**3GPP TSG RAN WG1 Meeting #108-e R1-210xxxx**

**E-Meeting, February 21 – March 3, 2022**

**Agenda Item: 7.2.5**

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

**Title: Summary of [108-e-R16-URLLC-04] Issue#6: Discussion on determination of SRS resource set triggered by DCI format 2\_3**

**Document for: Discussion and Decision**

# Introduction

Following email thread is dedicated to discuss the Determination of SRS resource set triggered by DCI format 2\_3 according to the issues raised in R1-2112727 [1], R1-2201624 [2] and R1-2202120 [3]

[108-e-R16-URLLC-04] Issue#6: Discussion on determination of SRS resource set triggered by DCI format 2\_3 by February 25 – Thorsten (Huawei)

**Background**

The DCI formats 0\_2/1\_2 were introduced for Rel-16 URLLC and an SRS request field was included in both of them for triggering the transmission of an aperiodic SRS resource set. Correspondingly, independent from *srs-ResourceSetToAddModListDCI* used for DCI format 0\_1/1\_1, *srs-ResourceSetToAddModListDCI-0-2* was introduced for DCI formats 0\_2/1\_2. The SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* can be the same as or can also be different from the one in *srs-ResourceSetToAddModListDCI*.

In RAN1 #107-e, a CR on SRS resource set trigger for DCI format 0\_2 was discussed [1]. During this discussion a related question was raised for the situation when the UE is configured with both *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2* and the SRS resource set is triggered by DCI format 2\_3. It was said that it is then unclear what SRS resource set shall be used, and the suggested solution was to define to always take the SRS resource set(s) from *srs-ResourceSetToAddModList.*

Due to lack of time, this issue was not further discussed during that meeting.

# Discussion

## Round 1

**Due to the short time available for discussion, please provide you input for the first round before Feb 22, 06:00 am (UTC)**

When the DCI 2\_3 is used to trigger SRS resource set, then the usage of the SRS resource set should be set to '*antennaSwitching*'.

Therefore, a first question to discuss is if a SRS resource set can have *usage* set to “*antennaSwitching*” when being configured in *srs-ResourceSetToAddModListDCI-0-2.* If this would not be the case, then the possible ambiguity mentioned in the introduction cannot occur (and we could close this email thread with a corresponding conclusion).

According to Table 7.3.1.1.2-24 of TS38.212 [2], when the DCI format 2\_3 including the SRS request field is detected, the UE configured with *srs-TPC-PDCCH-Group* set to ‘*typeA*’ will transmit the SRS resource set(s) which are configured with higher layer parameter *usage* in *SRS-ResourceSet* set to '*antennaSwitching*' and *resourceType* in *SRS-ResourceSet* set to '*aperiodic'* in the set of serving cells according to code point of the SRS request.

However, according to TS38.214 [3], it is clear that the SRS resource set(s) configured in *srs-ResourceSetToAddModListDCI-0-2* can be used for codebook/non-codebook PUSCH transmission for Rel-16, but it is not clear whether SRS resource set(s) with *usage* set to '*antennaSwitching*' can be configured in *srs-ResourceSetToAddModListDCI-0-2*. This is because as opposed to the former, the usage “*antennaSwitching*” is not explicitly mentioned in the specification. This should be clarified firstly in the first round of discussion.

**Q1\_1: According to your understanding, following current specification, is it allowed to configure SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* with usage set to '*antennaSwitching*'?**

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| Company | Comments |
| Qualcomm | First, we don’t think this question is very relevant to the discussion. The issue about DCI format 2\_3 is which list of SRS resource sets the UE shall use when SRS resource set is triggered by DCI format 2\_3. We do not see a reason to mix this discussion with the **usage** of SRS resource set that can be triggered by each DCI format 0\_1/1\_1, or 0\_2/1\_2, or 2\_3. [Moderator1]: Thanks a lot for the feedback. According to my understanding, when DCI 2\_3 is triggering a SRS resource set, then the usage has to be set to ‘*antennaSwitching*’. I get this understanding from the part of the specification that I copied below. If my understanding is correct, then it is meaningful to clarify whether SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* can be configured with usage ‘*antennaSwitching’*. Because if they couldn’t, we would not have an ambiguity issue when DCI 2\_3 is triggering the SRS resource set(s), because they could only come from *srs-ResourceSetToAddModList.*It would be great to hear if you agree with my reasoning and it would also be great to hear the views of others. From 38.214

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| For an aperiodic SRS triggered in DCI format 2\_3 and if the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeA', and given by *SRS-CarrierSwitching,* without PUSCH/PUCCH transmission, the order of the triggered SRS transmission on the serving cells follow the order of the serving cells in the indicated set of serving cells configured by higher layers, where the UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'. For an aperiodic SRS triggered in DCI format 2\_3 and if the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeB' without PUSCH/PUCCH transmission, the order of the triggered SRS transmission on the serving cells follow the order of the serving cells with aperiodic SRS triggered in the DCI, and the UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'. |

But just for information, we think this is allowed. Recall that the motivation of introducing the RRC parameter ***srs-ResourceSetToAddModListDCI-0-2*** is to configure the size of the SRS request field in DCI format 0\_2, 1\_2 to be smaller than that of DCI format 0\_1/1\_1. There is no intention to limit the functionality of DCI format 0\_2/1\_2 in terms of the type of SRS can be triggered.  |
| Nokia/NSB | According to our understanding, there is no restriction to not allow the configuration with ‘antennaSwitching’ for srs resource set for DCI format 0\_2.  |
| DOCOMO | Share the same view as Nokia/NSB. In our understanding, it is allowed to configure SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* with usage set to *'antennaSwitching'* |
| Samsung | Since there is no agreement to make a restriction for usage for DCI format 0\_2, it should be understood that ‘antennaSwitching’ is allowed for DCI format 0\_2 in current specification.  |
| vivo | In our understanding, there is no restriction on usage for DCI format 0\_2. So, the usage in SRS resource set(s) configured in srs-ResourceSetToAddModListDCI-0-2 can be set to ‘antennaSwitching’. |
| ZTE | In Rel-16, there was no discussion and therefore no such restriction on the usage configuration for the SRS for DCI format 0\_2. The mentioned configuration is allowed.  |
| Intel | Same view as others above – there is no restriction regarding association of “antennaSwitching” usage with DCI format 0\_2. |
| OPPO | Similar view as other companies above, it should be allowed. |
| HW/HiSi | In our view, it is not clear that usage ‘*antennaSwitching*’ can be configured in *srs-ResourceSetToAddModListDCI-0-2****.*** If this would be the case, then it should have been treated in a similar way as the usage ‘codebook’ in 6.1.1.1 of 38.214.Only one SRS resource set can be configured in *srs-ResourceSetToAddModList* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook', and only one SRS resource set can be configured in *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook'.For codebook, both lists are explicitly mentioned. The same handling in the spec should then apply to usage ‘*antennaSwitching*’. |

The answer to Q1\_1 is the most important outcome for Round 1, since it will set the further direction of the discussion in this thread. However, since we only have 1 week to conclude this email thread, it will be good if companies already now also could give their views on the potential follow up issues:

If it is concluded in Q1\_1 that the current spec does support to configure SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* with usage set to '*antennaSwitching*', then the ambiguity raised in the introduction can occur and RAN1 should discuss further how to resolve it. Two options have been provided by companies ([2], [3]) and it would be good to hear more views, even if Question 1\_1 has not been concluded yet.

**Option 1 was raised in [3].** In his approach, to avoid the potential ambiguity, it is restricted from which higher layer parameter the SRS resource set(s) have to be taken, i.e. from *srs-ResourceSetToAddModListDCI,*

**Proposal from [3]: to avoid ambiguity when DCI 2\_3 is used to trigger SRS resource set(s)**

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| The SRS request field [5, TS38.212] in DCI format 0\_1, 1\_1, 0\_2 (if SRS request field is present), 1\_2 (if SRS request field is present) indicates the triggered SRS resource set given in Table 7.3.1.1.2-24 of [5, TS 38.212]. The 2-bit SRS request field [5, TS38.212] in DCI format 2\_3 indicates the triggered SRS resource set given in Clause 7.3 of [5, TS 38.212] and defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* if the UE is configured with higher layer parameter srs-TPC-PDCCH-Group set to 'typeB', or indicates the SRS transmission on a set of serving cells configured by higher layers if the UE is configured with higher layer parameter srs-TPC-PDCCH-Group set to 'typeA'. |

Option 1 is also discussed in [2]. According to the views raised in [2], a potential disadvantage with the above mentioned approach is that it might be restrictive and that it also would still allow that the *usage* can be set to “*antennaSwitching*” in both RRC parameters at the same time, even if they cannot be used together for DCI 2\_3.

Regarding the implementation impact of Option 1, it is said in [2] that it could result into an increase with factor 2 compared to Rel-15. The reason is that in Rel-15, the SRS resource set(s) configured in *srs-ResourceSetToAddModList* can be used for codebook/non-codebook PUSCH transmission, antenna switching/SRS carrier switching and beam management. For each application, the number of configured SRS resource sets is limited. For example, only one SRS resource set can be configured in *srs-ResourceSetToAddModList* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'non-codebook'. For SRS antenna switching, up to two SRS resource sets can be configured for different combinations of transmission and reception antenna switching such as “1T2R/2T/4R”. For beam management, the number of configured SRS resource sets depends on the indicated UE capability and the maximum number of configured SRS resource sets can be up to 8. If SRS resource set(s) with *usage* set to '*antennaSwitching*' also could be configured in *srs-ResourceSetToAddModListDCI-0-2*, then it seems likely that the same maximum numbers as defined in Rel-15 for configured SRS resource set(s) in *srs-ResourceSetToAddModList* should be assumed. But this could imply that the overall maximum number of configured SRS resource set(s) for different values of *usage* increases by a factor of 2 when both *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2* are configured.

**Option 2 was raised in [2].** To ease the implementation cost and to allow some more flexibility compared to Option 1, it is proposed that instead of constraining from which list to select the SRS resource set, to restrict the configurations for *usage* “*antennaSwitching*”.

Proposal from [2]: to avoid ambiguity when DCI 2\_3 is used to trigger SRS resource set(s)

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| ***Proposal: The SRS resource set(s) with 'usage' set to 'antennaSwitching'*** * ***Can only be configured for SRS resource set(s) in srs-ResourceSetToAddModList when both srs-ResourceSetToAddModList and srs-ResourceSetToAddModListDCI-0-2 are provided.***
* ***Can be configured in srs-ResourceSetToAddModList if only srs-ResourceSetToAddModList is provided and can be configured in srs-ResourceSetToAddModListDCI-0-2 if only srs-ResourceSetToAddModListDCI-0-2 is provided***
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**Moderator comment:**

Given the descriptions of Option 1 and Option 2 above, it would be great to hear more views from other companies how to address the potential ambiguity if SRS resource set(s) are triggered by DCI format 2\_3 and *usage* of SRS resource set(s) can be set to “*antennaSwitching*” in both *srs-ResourceSetToAddModList* and in *srs-ResourceSetToAddModListDCI-0-2*.

**Q1\_2: Assuming that *usage* for SRS resource set(s) can be set to “*antennaSwitching*” in both *srs-ResourceSetToAddModList* and in *srs-ResourceSetToAddModListDCI-0-2*, which option do you prefer to resolve the potential ambiguity (Option 1, Option 2, any other option)? Please give also your reason.**

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| Company | Comments |
| Qualcomm | **Option 1.**In our view, the issue is about which RRC parameter to use for SRS resource set triggered by DCI format 2\_3, when UE is configured with both *srs-ResourceSetToAddModList* and in *srs-ResourceSetToAddModListDCI-0-2.* Since thesize of the SRS request field in DCI format 2\_3 is the same as that in DCI format 0\_1/1\_1, it is natural to let UE follow the SRS resource set configured by *srs-ResourceSetToAddModList,* which is also the Rel-15 approach anyway (and this is in fact the reason why the Rel-15 spec didn’t explicitly mention the RRC parameter for SRS resource sets associated with DCI format 2\_3).   |
| Nokia, NSB | Option 1We agree with Qualcomm on the reasoning here, that based on the Rel-15 operation DCI format 2\_3 uses *srs-ResourceSetToAddModList*. We don’t see a need to change this operation in Rel-16 (as nothing seems to be broken, no need to change the operation here now for DCI format 2\_3 triggering).  |
| DOCOMO | Option 1.Share the same view as Qualcomm and Nokia/NSB. |
| Samsung | Option 1 because it is simple. No further optimization is needed at this stage.  |
| vivo | Option 1.According to our understanding, in current 38.331 spec, ***srs-ResourceSetToAddModListDCI-0-2*** is used to configure the list of SRS resource set to be added or modified for DCI format 0\_2, not for DCI format 2\_3. DCI format 2\_3 follows Rel-15 approach, i.e. uses the SRS resource set configured by *srs-ResourceSetToAddModList.*

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| ***srs-ResourceSetToAddModListDCI-0-2***List of SRS resource set to be added or modified for DCI format 0\_2 (see TS 38.212 [17], clause 7.3.1). |

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| ZTE | Option 1. We just introduced a new SRS list for new DCI format and didn’t enhance DCI format 2\_3 in Rel-16. So the legacy operation is used. That is the SRS defined by the higher layer parameter *ResourceSetToAddModList* is indicated by DCI format 2\_3. |
| Apple | Option 1. It seems the compact DCI design has brought endless troubles.  |
| Intel | Option 1.For the reasons explained by companies above that DCI 2\_3 should follow the Rel-15 SRS resource set configuration, via *srs-ResourceSetToAddModList*. |
| OPPO | Option 1. |
| HW/HiSi | Option 2. |

If you any have further aspect that should be taken into account for the continued discussion, you can bring them up here:

**Q1\_3: Do you have any further aspect you want to raise for the continued discussion?**

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| Company | Comments |
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**Summary of Round 1:**

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| Question 1\_1: | According to your understanding, following current specification, is it allowed to configure SRS resource set(s) in *srs-ResourceSetToAddModListDCI-0-2* with usage set to '*antennaSwitching*'? |
| allowed | (9): QC, Nokia/NSB, DOCOMO, Samsung, vivo, ZTE, Apple, Intel, Oppo  |
| Not allowed |  |
| Not clear if it is allowed | (1): HW/HiSi |

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| Question 1\_2: | Q1\_2: Assuming that *usage* for SRS resource set(s) can be set to “*antennaSwitching*” in both *srs-ResourceSetToAddModList* and in *srs-ResourceSetToAddModListDCI-0-2*, which option do you prefer to resolve the potential ambiguity (Option 1, Option 2, any other option)? Please give also your reason. |
| Option 1 | (8): QC, Nokia/NSB, DOCOMO, Samsung, vivo, ZTE, Apple, Intel, Oppo  |
| Option 2 | (1): HW/HiSi |

## Round 2

**Due to the short time available for discussion, please provide you input for the second round before Feb 23, 19:00 pm (UTC)**

The outcome of Round 1shows

1. A majority support (9 vs 1) for the understanding that the current specification allows SRS resource sets with *usage* ‘antennaSwitching’ can be configured in *ResourceSetToAddModListDCI-0-2*.
	1. HW/HiSi expressed a different opinion and pointed out that it is not clear, since for usage “*codebook*”, both *srs-ResourceSetToAddModList* and in *srs-ResourceSetToAddModListDCI-0-2* are explicitly mentioned in the specification, but for usage ‘antennaSwitching’ this is missing.
	2. Other companies answered that no restrictions have been discussed for the usage with DCI format 0\_2 and therefore all usages should be allowed.
2. A majority support (9 vs 1) to adopt Option 1 to resolve a potential ambiguity when a SRS resource set is triggered with DCI format 2\_3

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| 38.214 , section 6.2.1< Unchanged parts are omitted >The SRS request field [5, TS38.212] in DCI format 0\_1, 1\_1, 0\_2 (if SRS request field is present), 1\_2 (if SRS request field is present) indicates the triggered SRS resource set given in Table 7.3.1.1.2-24 of [5, TS 38.212]. The 2-bit SRS request field [5, TS38.212] in DCI format 2\_3 indicates the triggered SRS resource set given in Clause 7.3 of [5, TS 38.212] and defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* if the UE is configured with higher layer parameter srs-TPC-PDCCH-Group set to 'typeB', or indicates the SRS transmission on a set of serving cells configured by higher layers if the UE is configured with higher layer parameter srs-TPC-PDCCH-Group set to 'typeA'.< Unchanged parts are omitted > |

Before going further and concluding on the outcome and finalizing the TP accordingly, additional clarifications in the maximum number of configurable SRS resource sets seem to be needed and it would be great to hear more views:

There seems to be a difference how *usage* ‘codebook’ is handled compared to *usage* ‘antennaSwitching’. This should be clarified to avoid misunderstanding between gNB and UE implementations.

Usage ‘codebook’:

If we look at the part of the specification that defines *usage* ‘codebook’ which is copied below, both lists are explicitly mentioned and at most one SRS resource set can be configured per list. Thus, the maximum number of SRS resource sets with usage “codebook” is 2.

From 38.214, section 6.1.1.1 Codebook based UL transmission

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| The *SRS-ResourceSet(s)* applicable for PUSCH scheduled by DCI format 0\_1 and DCI format 0\_2 are defined by the entries of the higher layer parameter *srs-ResourceSetToAddModList* and *srs-ResourceSetToAddModListDCI-0-2* in *SRS-config*, respectively. Only one SRS resource set can be configured in *srs-ResourceSetToAddModList* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook', and only one SRS resource set can be configured in *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' |

Usage ‘antennaSwitching’:

If we now look at the part of the specification that defines *usage* ‘antennaSwitching’, the situation is different. Neither *srs-ResourceSetToAddModList* nor *srs-ResourceSetToAddModListDCI-0-2* are mentioned. Instead, it is specified that the UE transmits “the one or two SRS resource sets” configured with *usage* ‘antennaSwitching’. This could be read that the maximum number of SRS resource sets that can be **configured together in both lists** should not be more than two (since according to the majority view, it is allowed to configure *usage* ‘antennaSwitching’ also in *srs-ResourceSetToAddModListDCI-0-2*)*.*

From 38.214, Section 6.2.1.3 UE sounding procedure between component carriers

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| For an aperiodic SRS triggered in DCI format 2\_3 and if the UE is configured with higher layer parameter *srs-TPC-PDCCH-Group* set to 'typeA', and given by *SRS-CarrierSwitching,* without PUSCH/PUCCH transmission, the order of the triggered SRS transmission on the serving cells follow the order of the serving cells in the indicated set of serving cells configured by higher layers, where the UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching' and higher layer parameter *resourceType* in *SRS-ResourceSet* set to 'aperiodic'. |

Therefore, before going further with the final TP, I would like to ask the group the following two questions:

*Q2\_1a: For the following, is your understanding Opt1, Opt2, something else? For the part of the of 38.214 (Section 6.2.1.3) given as “UE in each serving cell transmits the configured one or two SRS resource set(s) with higher layer parameter usage set to 'antennaSwitching”, the “two SRS resource sets” refer to*

* *Opt1: The maximum number of SRS resource sets that can be configured with usage ‘antennaSwitching’ in srs-ResourceSetToAddModList*
	+ *Note: then the maximum number of SRS resource sets that can be configured in srs-ResourceSetToAddModListDCI-0-2 has to be define, e.g = [2]*
* *Opt2: The maximum number of SRS resource sets that can be configured in total with usage ‘antennaSwitching’ together in srs-ResourceSetToAddModList and srs-ResourceSetToAddModListDCI-0-2*

*Q2\_1b: Do you think a clarification in the specification (or conclusion) needed to capture your understanding about the maximum number of SRS resource sets that can be configured with usage ‘antennaSwitching”?*

* *For example for Opt1:*

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| *38.214. section 6.2.1.3**…where the UE in each serving cell transmits the configured one or two SRS resource set(s) from srs-ResourceSetToAddModList with higher layer parameter usage set to 'antennaSwitching'…..”* |

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| Company | Comments |
| vivo | For Q2\_1a:Since DCI format 2\_3 uses *srs-ResourceSetToAddModList,* one or two SRS resource set(s) with higher layer parameter *usage* set to 'antennaSwitching are also associated with *srs-ResourceSetToAddModList.* Our understanding is *Opt 1.*For Q2\_1b:In our opinion, the current spec is clear and no conclusion is needed. |
| Nokia/NSB | Q2\_1a: Agree with vivoQ2\_1b: we are open for a clarification as noted above adding ‘*from srs-ResourceSetToAddModList’* |
| DOCOMO | Q2\_1a: agree with vivo and Nokia/NSBQ2\_1b: we are open for the clarification change. |
| ZTE | Q2\_1a:We share the same view with vivo, Nokia and DOCOMO. In Rel-16, this issue was not discussed. Therefore, it should be the same with Rel-15.Q2\_1b:We share the same view with vivo. The spec is clear. |
| Qualcomm | **Q2\_1a:**We think the issue pointed out by the moderator is valid. A similar issue regarding SRS resource set with usage=”codebook” or “noncodebook” was discussed in RAN1 105e, in which we agreed that the SRS resource set with usage equal to “codebook” or “noncodebook” configured in *srs-ResourceSetToAddModListDCI-0-2* shall be either equal to or be a subset of the SRS resource set with the same usage configured in *srs-ResourceSetToAddModList.* This way, the maximum number of SRS resource set that the UE need to support with usage equal to “codebook” or “noncodebook” doesn’t increase compared to Rel-15. We think a similar approach could be taken for SRS resource set configured with usage=*’antennaswitching’*. That is, the SRS resource set(s) with usage=”*antennaswitching*” configured in *srs-ResourceSetToAddModListDCI-0-2* shall not be different from the SRS resource set(s) configured in *srs-ResourceSetToAddModListDCI* with the same usage. With this restriction, Option 1 and Option 2 become equivalent.**Q2\_1b:** we are open for the clarification change. |

# Outcome

TBD

# References

1. R1-2112727 Summary of email discussion [107-e-NR-L1enh-URLLC-08] Miscellaneous corrections on Rel-16 URLLC, RAN1 (Huawei), RAN1#107-e, e-Meeting, Nov. 11 – 19, 2021.
2. R1-2201624 Corrections on SRS, RAN1#108-e, e-Meeting, February 21 – March 3, 2022, Huawei, HiSilicon
3. R1-2202120 Draft 38.214 CR on SRS resource set trigger for DCI format 2\_3, RAN1#108-e, e-Meeting, February 21 – March 3, 2022, Qualcomm