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>** |

## 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. |

## 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 |

## 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 |

# 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>** |