3GPP TSG RAN WG1 #103-e R1-20xxxxx

e-Meeting, October 26th – November 13th, 2020

**Agenda item: 5.1**

**Source: Moderator (China Telecom)**

**Title: [103-e-NR-LS-TxSwitching-02] Email discussion/approval on maintenance of uplink Tx switching thread #1**

**Document for: Discussion and Decision**

# Introduction

In [1], maintenance issues are summarized for uplink Tx switching. As per the guidance of Chairman, following issues are identified for email discussion/approval during RAN1 #103 e-meeting:

[103-e-NR-LS-TxSwitching-01] Email discussion/approval a potential CR till 10/30 – Jianchi (CT)

* Clarification on T^mux\_{proc,CSI} (R1-2007603, R1-2007725, R1-2008564)
* Clarification on the ambiguity issue on SCS and align the description on carrier1 and carrier2 with TS 38.331 (R1-2007725, R1-2008229)

[103-e-NR-LS-TxSwitching-02] Email discussion/approval a potential CR till 10/30 – Jianchi (CT)

* Back to back switching caused by SRS transmission (R1-2008596)
	+ Note 1: no discussion on location of switching period.
	+ Note 2: the previous agreements should not be overturned.
* Maximum data rate (R1-2008596)

This contribution is the summary of email discussion/approval on maintenance of uplink Tx switching thread #2.

# Discussion

## Issue #1: Back to back switching caused by SRS transmission (R1-2008596)

R1-2008596 mentioned back to back switching could happen due to SRS transmission, and proposed not to support it as it consumes too many symbols as switching gaps illustrated in the following figure.

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| symbol # | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 0 | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 |
| CC2 | U | U | U | U | U | U | U | U | U | U | U | G | G |   | G | G | U | U | U | U | U | U | U | U | U | G | G |   |
| CC1 |  |  |  |  |  |  |  |  |  |  |  |  |  | S |  |  |  |  |  |  |  |  |  |  |  |  |  | S |

Q: If UL Tx switching is configured, whether back to back switching caused by SRS transmission could be supported?

Companies are invited to answer the above question.

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| **Companies** | **Comments** |
| Huawei, HiSilicon | Yes, it has been supported. Such back to back switching is useful in practical network and has been supported by SRS carrier switching. We don’t see a need to preclude such useful switching. |
| Qualcomm | No, the back to back switching should not be supported.In the above case, we assume transient time is 2 symbols and both CCs are with same SCS for simplicity. We think back to back switching is not the intention when we introduce the UL Tx switching. |
| FL | Suggest Qualcomm explain more details why back to back switching caused by SRS transmission should not be supported. |
| Qualcomm2 | In the above example, there is only one switch per slot but there are two switches in a consecutive 14-symbol period, which we propose to preclude. Assuming as an example that CC1 is FDD, then there are multiple slots where there is UL in CC1 but no UL in CC2. All CC1 SRS should be placed in those slots that has no UL in CC2. This reduces complexity and eliminates unnecessary interruptions due to gaps. We see no benefit in supporting more than one switch in a 14-symbol period.  |

R1-2008596 presented two solutions to avoid back to back switching caused by SRS transmission.

* Option 1: The switching period can only be placed at the slot boundary.
* Option 2: No more than 1 switching in consecutive 14 symbols.

According to the notes in [1], there is no discussion on location of switching period and the previous agreements should not be overturned, we focus on the discussion on option 2.

* Proposed TP to TS 38.214

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| 6.1.6 Uplink switching**< unchanged text omitted>**After an uplink switching, the UE does not expect to perform more than one uplink switching in a slot for a 14-symbol period starting at the end of the switch, where the symbol duration is according to with *µUL* = max(*µUL,carrier1, µUL,carrier2*), where the *µUL,carrier1* corresponds to the subcarrier spacing of the uplink transmitted before the switching gap and the *µUL,carrier2* corresponds to the subcarrier spacing of the uplink transmitted after the switching gap.**< unchanged text omitted>** |

Companies are invited to provide views on the above TP.

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| **Companies** | **Comments** |
| ZTE | The above TP is too restrictive. We would like to enable case1 to case2 switch for a periodic SRS transmission under case2 and then immediately switch back to case1 for PUSCH transmission after the SRS transmission. So, we propose the following alternatives in our tdoc R1-2007725. *Alternative#1: The UE does not expect to perform an uplink switching if the gap between the start of this uplink switching and the end of the previous uplink switching is smaller than 1 symbol based on numerology µUL**Alternative#2: The switching gap can only be placed at the slot boundary or the switching point for S slot.*We slightly prefer Alternative#2 but Alternative#1 is also acceptable if companies are reluctant to discuss about the location of switching gap. Alternative#1 should be sufficient to avoid back-to-back switching.  |
| Huawei, HiSilicon | The TP is not agreeable because it is not in line with previous agreement by adding a restriction to ALL uplink transmissions and is out of the scope of this email discussion as described in the chairman’s note.Additionally, as commented above, such restriction is too much and preclude a very useful use case.When we made a decision in the agreement whether the SCS of the slot is the larger one or the smaller one in case of two different SCS, the concerned SRS switching had been considered and allowed. As a result, the larger SCS was agreed. Therefore, we should not reopen the discussion and the TP is not necessary.Regarding ZTE’s alternative#1, it has been reflected by current specification as explained in FL preparation summary. The concern seems to be resolved.Regarding ZTE’s alternative#2, it is not an option as the note for the scope of this email discussion. |
| Qualcomm | We are ok with either Option 1 or Option 2. Regarding ZTE’s comment on switching to Case 1 PUSCH after a Case 2 SRS transmission, that is possible with the proposal, as long as there is no Case 1 transmission immediately before. This is the same restriction as we would have with Option 1 already.  |
| FL | We have the following note * Note 1: no discussion on location of switching period.

Thus, please follow the guidance and do not discuss option 1, i.e., the location of switching period.Regarding option 2, can the proponent address the concerns from Huawei? |
| ZTE2 | The two notes added in the preparation phase are confusing. We think the proposal itself is related to the relative locations of two switching periods. E.g. Given the current TP proposal, if the first switching period is at a slot boundary, next earliest switching period should be located at next slot boundary. This is certainly related to how switching periods should be located. So from our understanding, note 1 only precludes the discussion of location which is not related to back-to-back switching caused by SRS transmission. Regarding note 2, the current proposal, we failed to see the current TP proposal overturned the previous agreement. It is just adding additional restriction. Otherwise, these two notes are just contradicting to the fact that the discussion on this TP proposal is allowed. Regarding QC’s comment that the scenario we described is allowed if there is no Case 1 transmission immediately before the SRS transmission, the current spec is not clear to us whether this is allowed since it is not clear whether/when UE will perform switching period. If the understanding on the current RAN1/RAN4 spec is that the switching period is always located immediately before any UL transmission which needs Tx switching, then it can be interpreted that the UE might see this as an error case and would not perform Tx switching for the SRS transmission. Therefore, we think clarification on the location of switching period relative to the SRS transmission is needed.  |
| CATT | We don't think the TP is needed. If overhead is an issue, gNB could avoid such case by implementation. Network should be given the flexibility to schedule/trigger SRS when necessary. |
| Qualcomm2 | As stated above, we need either option 1 or 2 to avoid more than 1 switching in a single slot. Among the two options, we slightly prefer option 1 which is clearer. However, there were some discussion in past couple meetings on the transient time position, and we feel it’s not easy to get it concluded. We are also ok with option 2 if FL and companies prefer not to discuss option 1 again. |
| Huawei, HiSilicon2 | It seems that our previous comments received no responses. The proposal is trying to preclude one important SRS transmission scheme and the TP further extended such restriction to all uplink transmissions which is even beyond the scope of the discussion thread. But based on the discussions, the motivation of the proposal is still unclear. |
| FL | Considering the current situation, it seems difficult to achieve consensus on whether back to back switching caused by SRS transmission should be precluded. As commented by CATT, gNB could avoid such case by implementation. One possible way is to make a conclusion:* The back to back switching caused by SRS transmission can be avoided by gNB implementation.
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## Issue #2: Maximum data rate (R1-2008596)

* Proposed TP to TS 38.306

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| 4.1.2 Supported max data rate**< unchanged text omitted>**NOTE 1: Only one of the UL or SUL carriers (the one with the higher data rate) is counted for a cell operating SUL.NOTE 2:  When the UE is configured with UL Tx switching, only the supported MIMO layer combination that results in the highest combined data rate is counted for the cells.NOTE 3:  When the UE is configured with UL Tx switching, and the supported MIMO layer combination with the highest combined data results in switching gaps in either DL or UL then the maximum data rate is correspondingly reduced in the DL or UL, respectively.**< unchanged text omitted>** |

Companies are invited to provide views on the above TP.

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| **Companies** | **Comments** |
| ZTE | It may not be clear what MIMO layer “combination” means here. From our understanding, NOTE 2 is to avoid invalid assumption of MIMO layer combination across the carriers involving UL Tx switching when supported max data rate is calculated. We can make it clearer. NOTE 3 does not seem necessary. Otherwise, all other time gaps/overhead defined in the specs should be taken into account.  |
| Huawei, HiSilicon | There is overlaps between NOTE 2 and NOTE 1 in case of SUL. It is unclear why the redefinition with “MIMO layer combination” is necessary or better. A clarification is suggested. |
| Qualcomm | The current note does not indicate how to get the maximum data rate with UL Tx switching. Note 2 applies to the case of no gap, while Note 3 applies to the case where switching gaps occur.  |
| Ericsson | Regarding Note 2, our understanding it would be applicable for uplink data rate only, so perhaps that can be clarified, in addition to reflecting that it is applied for UL carriers involving TX switching.Regarding Note 3, we think it is not needed since the gaps/overheads are already considered in the data rate calculation. If any additional gaps/overheads are to be considered in maximum data rate calculation, it can be made clearer since proposed formulation is unclear on how to determine (quantitatively) the “correspondingly reduced” or “….highest combined data rate results in switching gap,..”part.Also, given 38.306 formula is for UE maximum data rate calculation from signalled UE capabilities, it is preferable to avoid linkage with RRC configuration in the note. |
| FL | It seems the notes are not clear enough. Could the proponent clarify the concerns? |
| CATT | Note 3 is not needed as explained by other companies.Note 2 needs more clarification. When UL Tx switching is configured for UL CA, what is the number of layers assumed when calculating the peak data rate? |
| Qualcomm2 | We are ok to accept Ericsson’s comment to clarify this is only for UL. NOTE 2:  When the UE is configured with UL Tx switching, only the supported MIMO layer combination that results in the highest combined data rate is counted for the cells in the supported maximum UL data rate. For Note 3, if majority feels unnecessary, we can accept removing it.In response to ZTE’s comment: “MIMO layer combination” includes selecting between Case 1 and Case 2 for a slot. Assume for example that the bandwidth of Carrier1 is greater than the bandwidth of Carrier2. In this case, in a slot that is UL for both Carrier1 and Carrier2, the supported maximum UL data rate should be based on Case 1 with 1L+1L. On the other hand, when the bandwidth of Carrier1 is smaller than the bandwidth of Carrier2, then in a slot that is UL for both Carrier1 and Carrier2, the supported maximum UL data rate should be based on Case 2 with 0L+2L.In response to Huawei’s comment: There is no conflict between Note 1 and Note 2. Selecting between Case 1 and Case 2 also applies to SUL. However, if there is a strong preference, we are ok with excluding SUL from Note 2. But in any case, Note 2 is still needed for the UL CA case, even if SUL is excluded. |
| Ericsson2 | We are OK with updated proposal by Qualcomm. However, one comment (regarding linkage with RRC configuration) from our previous input was probably missed. We would suggest a minor update as below. NOTE 2:  ~~When the UE is configured with~~ For UL Tx switching, only the supported MIMO layer combination that results in the highest combined data rate is counted for the cells in the supported maximum UL data rate.  |
| FL  | It seems no further comments regarding Ericsson’s revised NOTE2. The TP is revised as follows:

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| 4.1.2 Supported max data rate**< unchanged text omitted>**NOTE 1: Only one of the UL or SUL carriers (the one with the higher data rate) is counted for a cell operating SUL.NOTE 2:  For UL Tx switching, only the supported MIMO layer combination that results in the highest combined data rate is counted for the cells in the supported maximum UL data rate.**< unchanged text omitted>** |

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# References

1. R1-2008814, Summary of uplink Tx switching, Moderator (China Telecom), RAN1#103e, October 26th – November 13th, 2020.
2. R1-2007603, Discussion on the remaining problems of supporting Tx switching between two uplink carriers, Huawei, HiSilicon, October 26th – November 13th, 2020.
3. R1-2007725, Remaining Maintenance Issues of UL Tx Switching, ZTE, October 26th – November 13th, 2020.
4. R1-2008229, Text Proposals for Tx Switching between Two Uplink Carriers, OPPO, October 26th – November 13th, 2020.
5. R1-2008564, Draft CR to 38.213 on corrections for UL Tx switching, Ericsson, October 26th – November 13th, 2020.
6. R1-2008596, Remaining issues for 1Tx-2Tx switching, Qualcomm Incorporated, October 26th – November 13th, 2020.

# Appendix

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| **Companies** | **Views** |
| **ZTE** **(R1-2007725)** | ***Proposal 2****: Consider the following two alternatives to address the back-to-back switching issue.**Alternative#1: The UE does not expect to perform an uplink switching if the gap between the start of this uplink switching and the end of the previous uplink switching is smaller than 1 symbol based on numerology µUL**Alternative#2: The switching gap can only be placed at the slot boundary or the switching point for S slot.* |
| **Qualcomm** **(R1-2008596)** | 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: conclude NOT to support switching caused by SRS transmission or other reasons.Proposal 5: to avoid the back-to-back SRS switching, adopt one of the following proposals* Option 1
* The switch location should be always at a slot boundary in the CC with higher SCS
* Placing transient always in CC1 (FDD) should be default
* Relative placement of transient is RRC configured
* Option 2
* Adopt the text proposal in section 3.2

Proposal 6: adopt the following notes for the maximum data rateNOTE 2:  When the UE is configured with UL Tx switching, only the supported MIMO layer combination that results in the highest combined data rate is counted for the cells.NOTE 3:  When the UE is configured with UL Tx switching, and the supported MIMO layer combination with the highest combined data results in switching gaps in either DL or UL then the maximum data rate is correspondingly reduced in the DL or UL, respectively. |