2101554 proposed to adopt the following revision of the note for the maximum data rate.

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| NOTE 2:  For UL Tx switching between two cells, only the supported MIMO layer combination across the two cells that results in the highest combined data rate is counted for those cells in the supported maximum UL data rate. |

Companies are invited to provide views on the above TPs.

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| **Companies** | **Comments** |
| CATT | The TP from R1-2101445 is more generic and covers the case that more than two cells are configured with UL Tx switching. |
| QC | The intention of max data rate discussion is for UL CA where one carrier is corresponding to one cell. We suggest removing the highlighted part above to avoid the misunderstanding. SUL allows more than one carrier in one cell, but there is a dedicated note for SUL to clarify only one carrier is considered in any case which is pointed out by R1-2101554 as well.  Either of the above two proposals is acceptable to us. |
| ZTE | Ok with TP from R1-2101445. |
| Huawei, HiSilicon | It looks unnecessary to change the current general description “cells” into “two cells” as proposed in R1-2101554 because it has been agreed in Rel-17 WI to introduce the third cell, an intra-band cell. It also looks unnecessary to have the change proposed in R1-2101445 because the current text “cell(s)” with plural form have clearly incorporated CA case as the proposal required, i.e. the motivation has been fulfilled already. |
| Ericsson | We prefer to clarify the spec as the existing text can lead to misunderstanding. While we prefer the TP in R1-2001554, we are also OK with the TP in R1-2101445. |
| FL | The majority are fine with the TP from R1-2101445. In addition, it seems Huawei is basically fine with the revision as well, but has concern on the necessity. From FL perspective, the TP from R1-2101445 can address the concerns from QC and Ericsson, while it is not restricted to two cells, which means it keeps forward compatibility for Rel-17. Thus, FL proposes to adopt the TP from R1-2101445 to TS 38.306.  NOTE 2:  For UL Tx switching ~~between carriers in cell(s)~~, only the supported MIMO layer combination ~~across carriers~~ that results in the highest combined data rate is counted for the cell(s) in the supported maximum UL data rate. |
| Huawei, HiSilicon | We are not OK with the FL proposal. Last meeting we have explained why “across carriers” and “between cells” as copied below for your convenience, thus we are not OK to revert these two agreed parts.  Regarding the TP for TS 38.306, two points can be clarified,   * The MIMO layer combination means the combination of MIMO-layer on different carriers instead of the combination of MIMO-layer on only single carrier for different slots. * There is already formula to calculate maximum date rate for the cells that are not configured with UL Tx switching, which are not changed or redefined by the NOTE 2. For example, A, B, C, D cells, only two cells A and B are configured with UL Tx switching, then max date rate of C, D cells are calculated based on existing text.   More importantly, the concerns of proponents have been solved by the plural term “cell(s)” in the agreed text. |

**FL’s comments: It seems companies have different understandings on “carriers” and “cells”. Suggest to keep “carriers” and delete “cells” to address the concerns.**

**Proposal 2:**

* Adopt the following TP to TS 38.306

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| 4.1.2 Supported max data rate **< unchanged text omitted>**  NOTE 2:  For UL Tx switching between carriers ~~in cell(s)~~, only the supported MIMO layer combination across carriers that results in the highest combined data rate is counted for the carriers ~~cell(s)~~ in the supported maximum UL data rate.  **< unchanged text omitted>** |

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| QC4 | We are supportive to FL’s proposal. |
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## Issue#4: Clarification of *Tswitch* in TS 38.213

R1-2101738 proposed the following TP to TS 38.213.

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| 9.2.5 UE procedure for reporting multiple UCI types  **< unchanged text omitted>**  - if there is an aperiodic CSI report multiplexed in a PUSCH in the group of overlapping PUCCHs and PUSCHs, is not before a symbol with CP starting after after a last symbol of  - any PDCCH with the DCI format scheduling an overlapping PUSCH, and  - any PDCCH scheduling a PDSCH, or SPS PDSCH release, or providing a DCI format 1\_1 indicating SCell dormancy, or a DCI format 1\_1 indicating a request for a Type-3 HARQ-ACK codebook report without scheduling PDSCH, with corresponding HARQ-ACK information in an overlapping PUCCH in the slot  where corresponds to the smallest SCS configuration among the SCS configuration of the PDCCHs, the smallest SCS configuration for the group of the overlapping PUSCHs, and the smallest SCS configuration of CSI-RS associated with the DCI format scheduling the PUSCH with the multiplexed aperiodic CSI report, and for , for and for . is defined in [6, TS 38.214] and it is applied only if of table 5.4-1 in [6, TS 38.214] is applied to the determination of .  - , , , , , and are defined in [6, TS 38.214], and and are defined in [4, TS 38.211].  **< unchanged text omitted>** |

Companies are invited to provide views on the above TP.

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| **Companies** | **Comments** |
| QC | We are ok with this proposal. |
| ZTE | Ok with the change. |
| Huawei, HiSilicon | Support |
| Ericsson | OK |
| FL | Seems the above TP is agreeable. |

## Issue#6: Clarification on the state of Tx chains for SRS antenna switching

**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 invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| CATT | Ok with the proposal. |
| QC | The Y-symbol gap is in-between the SRS resources of the SRS resource set and the UE shall expect to be configured with the same number of SRS ports for all SRS resources in the SRS resource set(s) with higher layer parameter *usage* set as 'antennaSwitching'. To be consistent with the current spec, the UE should be assumed to operate with the same number of ports as before and after the gap with UL Tx switching. |
| ZTE | Ok with the proposal. |
| Huawei, HiSilicon | Firstly, some clarification is needed for “the gap” in “as before and after the gap” in the proposal. Does it refer to the Y-symbol gap in the proposal or the gap of UL Tx switching? Currently, it seems to refer to the Y-symbol gap, which makes the proposal addressing a pure MIMO issue that is supposed to be discussed in MIMO session. If the gap refers to the latter, then there are two switching gaps since the concerned SRS are supposed to transmitted on the same carrier. Then which gap are the proposal referring to?  Secondly, it is unclear why the proposal is needed and what spec impact could be. Because in all cases of 1T2R, 2T4R and 1T4R, the same number of SRS ports are configured in one SRS resource set. When a SRS resource set is triggered, the same number of SRS ports have been required for transmission. Therefore, what kind of spec impact is being expected? |
| FL | Suggest Qualcomm answer the questions from Huawei.  If possible, suggest Qualcomm provide the corresponding TP. |
| QC2 | Thanks for the note and here is the further clarification. The intention here is to clarify what UL switching state is associated with the Y-symbol gap between SRS transmissions defined by Table 6.2.1.2-1 in 38.214. therefore, this is not a pure MIMO issue.  The proposal is to clarify what the UE’s switching state is in the Y symbol gap between SRS transmissions. In this symbol(s) the UE is not transmitting on the CC with SRS. However, in order to determine the UE’s state for UL switching purposes, the UE must be assumed not as having no transmission but rather as having the same SRS transmission as before and after the gap. We feel this is straightforward to agree on. Without this agreement, the UE could be required to switch away during the Y symbol gap, which is obviously the UE is not capable of doing in the general case.  UL  SRS  SRS and UL  DL  Y symbol  CC1 UL  CC2  DL  Potential conflict w/o clarification |
| Huawei, HiSilicon | Thank Qualcomm very much for your figure to illustrate the issue.  The length of Y symbols as table below is smaller than 71.5us, which is not sufficient for a symbol on uplink 1 plus two gaps UL Tx switching. Therefore, the scheduling shown in the figure above is not a valid case for UL Tx switching in current spec.  Table 6.2.1.2-1: The minimum guard period between two SRS resources of an SRS resource set for antenna switching   |  |  |  | | --- | --- | --- | |  |  | *Y* [symbol] | | 0 | 15 | 1 | | 1 | 30 | 1 | | 2 | 60 | 1 | | 3 | 120 | 2 | |
| QC3 | Thanks Huawei & HiSilicon to dig out the requirements of Y Symbol.  Perhaps we can add more details to explain the scenario better. What we have in the current specification is that 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 this fact, we disagree with Huawei’s view that this is “not a valid case”.  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.  Hope this explains the background better. |
| Huawei, HiSilicon | Thank Qualcomm for follow-ups.  We still don’t understand how this case illustrated in your figure is valid. The maximum duration of Y symbol is 71.5 us and is not even big enough for two minimum gaps of UL Tx switching (35us). If any scheduling on carrier#1, then the UL interruption on carrier#2 must be larger than 35\*2 us + 1 symobl of carrier#1, which means some SRS symbols in the second blue block in your figure should be interrupted. |
| QC4 | Thanks Huawei & HiSilicon for the follow up response.  It seems there is a difference between views on what ‘valid’ and ‘not valid’ means. Let’s try to explain it better:   * ‘X is not a valid scenario’ if there is a statement in the specification saying, “The UE is not expected to be scheduled in scenario X”. In this case, it is completely up to the UE how to respond, including but not limited to disconnecting the call, failing RAN4 requirements, etc. The UE is not required to implement any algorithm for collision check. * ‘X is a valid scenario’: There is no specification statement saying, “The UE is not expected to be scheduled…”. In this case the UE is required to expect and gracefully handle scenario X, for example by implementing an algorithm for collision check and partial/full cancellation.   Since there is no statement in the specification saying that the UE is not expected to be scheduled in a switching period, \*the figure is a valid scenario\*.  Huawei is saying that some of the transmissions will be interrupted. That is exactly what we find not acceptable. That scheduling should not happen in the first case, so that the UE is not required to interrupt or cancel anything. Note that this is already the case if there was any scheduled transmission on CC1 overlapping with the CC2 SRS. The same thing should be extended to the gap.  It is not relevant if the UE ends up transmitting something or not. What is relevant whether the UE is required to have collision check and UL cancellation in order not to transmit.  The motivation here is quite clear in our last response which is labeled as “QC3”, which is the same as avoid the error case caused by any overlapping transmission requiring 3Tx chains. To move the discussion forward, we would like to provide the Text Proposal below. 6.1.6.2 Uplink switching for carrier aggregation **< unchanged text omitted>**  If the UE is configured with uplink switching with parameter *uplinkTxSwitching*, when the UE is to transmit in the uplink based on DCI(s) received before or based on a higher layer configuration(s):  - When the UE is to transmit a 2-port transmission on one uplink carrier and if the preceding uplink transmission is a 1-port transmission on another uplink carrier, then the UE is not expected to transmit for the duration of on any of the two carriers.  - When the UE is to transmit a 1-port transmission on one uplink carrier and if the preceding uplink transmission is a 2-port transmission on another uplink carrier, then the UE is not expected to transmit for the duration of on any of the two carriers.  - For the UE configured with *uplinkTxSwitchingOption* set to 'switchedUL', when the UE is to transmit a 1-port transmission on one uplink carrier and if the preceding uplink transmission was a 1-port transmission on another uplink carrier, then the UE is not expected to transmit for the duration of on any of the two carriers.  - For the UE configured with *uplinkTxSwitchingOption* set to 'dualUL', when the UE is to transmit a 2-port transmission on one uplink carrier and if the preceding uplink transmission was a 1-port transmission on the same uplink carrier and the UE is under the operation state in which 2-port transmission cannot be supported in the same uplink carrier, then the UE is not expected to transmit for the duration of on any of the two carriers.  - For the UE configured with *uplinkTxSwitchingOption* set to 'dualUL', when the UE is to transmit a 1-port transmission on one uplink carrier and if the preceding uplink transmission was a 1-port transmission on another uplink carrier and the UE is under the operation state in which 2-port transmission can be supported on the same uplink carrier, then the UE is not expected to transmit for the duration of on any of the two carriers.  - 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.  - the UE is assumed to operate with the same number of ports as before and after the gap in the Y-symbol gap between SRS transmissions defined by Table 6.2.1.2-1.  - In all other cases the UE is expected to transmit normally all uplink transmissions without interruptions.  **< end of TP>** |

## Discussion on the conclusion on CA based SRS switching

**Proposed conclusion:**

* For Rel-16 inter-band UL CA, SUL and EN-DC, if uplink Tx switching is configured on two uplinks, the case where SRS carrier switching is configured on a third uplink is not supported.
  + No spec impact.

Companies are invited to provide views on the above proposal.

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| **Companies** | **Comments** |
| CATT | We would like to understand the proposal more. A UE configured with UL Tx switching on CC1 and CC2, are configured with SRS carrier switching between CC3 and CC4. The proposed conclusion ruled out such configuration. Is that the intention? |
| QC | R1-2101445 lists 3 examples of possible conflict cases. We propose RAN1 to discuss these cases and make corresponding spec updates to enable UL Tx switching together with SRS carrier switching.  Again, in case companies have objections to discussing this feature then we would kindly request an agreement, to be captured in the specification, saying that SRS carrier switching is not supported together with UL Tx switching in any version of switching (CA, EN-DC, SUL).  In that case, the agreement text should be the following:  For Rel-16 inter-band UL CA, SUL and EN-DC, if uplink Tx switching is configured on two uplinks, the case where SRS carrier switching is configured to/from either of those two uplinks from/to any other uplink is not supported. |
| ZTE | We are ok to discuss the examples listed in R1-2101445.  If Tx switching and SRS carrier switching are not operated simultaneously, we are open to consider whether they cannot be operated dynamically or semi-statically. |
| Huawei, HiSilicon | Thank you for the proposal.  Suggest proponent to clarify what the issue/motivation is to rule out such configuration.  Could proponent clarify which CC is configured with “switch-from” for the SRS carrier switching in the example “For example, during the SRS transmission on CC3 and the interruption time caused by RF tuning, CC2 is not expected to be scheduled or configured with 2-port transmission, or CC1 is not expected to be scheduled or configured with 1-port transmission.”?  In our understanding, it is not the best interest of 3GPP to conclude exclusive relationship between two features UL Tx switching and SRS carrier switching. Additionally, the issue in R1-2101445 is not clear enough to make such conclusion, and has no corresponding TP/CR. Therefore, we don’t feel such conclusion is needed. But we are open for further discussion. Thanks! |
| FL | Suggest Qualcomm answer the questions from Huawei. |
| QC | This is the second meeting that we are submitting proposed solutions for the simultaneous operation of UL Tx switching and SRS carrier switching. It seems that there is little interest to address these proposals. Therefore, it is time to conclude whether the feature of SRS Carrier switching and UL TX switching are supported together or not.  To clarify the example scenarios once more, it is the following:  The UE is configured with CA, SUL or EN\_DC   * CC1 supports 1Tx * CC2 supports 2Tx * CC3 is DL only (no PUSCH is configured in CC3)   UL Tx switching is configured between CC1 and CC2.  SRS carrier switching is configured between CC2 and CC3, where CC2 is the “source”, i.e. “switch from” carrier and CC3 is the “target”, i.e. “switch to” carrier. The UE is configured with 2-port SRS resource on CC3.  The UE receives an aperiodic SRS trigger to transmit on CC3 and a dynamic grant on CC1 to transmit PUSCH on CC1 at the same time. The current specification requires the UE to perform the two transmissions (SRS on CC3 and PUSCH on CC1) simultaneously. The UE is obviously not capable of complying with this requirement because it has two Tx chains, not three.   * The specification is broken   Again, since there has not been any feedback on how to fix this, it is time to decide whether the two features are supported together. If not, no more discussion is necessary.  UL  DL  DL  RF tuning  CC1  UL  CC2  DL  SRS  DL  CC3  RF tuning  UL  SRS carrier switching |
| Huawei, HiSilicon | Thank Qualcomm very much for the figure.  To address this issue, referring to the spec text for SRS carrier switching, we propose,  ***Proposal****: For a UE configured with uplinkTxSwitching-r16 for uplink Tx switching between uplink#1 and uplink#2, if the UE is also configured for SRS transmission on uplink#3 with higher layer parameter srs-SwitchFromServCellIndex and srs-SwitchFromCarrier indicating either uplink#1 or uplink#2, then during SRS transmission on uplink#3 and its associated preceding and succeeding RF retuning time, the UE temporarily suspends the uplink transmission on both the uplink#1 and uplink#2.*  Please check whether it can address your concerns.  A CR is coped for discussion,  TS 38.214  **<Unchanged parts are omitted>**  6.1.6 Uplink switching  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* 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.  If an uplink switching is triggered for an uplink transmission starting at *T0*, after *T0-Toffset*, the UE is not expected to cancel the uplink switching, or to trigger any other new uplink switching occurring before *T0* for any other uplink transmission that is scheduled after *T0-Toffset*, where *Toffset* is the UE processing procedure time defined for the uplink transmission triggering the switch given in clause 5.3, clause 5.4, clause 6.2.1, clause 6.4 and in clause 9 of [6, TS 38.213].  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the uplink transmitted before the switching gap and the *µUL, 2* corresponds to the subcarrier spacing of the uplink transmitted after the switching gap.  For a UE configured with uplinkTxSwitching-r16 for uplink switching between two uplinks, if the UE is also configured for SRS transmission on a third uplink with higher layer parameter *srs-SwitchFromServCellIndex* and s*rs-SwitchFromCarrier* indicating one of the two uplinks configured for uplink switching, then during SRS transmission on the third uplink and its associated preceding and succeeding RF retuning time, the UE temporarily suspends the uplink transmission on both the uplinks configured for uplink switching*.*  **<Unchanged parts are omitted>** |
| QC3 | Thanks Huawei & HiSilicon’s response and efforts on trying to address this issue.  It’s good to see the discussion, even though we would not agree with the particular proposal for the following reasons:   * When the UE performs single Tx SRS transmission on CC3, it should be supported, at least as a capability, that it transmits single Tx transmission on either CC1 or CC2 at the same time. * 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 the Huawei proposal. We would not prefer to start to define a different carrier switching procedure just for UL Tx switching. * Have not discussed or defined what ‘temporarily suspends’ means. Does it mean the UE transmits the non-overlapping parts? That would be different for the existing SRS carrier switching requirement, and again we would prefer not to define unaligned new requirements and procedures. * If we were to introduce a requirement on ‘temporary suspension’, we would have to define timeline requirements, especially for the case of aperiodic triggered SRS transmission on CC3. * It is unclear what the UE requirement is if the transmission that is ‘temporarily suspended’ requires the UE to switch its RF state (i.e. Case 1 vs. Case 2). Do we assume that state change to have taken effect or not?   We will appreciate if the group is willing to discuss and solve these issues. As the 1st step, we propose to discuss and agree on the principles for the 3 examples listed in R1-2101445.  Firstly, 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.  Secondly, 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.  Thirdly, the group should consider choosing one of the following options. We slightly prefer option 1.   * Option 1: 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 * Option 2: Define rules on the order in which the UE state vs. dropping decisions are being made |
| Huawei, HiSilicon | Thank Qualcomm for follow-ups. Our responses bullet by bullet are the following,   * We feel current UE capability reporting of SRS carrier switching have supported such differentiation. Could you elaborate what is missing, with a TP or something? * Yes, the current prioritization rule for SRS carrier switching is retained which is in line with our CR and have no change to it. Which part of our CR provides a different procedure rather than matching up with the change required by your figure? * “temporarily suspends” is the current term in spec descripting SRS carrier switching. * The timeline of SRS carrier switching is already in current spec. Our CR has no change to it. What change on timeline do you want? * During the gap caused by SRS carrier switching with “temporarily suspends”, the UE RF state is for transmitting SRS on carrier#3, so it is neither Case1 nor Case2 that have RF on carrier#1 or carrier#2. We don’t see additional spec impact on this part. If any, please point it out.   Regarding the two options in your comment, since you commented to maintain the current prioritization rule for SRS carrier switching, does the Option 2 mean to keep the current rule instead redefining new ones? i.e. “Define rules” should be changed to “Reuse current rules”? |
| QC4 | It appears that none of our comments have been understood.  Huawei is saying that “Yes, the current prioritization rule for SRS carrier switching is retained”. What prioritization rules are being referred to here? If PUSCH with UCI is scheduled on CC1, then SRS is dropped. Could Huawei kindly point out in the specification where this is described? And what is the Huawei proposal for this scenario exactly?  It is difficult to comment on this further since it seems that none of our previous answers have been understood.  We are happy to provide a TP or CR in the next round or at a later stage, although it would be much more productive to agree on what we are trying to achieve first. For example, is there or is there not a prioritization between CC1 or CC3? The current specification supports no such prioritization, but it seems there is no agreement even on this yet. |

# Summary

**FL’s comments:** **Proposal 3 is stable.**

**Proposal 3:**

* Adopt the following TP to TS 38.213.

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| 9.2.5 UE procedure for reporting multiple UCI types  **< unchanged text omitted>**  - if there is an aperiodic CSI report multiplexed in a PUSCH in the group of overlapping PUCCHs and PUSCHs, is not before a symbol with CP starting after after a last symbol of  - any PDCCH with the DCI format scheduling an overlapping PUSCH, and  - any PDCCH scheduling a PDSCH, or SPS PDSCH release, or providing a DCI format 1\_1 indicating SCell dormancy, or a DCI format 1\_1 indicating a request for a Type-3 HARQ-ACK codebook report without scheduling PDSCH, with corresponding HARQ-ACK information in an overlapping PUCCH in the slot  where corresponds to the smallest SCS configuration among the SCS configuration of the PDCCHs, the smallest SCS configuration for the group of the overlapping PUSCHs, and the smallest SCS configuration of CSI-RS associated with the DCI format scheduling the PUSCH with the multiplexed aperiodic CSI report, and for , for and for . is defined in [6, TS 38.214] and it is applied only if of table 5.4-1 in [6, TS 38.214] is applied to the determination of .  - , , , , , and are defined in [6, TS 38.214], and and are defined in [4, TS 38.211].  **< unchanged text omitted>** |

# References

1. R1-2101782, Summary of Rel-16 uplink Tx switching, Moderator (China Telecom), RAN1#104-e, January 25th – February 5th, 2021.
2. R1-2100087, Remaining issues of Rel-16 UL Tx Switching, ZTE, RAN1#104-e, January 25th – February 5th, 2021.
3. R1-2100117, Text Proposals for Tx Switching between Two Uplink Carriers, OPPO, RAN1#104-e, January 25th – February 5th, 2021.
4. R1-2101445, Remaining issues for 1Tx-2Tx switching, Qualcomm Incorporated, RAN1#104-e, January 25th – February 5th, 2021.
5. R1-2101554, Maintenance for Rel-16 UL Tx Switching, Ericsson, RAN1#104-e, January 25th – February 5th, 2021.
6. R1-2101738, Discussion on the remaining problems of supporting Tx switching between two uplink carriers, Huawei, HiSilicon, RAN1#104-e, January 25th – February 5th, 2021.

# Appendix

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| **Companies** | **Views** |
| **ZTE(R1-2100087)** | ***Proposal 1****: Adopt TP Alt.1 or Alt.2 for 38.214 UL Tx switching.*   |  | | --- | | **TP Alt.1**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier. |  |  | | --- | | **TP Alt.2**  The UE does not expect to perform more than one uplink switching in a slot with *µUL* = max(*µUL, 1, µUL, 2*), where the *µUL, 1* corresponds to the subcarrier spacing of the active UL BWP of one uplink carrier after the switching gap and the *µUL, 2* corresponds to the subcarrier spacing of the active UL BWP of the other uplink carrier after the switching gap. | |
| **OPPO(R1-2100117)** | 1. 6.1.6.1 Uplink switching for EN-DC   **< unchanged text omitted>**  - when the UE is configured with *tdm-PatternConfig-r15* or by *~~tdm-PatternConfig-r16~~ tdm-PatternConfig2*  - for the E-UTRA subframes designated as uplink by the configuration, the UE assumes the operation state in which one-port E-UTRA uplink can be transmitted.  - for the E-UTRA subframes other than the ones designated as uplink by the configuration, the UE assumes the operation state in which two-port NR uplink can be transmitted.  **< unchanged text omitted>** |
| **Qualcomm(R1-2101445)** | **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: When the UE transmits SRS with Tx switching according to capability ‘xTyR’ on a CC, the UE is assumed to be in an UL Tx switching state supporting at least x ports on that CC.**  **Proposal 5: RAN1 should discuss and decide whether to introduce further capability with which a UE can indicate that 1TyR is counted as 2 ports on the CC supporting 2-port transmission.**  **Proposal 6: 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.**  **Proposal 7: Adopt the following revision of the note for the maximum data rate:**  NOTE 2:  For UL Tx switching ~~between carriers in cell(s)~~, only the supported MIMO layer combination ~~across carriers~~ that results in the highest combined data rate is counted for the cell(s) in the supported maximum UL data rate. |
| **Ericsson(R1-2101554)** | **Proposal** 1: NOTE 2 in the TP agreed for 38.306, section 4.1.2 is updated as follows:  NOTE 2:  For UL Tx switching between two cells, only the supported MIMO layer combination across the two cells that results in the highest combined data rate is counted for those cells in the supported maximum UL data rate. |
| **Huawei, HiSilicon(R1-2101738)** | 9.2.5 UE procedure for reporting multiple UCI types  **< unchanged text omitted>**  - if there is an aperiodic CSI report multiplexed in a PUSCH in the group of overlapping PUCCHs and PUSCHs, is not before a symbol with CP starting after after a last symbol of  - any PDCCH with the DCI format scheduling an overlapping PUSCH, and  - any PDCCH scheduling a PDSCH, or SPS PDSCH release, or providing a DCI format 1\_1 indicating SCell dormancy, or a DCI format 1\_1 indicating a request for a Type-3 HARQ-ACK codebook report without scheduling PDSCH, with corresponding HARQ-ACK information in an overlapping PUCCH in the slot  where corresponds to the smallest SCS configuration among the SCS configuration of the PDCCHs, the smallest SCS configuration for the group of the overlapping PUSCHs, and the smallest SCS configuration of CSI-RS associated with the DCI format scheduling the PUSCH with the multiplexed aperiodic CSI report, and for , for and for . is defined in [6, TS 38.214] and it is applied only if of table 5.4-1 in [6, TS 38.214] is applied to the determination of .  - , , , , , and are defined in [6, TS 38.214], and and are defined in [4, TS 38.211].  **< unchanged text omitted>** |