**3GPP TSG RAN WG1 Meeting #107-e R1-21xxxxx**

**e-Meeting, November 11th – 19th, 2021**

**Agenda Item: 7.1**

**Source: Moderator (Huawei, HiSilicon)**

**Title: Summary of [107-e-NR-7.1CRs-04] Issue#4: Discussion on SRS carrier switching**

**Document for: Discussion and Decision**

# Introduction

This document provides a summary for the following email discussion:

[107-e-NR-7.1CRs-04] Issue#4: Discussion on SRS carrier switching by Nov 17 – Keyvan (Huawei)

As the deadline for the email discussion is Nov 11, please provide your initial views by **UTC 23:59 pm, Nov. 12.**

SRS carrier switching prioritization rules have been discussed in RAN1 #104b-e [7], RAN1 #105-e [8], and RAN1 #106-e [9]. Also, issues regarding timeline and switching back to the source carrier when multiple SRS resource sets are triggered by the same DCI were discussed in RAN1 #106-e [9]. Based on companies inputs [1]-[6], above issues will be further discussed in this document. There are other issues related to SRS carrier switching that were raised by companies in their contributions to this meeting. These issues are also provided in Section 2.5.

# Discussion

## Priority rules

Following agreements were reached in RAN1 105-e:

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| Agreement:  The prioritization rules of SRS carrier switching apply to at least the source CC.   * FFS : Whether the specification needs to be updated or not     Agreement:  Down select one from the following two options in RAN1#106-e meeting to determine which UL CCs other than the source CC should be used for SRS carrier switching priority rules:   * Option 1: The UL CCs in the same band as the source CC * Option 2: The UL CCs can be any carriers which result in uplink transmissions beyond the UE ’s indicated uplink carrier aggregation capability.   + Companies should indicate how “UE’s indicated uplink CA capability” is derived based on current ASN.1 signaling. |

Companies’ views on priority rules are provided below:

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| Company | View |
| ZTE [1] | Proposal 1: The UL CCs in the same band as the source CC should be used for SRS carrier switching priority rules. |
| Vivo [2] | Observation 1: For architecture with independent Tx chains, same transmission behavior is applicable for both option 1 and option 2.  Observation 2: For architecture with shared Tx chains, two carriers, i.e. SRS on CC 2 and PUSCH/PUCCH on CC 1, will be transmitted for option 1.  Observation 3: For architecture with shared Tx chains, only SRS on CC 2 will be transmitted for option 2 without clear UE capability signaling.  Observation 4: For architecture with shared Tx chains, simultaneous transmission between CC 2 and CC 3 can be realized for option 2 with clear UE capability signaling.  Proposal 2: For SRS carrier switching, at least support priority rule applied among UL CCs in the same band as the source CC, i.e. option 1.  Proposal 3: For option 2, details on how UE can indicate uplink CA capability for SRS carrier switching should be provided, whether and how uplinkTxSwitching-r16 related signaling is used or other signaling. |
| Intel [3]: | Snippet from [3]: “In R1-1909020, it was explained that for SRS carrier switching collision handling, besides CA-ParametersNR, other UL CA capability parameters may also need to be considered, for example, ca-BandwidthClassUL-NR. The details could be found in [8].”  Proposal 1: Support Option 2 for SRS carrier switching dropping rule, i.e., the dropping rule could be applied to any UL CC which can result in uplink transmission beyond UE's capability. |
| Qualcomm [5]: | Observation 1: Under current rules for SRS carrier switching:   * The UE performs prioritization between source and target CCs. RAN1 specifications define which channel the UE SHALL drop * For CCs other than source and target, RAN4 specifications define an interruption period during which the UE MAY skip transmission.   Proposal 1: For Rel-16, define joint prioritization rules for carriers that are in the same band as the source CC, taking as baseline the CR in R1-2103759.  Observation 2: There is no explicit capability in current ASN.1 indicating that, while operating in a band combination with SRS carrier switching, the UE cannot perform simultaneous transmission in the target band and a third band (other than the source and target).  Observation 3: Using an implicit method (based on a separate band combination) to determine support of simultaneous transmission during SRS CS has several issues and should be avoided.  Proposal 3: RAN1 concludes that current ASN.1 does not include a capability to indicate “beyond UE’s indicated uplink CA capability”   * Based on current specification, UEs not supporting simultaneous transmission in the target band and a third band (other than source and target bands) are allowed to drop transmissions in the third band (per RAN4 requirements) * FFS: RAN1 to consider discuss the need of introducing a new UE capability for indicating simultaneous transmission while switching. |
| Huawei, HiSilicon [6] | “Observation 1” [from CR cover sheet]: Because the UE Tx RF chains are shared between the two uplinks configured with uplinkTxSwitching-r16, both uplinks are impacted and suspended by a SRS transmission on the third uplink triggered by SRS carrier switching, whose corresponding UE capability for SRS carrier switching is reported via BandCombinationList-UplinkTxSwitch.”  “Observation 2” [from CR cover sheet]: The UE capability container BandCombinationList-UplinkTxSwitch is dedicated to UE feature UL Tx switching. If a UE reports a support of SRS carrier switching via BandCombinationList-UplinkTxSwitch, the UE has indicated that its UE Tx RF chains are shared between uplinks configured with UL Tx switching and uplinks configured with SRS carrier switching. Therefore, “the UE's indicated uplink carrier aggregation capability” in sub-clause 6.2.1.3 of TS 38.214 can refer to this existing UE capability for this case.  “Proposal 1” [extracted from CR]: For SRS carrier switching, priority rule applies to CCs in the same band as the source CC or to CCs that, together with the source CC, are configured with *uplinkTxSwitching-r16*. In either of the cases, the CC should be in the same tag as the source CC. |

### First round of discussion:

The issue of SRS CS priority rules have been discussed for 3 RAN1 meetings without much of progress. 5 companies have discussed this issue again in this meeting. 4 of these 5 companies seem to agree that for SRS carrier switching, other than the source CC, priority rule applies at least to UL CCs in the same band [and the same TAG] as the source CC. One company, while not disagreeing with the above understanding, prefers to discuss priority rules in a more general setup. Moderator’s understanding is that such Rel-15 CR discussion cannot continue indefinitely and will eventually be stopped even if there is no conclusion. As such, Moderator would like to urge companies to consider if they can live with the following proposal 2.1.1-1 which seems to be the common denominator of all views.

***Proposal 2.1.1-1:*** *For SRS carrier switching, other than the source CC, priority rule applies at least to UL CCs in the same band and the same TAG as the source CC.*

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| Company | View |
| Apple | Option 1 is not desired, as it does not consider UE capability for simultaneous UL transmission between target cc and a cc inter-band with source (it refers to RAN4 spec which allows UE to interrupt transmission on cc inter-band with source, but if such transmission is higher priority than SRS on target, UE has to interrupt a higher priority transmission, as priority rules are NOT applied between target and 3rd ccs inter-band with source under Option 1…)  Option 2 is not desired as it is not clear by repurposing current capability signaling, which is not fully defined for SRS CS, what the UE behavior will be exactly. For example, if UE does not indicate BandCombinationList-UplinkTxSwitch for c2/c3, in our view ULTx switching is not allowed between c2 and c3. Now for SRS CS, if UE does not indicate BandCombinationList-UplinkTxSwitch under SRS carrier switching (say c2 is source and c3 is inter-band with source), does it mean that SRS on target will not impact c3, or it means SRS CS is not allowed at all…?  So, in our view, while no further capability signaling is needed for CCs intra-band with source, the above issues are fully resolved by defining a new capability that clearly indicates which UL bands inter-band with source are impacted due to SRS CS. We understand some companies may see this new signaling NBC for R16, so as a compromise we can accept *Proposal 2.1.1-1* if such capability is introduced at least for R17. Otherwise, we prefer the current specification, and we don’t see the need to go with *Proposal 2.1.1-1* (anyway, RAN4 spec is applicable to ccs intra-band with source as well). |
| Qualcomm | Agree with the proposal. We are also OK with Apple’s suggestion of adding a new capability to Rel-17. |
| Samsung | We agree with the proposal and fine with adding the new capability. |
| ZTE | Considering the same situation and statements as previous meeting, we think Apple’s suggestion is a good way, perhaps we need to introduce a new UE capability for each inter-band pair per band combination for Rel-17. |
| CATT | Agree with the proposal. We are OK to further discuss whether the priority rule also applies to inter-band CCs. |
| MTK | We have concern on Proposal ***2.1.1-1*** that, currently we have only one to one mapping as introduced in 2.1; this proposal introduces one to many mapping, so UE would have to check more UL carriers before transmitting. Apple’s suggestion of adding a new capability to Rel-17 seems fine to us; however, at the same time, we think this should not mandate Proposal ***2.1.1-1*** for Rel-16 UEs. |
| Futurewei | Agree with the proposal. Adding new capability signaling to Rel-17 needs a separate discussion as this email thread is about Rel-15/16 behavior. |
| Intel | We still prefer Option 2. But we are fine with Apple’s suggestion to have new UE capability in Rel-17 to make it more clear. Also, similar view as MTK, Proposal 2.1.1-1 should not be mandated for Rel-16 UE. |
| Huawei, HiSilicon | Our preference is to agree no new UE capability for both intra-band case and UL Tx switching case because both have the underlying UE RF sharing between CCs and UL Tx switching has a dedicated container to report support of SRS carrier switching as the TS 38.331 excerpt below.  But we are fine with new UE capability with clarification for UL Tx switching as our comments for the proposal 2.1.1-2.  In TS 38.331, S5.6.1.4, a capability container *BandCombinationList-UplinkTxSwitch* dedicated to UL Tx switching has been introduced to indicate UE RF sharing which is different from the container *BandCombinationList* for normal UL-CA. Feature SRS carrier switching can be reported in both containers with different values of *srs-SwitchingTimesListNR*.  1> if the requested *rat-Type* is *nr*:  2> include into *supportedBandCombinationList* as many NR-only band combinations as possible from the list of "candidate band combinations", starting from the first entry;  3> if *srs-SwitchingTimeRequest* is received:  4> if SRS carrier switching is supported;  5> include *srs-SwitchingTimesListNR* for each band combination;  4> set *srs-SwitchingTimeRequested* to *true*;  2> include, into *featureSetCombinations*, the feature set combinations referenced from the supported band combinations as included in *supportedBandCombinationList* according to the previous;  2> compile a list of "candidate feature set combinations" referenced from the list of "candidate band combinations" excluding entries (rows in feature set combinations) with same or lower capabilities;  2> if *uplinkTxSwitchRequest* is received:  3> include into *supportedBandCombinationList-UplinkTxSwitch* as many NR-only band combinations that supported UL TX switching as possible from the list of "candidate band combinations", starting from the first entry;  4> if *srs-SwitchingTimeRequest* is received:  5> if SRS carrier switching is supported;  6> include *srs-SwitchingTimesListNR* for each band combination;  5> set *srs-SwitchingTimeRequested* to true;  3> include, into *featureSetCombinations*, the feature set combinations referenced from the supported band combinations as included in s*upportedBandCombinationList-UplinkTxSwitch* according to the previous; |
| Ericsson | Support the proposal |

Other than the UL CCs in the same band [and the same TAG] as the source CC, [6] suggests that priority rule applies to CCs that, together with the source CC, are configured with *uplinkTxSwitching-r16* because UE Tx RF chains are shared between the two CCs and the UE capability for such sharing is indicated by its dedicated container *BandCombinationList-UplinkTxSwitch* which is independent of container *BandCombinationList* for normal UL-CA. In turn, [3] suggests that UL CCs which result in uplink transmissions beyond the UE ’s indicated uplink carrier aggregation capability are derived at least from *CA-ParametersNR* and *ca-BandwidthClassUL-NR* [within *BandCombinationList*] while [5] suggests that UL CCs which result in uplink transmissions beyond the UE’s indicated uplink carrier aggregation capability cannot be derived based on any current ASN.1 signaling and, therefore, RAN1 should consider discussing the need of introducing a new UE capability for indicating simultaneous transmission while switching.

Based on the above views, moderator provide the following proposal.

***Proposal 2.1.1-2:*** *For SRS carrier switching, other than the source CC, priority rule applies to UL CCs which result in uplink transmissions beyond the UE ’s indicated uplink carrier aggregation capability derived by one of the following alternatives*

*Alt 1) UL CCs that, together with the source CC, are configured with uplinkTxSwitching-r16, whose UE capability is derived from BandCombinationList-UplinkTxSwitch.*

*Alt 2) UL CCs that are derived at least from CA-ParametersNR and ca-BandwidthClassUL-NR within BandCombinationList*

*Alt 3) Other UL CCs that cannot be derived based on any current ASN.1 signaling. RAN1 should consider discussing the need of introducing a new UE capability for indicating simultaneous transmission while switching.*

Please provide your views on Proposal 2.1.1-2:

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| Company | View |
| Apple | We suggest Alt3 to be revised (or Alt4 is added) as follows  Introduce a new UE capability for indicating CCs inter-band with source for which simultaneous transmission with SRS switching on target cc is beyond UE’s capability. |
| Qualcomm | We are OK with Apple’s proposal of adding a new capability. Alt 1) and alt 2) are not feasible. |
| Samsung | We support Alt 3 and fine with apple’s proposal. |
| ZTE | Our understanding is Alt 1(only for Rel-16 feature) and Alt 3. We are OK to introduce a new UE capability as a complete solution. In such case, Alt 1 and 2 will not be used. |
| CATT | There are lots of parameters in *CA-ParametersNR* and *ca-BandwidthClassUL-NR*, we prefer to indicate the related UE capability parameters explicitly. It is our view that at least *parallelTxMsgA-SRS-PUCCH-PUSCH-r16*, *parallelTxSRS-PUCCH-PUSCH*, *parallelTxPRACH-SRS-PUCCH-PUSCH*, and *simulTX-SRS-AntSwitchingInterBandUL-CA-r16* in *CAParametersNR* indicate whether UE can simultaneously transmit SRS in a carrier with a UL signal in another carrier together. The dropping rule can be applied at least for band combinations that UE does not report these capabilities. We are open to discuss whether and how to apply the dropping rule for other band combinations. |
| MTK | We support Alt 3 and fine with Apple’s proposal. |
| Futurewei | Though we are open to discuss the introduction of new capability in Rel-17, at least the details should not discuss/agree here. Furthermore, it will need a Rel-17 TEI which we are not sure we have time to finish in this RAN1 meeting. If the companies agree to introduce this in Rel-17, a proper approach may be a RAN2 lead TEI.  For Rel-16, based on the current text in 38.214 “that can result in uplink transmissions beyond the UE's indicated uplink carrier aggregation capability included in [13, TS 38.306]”, our understanding is that unless certain band combination is indicated by UE capability explicitly per Rel-15/16 capability, the combination should be deemed as not supported and it is up to UE to drop or interrupt certain transmission(s). No specification change is needed. |
| Intel | Fine with Apple’s suggestion for having new UE capability. |
| Huawei, HiSilicon | As shown in the following figure, the container *BandCombinationList-UplinkTxSwitch* is independent of the container *BandCombinationList* for normal UL-CA. The new capability is not necessary for bands in *BandCombinationList-UplinkTxSwitch*, because UE Tx RF chains are always shared between the two CCs in *BandCombinationList-UplinkTxSwitch.* If a new capability were added as Apple suggested, the new capability would never be able to indicate that simultaneous transmission between the two CCs is supported. Additionally, the same UE capability IEs, e.g. srs-CarrierSwitch are shared between two containers *BandCombinationList-UplinkTxSwitch* and *BandCombinationList*, the introduction of new UE capability has impact on both containers. Therefore, we suggest that if such a new capability is introduced, then it is optional signaling with default capability of no simultaneous transmission if absent (In RAN2 suggestions, a UE capability indicating incapability should be avoided). If it is signaled within *BandCombinationList-UplinkTxSwitch,* it should always indicate no simultaneous transmission.    ***Proposal***:  *Alt3-rev: Introduce a new UE capability with optional signaling for indicating CCs in inter-band relationship with source CC of SRS carrier switching for which simultaneous transmission with SRS carrier switching on target cc is capable ~~beyond UE’s capability~~.*   * *The new UE capability is not expected to be signaled within BandCombinationList-UplinkTxSwitch. In case it is signaled there, it always means not capable of simultaneous transmission.*   If no new UE capability is agreed at this stage, then we suggest to at least agree Alt1 for UL Tx switching as explained above, no simultaneous transmission between |
| Ericsson | Support the proposal |

## Suspending rules

In TS 38.214, a UE behavior about suspending rules is specified as below.

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| 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*. |

In RAN1#105-e, according to the discussion under Question 1 in summary [8], there seems to be the majority view that the suspending rules are different from prioritization rules because the former is about the UE behavior after SRS transmission is determined while the latter discusses how to determine the SRS transmission in case of any collision.

### First round of discussion:

In [6], a change to the current suspending rules in TS 38.214 is proposed for the case of UL Tx switching where the third CC is sharing UE RF chains with the carrier *c2*. If carrier *c2* is suspended because its UE RF chain is occupied by carrier *c1* for SRS carrier switching, the third CC has also no sufficient UE RF chain for any transmission and should be suspended as well:

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| Company | View |
| Huawei, HiSilicon [6] | A UE can be configured with SRS resource(s) on a carrier *d* with slot formats comprised of DL and UL symbols and not configured for PUSCH/PUCCH transmission. For carrier *d*, the UE is configured with higher layer parameter *srs-SwitchFromServCellIndex* and *srs-SwitchFromCarrier* the switching from carrier *s*0(*d*) which is configured for PUSCH/PUCCH transmission. During SRS transmission on carrier *d*(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 *S*(*d*). |

In case of no collision scheduled by a gNB, an SRS transmission is determined regardless the outcome of Section 2.1, but it is still possible that after the SRS transmission determination the UE is scheduled with a late received DCI; causing some collision. In this case, suspending rules should be applied and be clarified. Similarly, for any received DCI that does not comply with the timeline, the DCI is not taken into account in the priority rules and suspending rules should be also applied.

Based on the above discussion and the discussions on priority rules in Section 2.1, moderator provide the following proposal.

***Proposal 2.2.1-1:*** *For SRS carrier switching, in addition to the source CC,*

*Alt 1) the third CC is also suspended if both the source CC and the third CC are configured with uplinkTxSwitching-r16, or if the concurrent transmission between source CC and the third CC are not expected according to at least CA-ParametersNR and ca-BandwidthClassUL-NR within BandCombinationList*

*Alt 2) the third CC is also suspended on condition that new UE capability is introduced to indicate it.*

*Alt 3) it is up to UE implementation on whether a third CC is also suspended.*

Please provide your views on Proposal 2.2.1-1:

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| Company | View |
| Apple | All the ccs that are impacted due to SRS CS are suspended (UE is not expected to transmit on those CCs within the SRS transmission on target including RF tuning time, as specified in RAN4). If by suspension the interpretation is to stop at the middle of an ongoing transmission, we do NOT support such interpretation (the purpose of timeline for cancellation is to prevent cancellation after a transmission is in UE’s pipeline) |
| Qualcomm | We agree with the Huawei CR, assuming S(d) includes the intra-band CCs + potentially the CCs as indicated by the capability proposed by Apple. |
| Samsung | Alt 2)  If the UE has new capability (maybe that capability is that the UE can transmit UL on the other CC simultaneously with SRS CS on the target CC), third CC cannot be suspended. Otherwise, it would be suspended (this case includes the same PA condition like LTE (as HW’s TP)). |
| ZTE | Alt 2. This should be on the condition that the source CC and the third CC are determined as lower priority than SRS transmission. |
| CATT | Whether the SRS is transmitted in a PUSCH-less CC is determined by the timeline for the SRS transmission in the PUSCH-less CC and UL transmissions in all the CCs that the dropping rule is applied. It is error case for the UE to receive a late DCI that cause collision after the SRS transmission determination. |
| MTK | Alt 2. Same view as Samsung. |
| Futurewei | We are fine with the Huawei CR. However, for Rel-16, S(d) should only include the intra-band CCs. New capability introduction can only be for Rel-17 at this point of time. |
| Intel | We think this depends on the outcome of discussion in Section 2.1. Suggest discussing this after Section 2.1 is concluded. |
| Huawei, HiSilicon | Agree with Samsung that the UE capability should indicate capability of simultaneous transmissions because in previous received RAN2 LS, RAN2 has suggested that a UE capability indicating incapability should be avoided. In this sense, if a UE does not indicate a new capability, the third CC is also suspended, otherwise, not suspended. |
| Ericsson | Agree with Intel on the dependency of this proposal on the outcome of 2.1 and that this proposal should wait on that outcome. |

## Timeline

Following agreement was reached in RAN1 106-e:

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| Agreement:  For a target CC, In the case that multiple SRS resource sets are triggered by the same DCI, regarding the applicable timeline(s), further discuss the following alternatives:   * Alt 1) Individual timeline is applied to each triggered SRS resource set   + “Individual timeline” means that for each SRS resource set, the deadline to consider DCI triggering the SRS resource set or other uplink signals is applied and decision is made independently amongst the SRS resource sets. * Alt 2) The same timeline is applied to all the triggered SRS resource sets   “Same timeline” means that the deadline to consider DCI triggering the SRS resource sets or other uplink signals is applied considering the multiple SRS resource sets as a whole so that a single decision on collision handling is made for these SRS resource sets. |

Companies’ views on timeline are provide below:

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| Company | View |
| ZTE [1] | Proposal 3: For a target CC, In the case that multiple SRS resource sets are triggered by the same DCI, regarding the applicable timeline(s), the same timeline should be applied to all the triggered SRS resource sets. |
| Vivo [2] | Proposal 5: Individual timeline may be overly optimized and we prefer same timeline applied to multiple SRS resource sets triggered by single DCI for carrier switching. |
| Intel [3] | Proposal 3: When multiple SRS resource sets for carrier switching are triggered by the same DCI, the same timeline is applied to all the triggered SRS resource sets. |
| Qualcomm [5] | Proposal 4: For the case of multiple SRS resource sets being triggered in the same CC, the current specification describes the following behavior:   * UE switches back to source CC between the SRS resource sets (Alt 4) * Individual timeline is applied to each triggered SRS resource set (Alt 1)   RAN1 to further discuss whether and how to enhance this behavior under TEI. |

### First round of discussion:

Three companies prefer that when multiple SRS resource sets for carrier switching are triggered by the same DCI, the same timeline to be applied to all the triggered SRS resource sets. One company believes that although the current specification support applying individual timeline to each triggered SRS resource set, this behavior may need to be enhanced. Given companies views, Moderator provides the following proposal:

***Proposal 2.3.1-1:*** *When multiple SRS resource sets for carrier switching are triggered by the same DCI, the same timeline is applied to all the triggered SRS resource sets.*

Please provide your views on Proposal 2.3.1-1

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| Company | View |
| Apple | Do not support. Timeline is applied per SRS resource set (similarly, for ULCI cancellation is applied per PUSCH repetition). |
| Qualcomm | We suggest to solve this issue after “switching to source CC”.  Having said this, the proposal as it is doesn’t seem to be reasonable. In the case of triggering many SRS resource sets, it is possible that the gNB gets new traffic after the initial triggering. |
| Samsung | We think there are two ways: The first one is more optimized way and the other one is simple way.  To support more optimized method, individual timeline (Alt1) can be considered.  To support simpler method, same timeline for multiple SRS resource sets (Alt2) can be considered.  We don’t have strong preference but Alt1 (individual timeline) seems useful to support more flexible scheduling.  By the way, for the clarification, according to proposal 2.3.1-1 (Alt2), we think the below situation seems not allowed because the UE cannot apply the priority rule for second SRS resource set due to the same timeline:   * New DCI is received **between two SRS resource sets** for SRS carrier switching * New DCI schedules other UL transmission on the source CC that is **overlapped with the second SRS resource set**   Is it correct understanding? And if it is correct, cancelling only second SRS resource set for carrier switching might be impossible after preparing to transmit SRS carrier switching. |
| ZTE | Support. We don’t find the reason to have separate timelines. SRS sets for carrier switching should be treat together, if one of all sets is dropped, it is meaningless to still transmit the other ones since the full channel estimation has been broken. |
| CATT | It is our interpretation that the timeline is determined per SRS resource in current specs. We think even a subset of SRS resources are transmitted is helpful for gNB to acquire the DL CSI. We suggest the proponents to provide more explanations on the necessity of the enhancement. |
| MTK | Do not support. We prefer individual timeline as indicated by current spec. |
| Futurewei | Do not support. We prefer individual timeline. Similar to Qualcomm’s question, it is not clear how common timeline will work in general. |
| Intel | Support. To apply the same timeline for all the triggered SRS resource sets is a simpler way. With individual timeline, the processing could be complicated. With current spec, it’s not clear whether individual timeline is applied one SRS resource set. Following CATT’s interpretation, if the timeline is determined per SRS resource, the processing could be even more complicated.  Similar view as ZTE, it’s better to treat the triggered SRS resource sets together to get the full channel information.  Anyway, we think this issue should be clarified. |
| Ericsson | Would also like to better understand the need for the proposal. |

## Switching to source CC

Following agreement was reached in RAN1 106-e:

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| Agreement:  For a target CC, when multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule, regarding UE behaviour on switching back to the source CC after transmitting one SRS resource set, further discuss the following alternatives:   * Alt 1) The behavior depends on the UE implementation * Alt 2) UE stays in the target CC in the period between the SRS resource sets. * Alt 3) If the time period between the SRS resource sets is smaller than the total required RF switching time to the source CC and back to the target CC and a higher priority UL transmission and/or DL reception is not scheduled on the source CC in the time period between the two SRS resources sets, the UE stays in the target CC in the period between the SRS resource sets; otherwise, the UE switches back to the source CC after transmitting each SRS resource set. * Alt 4) UE switches back to source CC between the SRS resource sets |

Companies views on whether or not to switch back to the source CC when multiple SRS resource sets are triggered by the same DCI are provide below:

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| Company | View |
| ZTE [1] | Proposal 2: For a target CC, when multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule, regarding UE behavior after transmitting one SRS resource set, Support Alt 2, i.e. UE stays in the target CC in the period between the SRS resource sets. |
| Vivo [2] | Proposal 4: UE stays in the target CC or switches back to source CC in the period between the SRS resource sets is up to UE implementation when multiple SRS resource sets for carrier switching are triggered by single DCI, i.e. support Alt 1. |
| Intel [3] | Proposal 2: When multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule, if the time period between the SRS resource sets is smaller than the required RF switching time, the UE stays in the target CC in the period between the SRS resource sets; otherwise, the UE switches back to the source CC after transmitting the first SRS resource set. |
| Qualcomm [5] | Proposal 4: For the case of multiple SRS resource sets being triggered in the same CC, the current specification describes the following behavior:   * UE switches back to source CC between the SRS resource sets (Alt 4) * Individual timeline is applied to each triggered SRS resource set (Alt 1)   RAN1 to further discuss whether and how to enhance this behavior under TEI. |

### First round of discussion:

When multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule, regarding UE behavior after transmitting one SRS resource set, one company support UE to stay in the target CC in the period between the SRS resource sets (Alt 2), one company suggest to leave it to implementation (Alt 1), one company support staying on the target CC or switching back to the source CC depending on the time period between the SRS resource sets (Alt 3), and one company suggests that the current specification indicates that UE should switch back to the source CC (Alt 4), however, this behavior may be sub-optimal and can be improved.

Four companies have provided four different views about this issue. Moderator tends to agree with [5] that the current specification implies Alt 4 and this behavior may need to be enhanced. As Alt 4 is already implied in specification, supporting Alt 1 (based on implementation) does not seem to be the best way forward. However, since there is no majority view on how to enhance UE behavior, Moderator would like to provide the following conclusion and proposal:

***Conclusion 2.3.1-1:*** *When multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule, regarding UE behavior after transmitting one SRS resource set, current specification supports Alt 4.*

Please provide your views on Conclusion 2.3.1-1.

|  |  |
| --- | --- |
| Company | View |
| Apple | Alt4 is current spec as mentioned by QC. The proposal is a bit problematic “*all the SRS resource sets will be transmitted according to the dropping rule”* it does not have to be the case that all SRS sets are transmitted |
| Qualcomm | I think there may be an issue with the proposal, as mentioned by Apple. What about the following?  *When multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and for the SRS resource sets which are transmitted according to the dropping rule, regarding UE behavior after transmitting one SRS resource set, current specification supports Alt 4.* |
| Samsung | We can agree on the conclusion. However we think Alt3 seems more efficient way to prevent inefficient switching back and allow to transmit or receive UL/DL between two SRS resource sets. |
| ZTE | As long as UE behavior is clarified, we would be fine for any solution. However, for Alt 4, we think it wastes resources and UE energy somehow. Because gNB usually should not schedule any transmission among SRS resource sets, it is not necessary for UE to switch back to the source CC, and then switch to the target CC again. In such case, the sufficient gap between SRS sets should be always ensured by gNB scheduling. Hence, we hope we can go for a more efficient way, i.e. Alt 2 or Alt 3 |
| CATT | Agree with the conclusion and OK for QC’s change. |
| MTK | We are generally fine with the conclusion and think QC’s change can make the wording more clear. |
| Futurewei | Based on the current 38.214 text “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*”, our understanding of the UE behavior specified here is only “suspends”. Whether UE switches back to source or stay on the target depends on the time period between the SRS resource sets. When the time period is large enough such that there is a gap between the 2 intervals of “suspends” caused by the 2 SRS resource sets, UE should return to the source. Otherwise, the UE needs not return to the source. This is basically Alt.3 and no specification change is needed. |
| Intel | We don’t think current spec supports Alt 4. This case is missing in the spec.  We prefer Alt-3. |
| Ericsson | Share ZTE’s view that it is most important to get clear UE behavior, and do not have a strong view. OK with Qualcomm’s proposal. |

***Proposal 2.3.1-2:*** *Support at least one of Alt 2, Alt 3, or Alt 4 as the UE behavior after transmitting one SRS resource set for the case that multiple aperiodic SRS resource sets for carrier switching are triggered by the same DCI and all the SRS resource sets will be transmitted according to the dropping rule.*

Please provide your views on Proposal 2.3.1-2 along with your supported alternative and/or to which alternative you have a strong objection:

|  |  |
| --- | --- |
| Company | View |
| Apple | We prefer not to further optimize this case (concluding on current spec based on Alt4 is sufficient) |
| Qualcomm | We are open to optimizing this case. Ideally, a UE may stay in the target CC if the separation between the SRSs is smaller than the time to tune back and forth – although the details need to be spelled out. |
| Samsung | Under the condition, Alt2, Alt3 or Alt4 can be available but we prefer Alt3. Alt2 does not allow to transmit or receive between two SRS resource sets and Alt4 can make unnecessary switching back if only SRS carrier switching is scheduled.  If we missed some issues, we are open to discuss. |
| ZTE | We think all SRS resource sets should be a whole. We prefer Alt 2 or Alt 3 |
| CATT | We are open to discuss whether Alt 3 is supported for this case. |
| MTK | We prefer not to further optimize this case (concluding on current spec based on Alt4 is sufficient) |
| Futurewei | Based on the current 38.214 text “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*”, our understanding of the UE behavior specified here is only “suspends”. Whether UE switches back to source or stay on the target depends on the time period between the SRS resource sets. When the time period is large enough such that there is a gap between the 2 intervals of “suspends” caused by the 2 SRS resource sets, UE should return to the source. Otherwise, the UE needs not return to the source. This is basically Alt.3 and no specification change is needed. |
| Intel | We support Alt 3.  If the UE always switch back to source CC, then the time is not sufficient for the UE to transmit the second SRS resource set if the gap is smaller than the required RF retuning time. |
| Ericsson | Ok to further discuss this case. Is the intention to consider Rel-17 SRS configurations? |

## Other issues

Other issues discussed by companies are provided below:

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| --- | --- | --- |
| Issue # | Company | View |
| Issue 1 | Vivo [2] | 1. To avoid misunderstanding in application scenario of collision handling rule, we can support the following modified version for updating the specification of 38.214.  |  | | --- | | 38.214 section 6.2.1.3  When SRS transmission on carrier c1 is performed according to the prioritization/dropping rules in this subclause, 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. | |
| Issue 2 | Intel [3] | Observation 1: From RAN1 spec perspective, DCI 2\_3 could be used for a CC without PUSCH/PUCCH or for a CC on which SRS power control is not tied with PUSCH.   * DCI 2\_3 could be configured as Type A or Type B.   Observation 2: According to RRC spec, Type A or Type B for DCI 2\_3 is only for a CC without PUSCH.  Observation 3: RAN1 spec and RRC spec are not fully aligned on the configuration of DCI 2\_3.  Proposal 4: RAN1 to clarify how to use DCI 2\_3 for a CC according to the current RRC spec, wherein over the CC SRS is configured with separate power control state as PUSCH. |
| Issue 3 | Samsung [4] | Observation 1: If the UE supports half-duplex TDD CA and SRS carrier switching, and if the UE should handle the directional collision and overlapping between SRS carrier switching on target CC and other UL transmission on source CC together, ambiguity of UE behavior can occur according to the application order between directional collision handling and priority check for SRS carrier switching.  Proposal 1: Need discussion related to ambiguity according to the application order between directional collision handling and priority check for SRS carrier switching.  Proposal 2: As a simple method to solve the ambiguity, we can consider that the application order follows the order of transmission or reception from the UE side in timeline. |

### First round of discussion:

Please provide your views on the priority of these issues. Moderator suggests that, due to the limited time, only high priority issues in this section be further discussed in this meeting. In the comment section, please also provide your views about the proposed solution by proponent for each issue. Provide alternative or modified solution if necessary.

|  |  |  |
| --- | --- | --- |
| **Company** | **Priority: High/Medium/Low** | **Comment** |
| Apple | Issue 1:  Issue 2:  Issue 3: High | Issue 1:  Issue 2:  Issue 3: We need to fist discuss and establish TDD conflict resolution rules for a HD UE when SRS CS is involved (which is not well specified for SRS CS in 38.213 Sec 11.1) |
| Samsung | Issue 1: Medium  Issue 2: Medium  Issue 3: High | Issue 1: We think that “During SRS transmission on carrier c1” can imply the condition added by Vivo but we are fine with the Vivo’s proposal.  Issue 2: This is not RAN1 issue. We can ask RAN2 to update the field description (2\_3 is used for SRS CS or SRS PC which is not tied with PUSCH PC)  Issue 3: We think the ambiguity can occur. So, we need to discuss and solve this issue. |
| CATT | Issue 1:  Issue 2:  Issue 3: High | Issue 1:  Issue 2:  Issue 3: We prefer to determine the direction first and then apply the dropping rule. |
| Futurewei | Issue 3: High | We are ok to discuss Issue 3. |
| Intel | Issue 1:  Issue 2: High  Issue 3: Medium | Issue 1:  Issue 2: We think RAN1 should clarify this issue. The feature is defined in RAN1, but the feature doesn’t work due to RAN2 spec configurations.  We suggest RAN1 to conclude that DCI 2\_3 could be used for a CC over which SRS is configured with separate power control state as PUSCH, but it doesn’t work due to RRC configuration. And we can send LS to notify RAN2.  Issue 3: Since it’s new issue, we need some time to check the details. But we could be open for discussion |

# Discussion outcome

# References

1. R1-2110965, Discussion on SRS carrier switching, ZTE
2. R1- 2111206, Discussion on SRS carrier switching, vivo
3. R1-2111474, Discussion on SRS carrier switching, Intel Corporation
4. R1-2111712, Discussion on ambiguity for SRS carrier switching, Samsung
5. R1-2112191, Discussion on SRS carrier switching, Qualcomm Incorporated
6. R1-2112413, Correction on prioritization rules of SRS carrier switching, Huawei, HiSilicon
7. [R1-2104067](file:///C:\Users\K00903651\AppData\Local\Temp\Docs\R1-2104067.zip) Summary of [104b-e-NR-7.1CRs-02] Correction on prioritization rules of SRS carrier switching, Moderator (Huawei, HiSilicon)
8. [R1-2106100](file:///D:\RAN1%20106-e\Agreements%20and%20SR%20and%20LS%20prior%20to%20106-e\Docs\R1-2106100.zip), Summary of [105-e-NR-7.1CRs-12] Issue#26 SRS carrier switching, Moderator (ZTE)
9. R1-2108320, Summary of [106-e-NR-7.1CRs-02] Issue#2: Correction on prioritization rules of SRS carrier switching, Moderator (Huawei, HiSilicon)