3GPP TSG RAN WG1 Meeting #108-e R1-220xxxx

**e-Meeting, February 21st - March 3rd, 2022**

**Source: Moderator (ZTE)**

Title: FL summary #2 on SRS enhancements

Agenda Item: 8.1.3

Document for: Discussion and Decision

# Technical issues

## Issue 3.1: Support more antenna switching configurations

***FL Proposal 3-1:*** *Support N = 1 for aperiodic SRS configuration for 1T4R*

* *This new configuration is UE optional.*

Companies’ further views are collected as follows.

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| Companies | Views |
| *FL* | Status of the first round:Supported by CATT, NTT DOCOMO, Intel, vivo, Qualcomm, CMCC, Huawei/HiSilicon, XiaomiConcern: EricssonThe only company who showed concern in the first round is Ericsson. I’d like to check with Ericsson whether proposal 3-1 is acceptable given it seems the majority can support this new configuration. |
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## Issue 3.3: Handling of the case where the interval between SRS resource sets is larger than Y

Table 3-3

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| **Issue 3.3: How to handle the case where the interval between SRS resource sets is larger than Y** |
| Alternatives | Companies |
| Alt 1: UL/DL signals are allowed to be transmitted in the interval between SRS resource sets for antenna switching when the interval is larger than Y symbols, i.e., no scheduling restriction | CMCC, Huawei/HiSilicon, NTT DOCOMO, Lenovo/MotM, Xiaomi |
| Alt 2: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, Y consecutive symbols in the interval is reserved for scheduling restriction.* Supported by Nokia/NSB, CATT, NTT DOCOMO, vivo, NEC, Intel, OPPO, LGE, CMCC, InterDigital
 | Alt 2-1: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, the position of guard period for scheduling restriction is the last Y symbols of the interval. | Nokia/NSB, CATT, NTT DOCOMO, OPPO, NEC, Intel, InterDigital |
| Alt 2-2: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, the position of guard period for scheduling restriction is the first Y symbols of the interval | Nokia/NSB, CATT, OPPO, NEC, Intel, Interdigital, NTT DOCOMO |
| Alt 2-3: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, the position of guard period for scheduling restriction is configured by signaling | Vivo, LGE |
| Alt 3: Any DL/UL signal is not expected to be transmitted in the interval between two SRS resource sets | Qualcomm, InterDigital, Apple |
| Alt 4: If the interval between two SRS resource sets for antenna switching is larger than 2Y symbols, the first Y symbols and the last Y symbols of the interval are reserved for scheduling restriction. | Samsung |

***FL Proposal 3-3:*** *Support one of the Alts for handling the case where the interval between SRS resource sets is larger than Y.*

* *Alt 1: UL/DL signals are allowed to be transmitted in the interval between SRS resource sets for antenna switching when the interval is larger than Y symbols, i.e., no scheduling restriction*
* *Alt 2: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, Y consecutive symbols in the interval is reserved for scheduling restriction.*
	+ *Alt 2-1: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, the position of guard period for scheduling restriction is the last Y symbols of the interval.*
	+ *Alt 2-2: If the interval between two SRS resource sets for antenna switching is larger than Y symbols, the position of guard period for scheduling restriction is the first Y symbols of the interval*

Companies’ further views are collected as follows.

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| --- | --- |
| Companies | Views |
| *FL* | Looks like Alt 2-1, Alt 2-2 and Alt 1 attracts most companies. Based on this merit, FL would like to ask companies to indicate which one(s) from these three alternatives is acceptable to you. |
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## Issue 4.1: Applicable case of RPFS

Table 4-1

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| **Issue 4.1: Whether RPFS is applicable to non-FH case** |
| Views | Companies |
| RPFS is applicable for frequency hopping case only | Intel, Qualcomm, OPPO, vivo |
| RPFS is applicable for both frequency hopping and non-frequency hopping cases | Ericsson, Huawei/HiSilicon, Futurewei, CATT, NTT DOCOMO, Lenovo/MotM, Spreadtrum, NEC, Samsung, Xiaomi |
| Support of RPFS for non-FH case is an optional UE feature for UEs supporting RPFS | ZTE |

***FL Proposal 4-1:*** *RPFS is applicable for both frequency hopping and non-frequency hopping cases, where support of RPFS for non-FH case is an optional UE feature for UEs supporting RPFS.*

Companies’ further views are collected as follows.

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| Companies | Views |
| *FL* | This is about an editor’s note in TS 38.211, which has to be addressed. Majority of companies support to apply RPFS on both FH and non-FH. Considering the concern from 4 companies holding negative view, FL recommends proposal 4-1 as a compromise. Please indicate whether it is acceptable to you or you have better suggestions.  |
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## Issue 4.3: Maximum number of CSs for RPFS

Table 4-3

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| **Issue 4.3: To address the issue of Max CS for RPFS** |
| Views | Companies |
| Alt 1: Clarify in TS 38.211 that $n\_{SRS}^{CS,max}=6$ for comb-2 and comb-4 if the length of SRS sequence is 6. | ZTE |
| Alt 2: If $P\_{F}$ is configured to be 2 or 4, the maximum number of cyclic shifts should be based on the SRS sequence length, for example, a function of $K\_{TC}$ and $P\_{F}$, and when $K\_{TC}=2$ and $P\_{F}=2$, $n\_{SRS}^{cs,max}=12$, otherwise $n\_{SRS}^{cs,max}=6$. | NEC |

***FL Proposal 4-3:*** *When P\_F = 2 or 4,*

* $n\_{SRS}^{cs,max}=12$ *if P\_F is 2 and K\_TC = 2, otherwise* $n\_{SRS}^{cs,max}=6$*.*

Companies’ further views are collected as follows.

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| --- | --- |
| Companies | Views |
| *FL* | On the technical need to address this issue, based on FL’s understanding, there are at least the following issues to support 4 ports* When the sequence length is 6, and comb 2 or comb 4 is configured, $n\_{SRS}^{CS,max}=8 $ or 12 based on the current specification. In this case, one comb offset cannot accommodate 4 ports. If we set $n\_{SRS}^{CS,max}=6$ in these cases, which is natural given the sequence length is 6, two comb offsets are used for all the configured CSs. Then there would be no issue to carry 4 ports.
* (copied from NEC’s comment in round 1) When $K\_{TC}=2$ and sequence length is 6 (actually the issue exists not only for sequence length is 6, but also when sequence length is a multiple of 6 but not a multiple of 8, e.g. 12, 36,…), based on current $n\_{SRS}^{cs,max}$ determination rule, $n\_{SRS}^{cs,max}$ is determined to be 8, so there is no way to allocate CS0/4 on comb 1 and CS 2/6 on comb 2 for 4-port SRS based on following formula, the condition for the first row can not be satisfied, as $n\_{SRS}^{cs,max}$ is determined to be 8, and for the second row, as we discussed in our contribution, there are always 3 ports on same REs, so orthogonality cannot be achieved.

$$k\_{TC}^{\left(p\_{i}\right)}=\left\{\begin{matrix}\left(\overbar{k}\_{TC}+{K\_{TC}}/{2}\right) mod K\_{TC}&if N\_{ap}^{SRS}=4, p\_{i}\in \left\{1001, 1003\right\}, and n\_{SRS}^{cs,max}=6 \\\left(\overbar{k}\_{TC}+{K\_{TC}}/{2}\right) mod K\_{TC} &if N\_{ap}^{SRS}=4, p\_{i}\in \left\{1001, 1003\right\}, and n\_{SRS}^{cs}\in \left\{{n\_{SRS}^{cs,max}}/{2}, …, n\_{SRS}^{cs,max}-1\right\}\\\overbar{k}\_{TC}&otherwise\end{matrix}\right.$$FL would like to ask companies to think about this technical issue seriously and feed back your comments/understanding with technical arguments, rather than just stating that more discussion is needed. |
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# Text proposals

## TP 2-1 – Part 2

***TP 2-1 – Part 2 (from Futurewei):*** *For the text in clause 6.2.1, TS 38.214 v17.0.0 on AP SRS triggering*

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| **<**Unchanged text is omitted>- If the UE receives the DCI triggering aperiodic SRS in slot *n* and at least one resource set is configured with parameter *availableSlotOffset* across all configured BWPs in a component carrier for the triggered aperiodic SRS transmission except when SRS is configured with the higher layer parameter *SRS-PosResource*, …**<**Unchanged text is omitted> |

Companies’ further views are collected as follows.

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| --- | --- |
| Companies | Views |
| *FL* | Supported by OPPO, Lenovo/MotM, Spreadtrum, Futurewei, Apple, Ericsson, Xiaomi, Huawei/HiSiliconConcern: NTT DOCOMO, CATT, Qualcomm, InterDigital@Futurewei, FL’s understanding is that for cross-carrier scheduling/triggering, the current spec has somehow specified DCI signaling should be applied on the scheduled CC as clause 7.3.1 of TS 38.212 has clearly stated the size of the DCI field depends on the scheduled CC. With this, it would be nice if you can further elaborate why this TP is additionally needed.  |
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## TP 2-3

***TP 2-3 (from CATT):*** *Adopt the following TP for TS38.214 on AP-SRS*

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| ----------------Start of TP for TS38.214---------------------6.2.1 UE sounding procedure……- Slot level periodicity and slot level offset as defined by the higher layer parameters *periodicityAndOffset-p* or *periodicityAndOffset-sp* for an SRS resource of type periodic or semi-persistent. The UE is not expected to be configured with SRS resources in the same SRS resource set *SRS-ResourceSet* or *SRS-PosResourceSet* with different slot level periodicities. For an *SRS-ResourceSet* configured with higher layer parameter *resourceType* set to ‘aperiodic’, a slot level offset is defined by the higher layer parameter *slotOffset.* For an *SRS-ResourceSet* configured with higher layer parameter *resourceType* set to ‘aperiodic’, a list of zero up to four available slot offset values from the reference slot *n* + *k* to the slot where the aperiodic SRS resource set is transmitted where *n* is the slot with triggering DCI and *k* is *SlotOffset* is defined by the higher layer parameter *AvailableSlotOffset.* The parameter *AvailableSlotOffset* can be configured up to 4 values*.* For an *SRS-PosResourceSet* configured with higher layer parameter r*esourceType* set to ‘aperiodic’, the slot level offset is defined by the higher layer parameter *slotOffset* for each SRS resource.……*- t* is configured via higher layer parameter *availableSlotOffset* with up to four valuesfor each triggered SRS resources set and is based on the subcarrier spacing of the triggered SRS transmission. When one or more SRS resource sets across all configured BWPs in a component carrier are configured, and at least one resource set is configured with *availableSlotOffset* parameter of more than one values, the indicated value of *availableSlotOffset* is indicated by SOI field in DCI scheduling PUSCH/PDSCH and DCI 0\_1/0\_2 without data and without CSI request described in [5, TS 38.212]. The UE shall apply indicated value of *availableSlotOffset* set specificallyfor those sets with configured *availableSlotOffset* parameter. When one or more SRS resource sets across all configured BWPs in a component carrier are configured and at least one resource set is configured with *availableSlotOffset* parameter, and the *availableSlotOffset* parameter for each SRS resource set has only one value, the UE shall apply the configured value of *availableSlotOffset* specificallyfor those sets with configured *availableSlotOffset* parameter. For SRS resource set configured with *availableSlotOffset* parameter, each of resource set is configured with *K* values of *availableSlotOffset* parameter. For SRS resource set configured without *availableSlotOffset* parameter, *t* = 0 is applied for each of resource set.……----------------End of TP for TS38.214--------------------- |

Companies’ further views are collected as follows.

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| --- | --- |
| Companies | Views |
| *FL* | Status of the first round: Supported by CATT, Intel, vivo, CMCC, Huawei/HiSilicon, InterDigitalConcern: Qualcomm, LGE, Apple, Ericsson, XiaomiFL would like to ask companies to provide more technical argument on why this TP is needed or not needed. |
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## TP 3-1

***TP 3-1 (from CMCC):*** *For the enhancement on antenna switching up to 8Rx, the TP suggestion for TS 38.214 in Section 6.2 is as the following*

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| **<**Unchanged text is omitted>- For 1T8R, zero or one or two SRS resource sets configured with a different value for the higher layer parameter *resourceType* in *SRS-ResourceSet* set to ‘periodic ‘or ‘semi-persistent’ if the UE is not indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets], or up to two SRS resource sets configured with ‘semi-persistent’ and up to one SRS resource set configured with ‘periodic’ if the UE is indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets], where the two SRS resource sets configured with ‘semi-persistent’ are not activated at the same time. Each SRS resource set with eight SRS resources transmitted in different symbols, and where the SRS port of each SRS resource in each set is associated with a different UE antenna port. And**<**Unchanged text is omitted> |

Companies’ further views are collected as follows.

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| Companies | Views |
| *FL* | Status of the first round: Supported by OPPO, CATT, NTT DOCOMO, vivo, Lenovo/MotM, LGE, CMCC, Huawei/HiSilicon, Apple, EricssonConcern: Intel, Samsung@Intel, Samsung, FL’s understanding on the intention of this TP is to clarify when [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets] is not supported, two configured SRS resource sets has to be one periodic set and one semi-persistent set. Configurations like two periodic sets cannot be used in this case. This text is aligned with legacy description of <=4Rx. With this, can you accept this TP? |
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## TP 3-2

***TP 3-2 (From Huawei/HiSilicon):*** *We have the following text proposal for TS 38.214 V17.0.0*

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| < Start of the text proposal >6.2.1.2 UE sounding procedure for DL CSI acquisition< Unchanged parts are omitted >- For 1T=1R, or 2T=2R, or 4T=4R, up to two SRS resource sets each with one SRS resource, where the number of SRS ports for each resource is equal to 1, 2, or 4. If the UE is indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets],two SRS resource sets configured with *resourceType* in *SRS-ResourceSet* set to ‘*semi-persistent*’ and one SRS resource set configured with *resourceType* in *SRS-ResourceSet* set to ‘*periodic*’ also can be configured, where each SRS resource set has one SRS resource, the number of SRS ports for each resource is equal to 1, 2, or 4, and the two SRS resource sets configured with ‘semi-persistent’ are not activated at the same time, or< End of the text proposal > |

Companies’ further views are collected as follows.

|  |  |
| --- | --- |
| Companies | Views |
| *FL* | Status of the first round: Supported by NTT DOCOMO, LGE, Xiaomi, Huawei/HiSiliconConcern: OPPO, CATTCATT’s alternative TP: - For 1T=1R, or 2T=2R, or 4T=4R, up to two SRS resource sets each with one SRS resource, where the number of SRS ports for each resource is equal to 1, 2, or 4. If the UE is indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets], up to two SRS resource sets configured with *resourceType* in *SRS-ResourceSet* set to ‘*semi-persistent*’ and up to one SRS resource set configured with *resourceType* in *SRS-ResourceSet* set to ‘*periodic*’, where the number of SRS ports for each resource is equal to 1, 2, or 4 and the two SRS resource sets configured with ‘semi-persistent’ are not activated at the same time, or up to two SRS resource sets each with one SRS resource, where the number of SRS ports for each resource is equal to 1, 2, or 4. OrHuawei/HiSilicon’s further clarification/response:* The wording in current spec is misleading that Rel-17 UE with the new capability even cannot support 1 Aperiodic SRS! It is incorrect.
* @ CATT: we appreciate the configuration combinations you listed and that’s why this TP is introduced. In terms of the INCORRECT situation “*the UE can be configured with up to 5 SRS resource sets*” you mentioned, this cannot happen, since the word “*also*” here doesn’t mean and cannot be interpreted as “additional”, it only guarantees that both “2SP + 1P” configuration and legacy configurations mentioned above are configurable when [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets] is supported.

Based on the above discussion, please indicate whether you can accept this TP 3-2 or the alternative TP from CATT, or suggest a better way to make the spec clearer.  |
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## TP 4-2

***TP 4-2 (from CATT):*** *The repetition factor R for Rel-17 SRS coverage and capacity enhancement and SRS transmission with frequency hopping when*$ N\_{s}$ *> 4, R > 2 need to be captured in current specification and the following TP for TS38.214 is adopted.*

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| --- |
| ----------------Start of TP for TS38.214---------------------6.2.1.1 UE SRS frequency hopping procedureFor a given SRS resource, the UE is configured with repetition factor R∈{1,2,4} or R∈{1,2,3,4,5,6,7,8,10,12,14} by higher layer parameter *resourceMapping* in *SRS-Resource* where *R*≤*Ns*. When frequency hopping within an SRS resource in each slot is not configured (*R=Ns*), each of the antenna ports of the SRS resource in each slot is mapped in all the  symbols to the same set of subcarriers in the same set of PRBs. When frequency hopping within an SRS resource in each slot is configured without repetition (*R=1*), according to the SRS hopping parameters , and defined in clause 6.4.1.4 of [4, TS 38.211], each of the antenna ports of the SRS resource in each slot is mapped to different sets of subcarriers in each OFDM symbol, where the same transmission comb value is assumed for different sets of subcarriers. When both frequency hopping and repetition within an SRS resource in each slot are configured (*Ns*>=*4, R* >= *2*), each of the antenna ports of the SRS resource in each slot is mapped to the same set of subcarriers within each pair of R adjacent OFDM symbols, and frequency hopping across the $\frac{N\_{s}}{R}$ pairs is according to the SRS hopping parameters , and ,where $N\_{s}$ should be divisible by $R$.For operation with shared spectrum channel access, the UE does not expect that multiple hops of an SRS resource transmission are in different RB sets.A UE may be configured $N\_{s}=24 $adjacent symbol aperiodic SRS resource with intra-slot frequency hopping within a bandwidth part, where the full hopping bandwidth is sounded with an equal-size subband across  symbols when frequency hopping is configured with *R=1*. A UE may be configured $N\_{s}4$ adjacent symbols aperiodic SRS resource with intra-slot frequency hopping within a bandwidth part, where the full hopping bandwidth is sounded with an equal-size subband across $\frac{\_{}}{}$ pairs of *R* adjacent OFDM symbols, when frequency hopping is configured with *R*$\geq $*2,* $ N\_{s}>R$and$\_{}$ should be divisible by $R$. Each of the antenna ports of the SRS resource is mapped to the same set of subcarriers within each pair of R adjacent OFDM symbols of the resource.A UE may be configured symbol periodic or semi-persistent SRS resource with inter-slot hopping within a bandwidth part, where the SRS resource occupies the same symbol location in each slot. A UE may be configured$N\_{s}=24$ symbol periodic or semi-persistent SRS resource with intra-slot and inter-slot hopping within a bandwidth part, where the N-symbol SRS resource occupies the same symbol location(s) in each slot. For $N\_{s}4$, when frequency hopping is configured with *R*$\geq $*2*, intra-slot and inter-slot hopping is supported with each of the antenna ports of the SRS resource mapped to different sets of subcarriers across $\frac{\_{}}{}$pairs of *R* adjacent OFDM symbol(s) of the resource in each slot, where $N\_{s}$ should be divisible by *R*. Each of the antenna ports of the SRS resource is mapped to the same set of subcarriers within each pair of *R* adjacent OFDM symbols of the resource in each slot. For *Ns= R*, when frequency hopping is configured, inter-slot frequency hopping is supported with each of the antenna ports of the SRS resource mapped to the same set of subcarriers in *R* adjacent OFDM symbol(s) of the resource in each slot.----------------End of TP for TS38.214--------------------- |

Companies’ further views are collected as follows.

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| Companies | Views |
| *FL* | Based on comments from OPPO and Huawei in the first round, three changes are made on top of the original TP from CATT, which are marked as yellow. Please indicate whether the updated TP is acceptable for you or you have other suggestions. |
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