3GPP TSG RAN WG1 Meeting #108-e R1-2202625

**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. |
| Nokia/NSB | Support FL proposal |
| Ericsson | OK |

## 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. |
| DOCOMO | Our best preference is Alt 1 from RAN1 perspective, while we think it may contradict to the information given by RAN4. Therefore, we are ok with either Alt 2-1 or Alt 2-2.  |
| Qualcomm | We don’t support FL proposal 3-3. We have strong opinion on keeping the guard period as is. In addition, out of the listed alternatives, only Alt 4 address UE timeline requirements for switching antenna ports and changing power in between SRSs and other UL signal/channel. As mentioned in RAN4 LS, there is at least 15us requirement to allow for such switching before and after other UL signal.  |
| NEC | We prefer Alt 2, and fine with either Alt 2-1 or Alt 2-2. |
| Nokia/NSB | Support Alt 2-1 or Alt 2-2 |
| OPPO | We are fine with either Alt.2-1 or Alt.2-2. However, we don’t support Alt.1 since it will lead to more complexity of UE implementation |
| CATT | Fine with either Alt 2-1 or Alt 2-2. |
| Samsung | According to RAN4 LS, we still think that Alt.4 is the only option which RAN1 can take. For interval between SRS resource sets, the first and last Y symbols (i.e., 2Y symbols) to obtain 15us each should be reserved for port/power switching. |
| vivo | Fine with either Alt 2-1 or Alt 2-2. |
| Intel | Something to clarify.1. Why the proposal is just for inter-set case? In Rel-16 and Rel-17, the SRS resource could be configured over any symbols within one slot. For Rel-17 antenna switching, the SRS configuration is very flexible. It’s also possible that the interval between two SRS resources in the same slot is larger than required Y symbols.We suggest changing “interval between SRS resource sets” to “interval between SRS resources”.2. The gap symbols are also used for collision handling. When we say ‘no scheduling restriction’ or ‘reserved for scheduling restriction’, how does it impact the collision handling operation? |
| CMCC | Although our initial preference is Alt 1 which depends on gNB’s scheduling. We also support to provide a clear guidance to UE and improve the operation efficiency. Alt 2 is slightly preferred. Either Alt.2-1 or Alt.2-2 is fine. |
| Huawei, HiSilicon | Support Alt 1.@DCM: We think Alt 1 will not contradict to the information given by RAN4. Your concern may be aroused by *RAN4 clarifies that the transient period between SRS resources is 15us* in LS from RAN4 (R4-2202413), however, as we discussed before, **this 15us transient period doesn’t mean gNB should always reserve 1 or 2 symbol (depend on SCS) containing this 15us without scheduling**, which can be further proved by agreement in RAN4 100-e meeting, *Do not define the scheduling restriction on symbols before and after SRS transmission for the cell with SRS antenna port switching and on SRS transmit symbols in Rel-17* and *Performance degradation on these symbols can be expected*. What RAN4 really cares is whether the interval between SRS resources can match the transient period demand, i.e., **whether the interval between SRS resources is larger than or equal to 15us transient period**, which is satisfied intrinsically when the interval is larger than Y symbols. Thus, extra scheduling restriction is unnecessary. @QC, Samsung: Hope further clarification above can also solve your concern.@OPPO: On the contrary, forcing GP to be located at either the first Y symbols of the interval (Alt 2-1) or the last Y symbols of the interval (Alt 2-2) will no doubt limit the flexibility of UE implementation.It seems that companies’ view is still divergent when the interval between SRS resource sets is larger than Y, here at least we can firstly reach a conclusion that **UE does not transmit any other signal on any symbols of the interval if the interval between SRS resource sets is Y symbols**, which makes the current spec clearer.  |
| LGE | Support Alt 2-1 or Alt 2-2. |
| *FL* | Based on the discussion so far, it seems companies still have strong view and do not have the willing to compromise. Let’s see whether we can have a baby step first by agreeing on the proposal from Huawei for the case when the interval is Y symbols.***FL Proposal 3-3A:*** *UE does not transmit any other signal on any symbols of the interval if the interval between SRS resource sets is Y symbols.*Companies are encouraged to share your views about the proposal above.Some response to Intel’s question for clarification based on FL’s understanding:1. My understanding is the issue of inter-resource GP is already clear that for Rel-15/16, the gap between resources should be at least Y symbols and reserved for scheduling restriction, i.e., no signal can be transmitted on the gap symbols. It’s gNB scheduling’s responsibility to efficiently use the gap symbols. As this is already clear, I don’t see a strong reason to change this for Rel-17, but inter-set gap is newly introduced in Rel-17. That is why my suggestion is to focus on inter-set gap here.
2. I don’t quite understand why resource collision is an issue here. My understanding is that spec is clear on the legacy behavior, which has been implemented in NR for years. I guess you may think the current specification is not clear enough based on Intel’s tDoc and previous comments? But I’m not sure whether other companies have same confusion. As I said, this has already been implemented in products.

This is just the understanding from my side. Companies are also encouraged to share your thoughts about the two questions from Intel. |
| vivo | Proposal 3-3A is not necessary as current spec captures it well |
| MTK | We don’t support Proposal 3-3 or 3-3A. Alt-3 is preferred. If it wants to max the resource usage, it should consider Alt-4 as additional interval is required between SRS and other channels. |

## 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.  |
| Futurewei | Support the FL proposal. |
| DOCOMO | We would like to echo Huawei’s 1st round input that the benefit of RPFS is common between FH case and non-FH case. Thus, our best preference is to support both cases with a single UE feature. We are not sure if separate FG can alleviate concerns raised by the companies opposing to support non-FH case since it seems they doubt the benefit of RPFS itself for non-FH case. But we are fine with FL proposal 4-1 if that is the only way forward to support RPFS for non-FH case.  |
| Qualcomm | RPFS doesn’t provide any additional coverage/capacity gain to non-frequency hopping scenario as compared to current specification. It may enable some new RBs configuration (e.g., 1RB, 2RBs), however coverage gain will be lost by MPR/A-MPR requirements. Regarding the argument that some RBs configurations (e.g., 38RBs) can’t be achieved by legacy configuration, this configuration doesn’t add anything extra compared to legacy configuration of 36 RBs or 40RBs in terms of coverage/capacity gains. |
| Nokia/NSB | We are fine with FL’s proposal. |
| CATT | Similar view as Docomo. We prefer to support both cases with a single UE feature. |
| Samsung | Okay with FL proposal 4-1. If a new UE feature of RPFS for non-FH case, then should we define a corresponding RRC parameter? |
| vivo | We don’t support the proposal. The use case of configuring RPFS is to quickly sweep the whole bandwidth hence larger subband configuration with shorter FH cycle is the most practical scenario. For the wideband SRS configuration which RRC configured and on top of it RRC configuration of RPFS doesn’t provide much value. |
| Intel | Don’t agree with FL proposal 4-1.There is consensus on frequency hopping case, but companies have different view on non-frequency hopping case.Suggest the following proposal:*Proposal:**RPFS is applicable for frequency hopping case. No consensus on the application of RPFS for non-frequency hopping case.* |
| Huawei, HiSilicon | RPFS should be applicable for both frequency hopping and non-frequency hopping cases. As a compromise, we could accept FL’s proposal.Regarding QC’s comments, the benefit of RPFS are both for multiplexing capacity and coverage enhancement, which show no difference under FH and non-FH case. RB configurations are the same for FH and non-FH cases, we do not see there is any problem for RB configurations for partial sounding as we support FH case already. Then, 38RBs configuration is only an example, there are many bandwidth could be for partial sounding but not for legacy configurations, e.g., 18RBs, 22RBs, 26RBs, etc. Even for 38RBs configuration, we also disagree that RPFS doesn’t add anything extra compared to legacy configuration of 36 RBs or 40RBs in terms of coverage/capacity gains.  |
| LGE | We don’t think separate UE feature is needed for non-frequency hopping case.We are fine with either supporting of RPFS for both cases or supporting of RPFS only for frequency hopping case. |
| *FL* | Based on several meetings’ discussion so far, proposal 4-1 is the only way I can come up to solve this issue. I’d like to remind the group that we have to solve this issue as we have an editor’s note in the current spec. I hope companies can be more open-minded considering this. Please feel free to share your further views considering both proposal 4-1 and Intel’s proposal (labelled as proposal 4-1A).***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.****FL Proposal 4-1A:****RPFS is applicable for frequency hopping case. No consensus on the application of RPFS for non-frequency hopping case.* |
| *Ericsson* | Support 4-1 |
| vivo | Given the current situation there is no consensus it is naturally 4-1A or we don’t need these proposals |

## 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. |
| Futurewei | We slightly prefer not to introduce new max CS numbers just for RPFS. This may be done by adding UE assumption that a PF value leading to a sequence length incompatible with the existing max CS number is not expected. We are also open to other simple solutions, preferably compatible with existing mechanisms.  |
| DOCOMO | Fine with the FL proposal 4-3.  |
| Qualcomm | There is a way to solve this issue by gNB implementation. For $N\_{ap}^{SRS}=4, n\_{SRS}^{CS}\geq \frac{n\_{SRS}^{cs,max}}{2} $, the 4 ports are multiplexed over two combs. Taking the example by NEC ($m\_{SRS, B\_{SRS}}$ = 20, $P\_{F}$=4, $K\_{TC}$ = 2) and following 38.211 CS and port-mapping when $n\_{SRS}^{CS}=4,$ the 4 ports will be assigned CS4/CS6/CS0/CS2. Then, P0/P2 will be assigned CS4/CS0 on comb0 and P1/P3 will be assigned CS6/CS2 on comb1. These are still orthogonal ports.The only drawback is that other CSs in each comb can’t be used otherwise sequence orthogonality is lost (In this example, the sequence length 30 which is not multiple integer of $n\_{SRS}^{cs,max}=8).$We have concern on the suggested solution as it overrides the maxCS based on whether RPFS is configured or not. In addition, multiplexing with legacy UE is not straightforward as legacy UEs will use different maxCS.  |
| NEC | With some restriction, 4-port SRS can be supported (sorry for some inaccurate description in first round), while we think the restriction is quite limited, and as discussed in our contribution, most configurations for frequency hopping case will be impacted.And as QC mentioned, even 4-port can be mapped on REs with two comb offsets, other CS values can not be used by other UEs, we think this is a quite severe issue.@QC. Regarding QC’s concern on multiplexing with legacy UE, in our understanding, multiplexing between RPFS UEs has higher priority, and even with current maxCS value, RPFS UE can not multiplex with legacy UE either, as the prerequisite for orthogonality with different CS values should be the sequence length is same. In other words, if sequence length for RPFS UE and legacy UE is same, then the values of $K\_{TC}$ for RPFS UE and legacy UE are certainly different. Still taking the example, if the sequence length is 30, the cases leading to 30-length sequence for legacy UE (the band for SRS is a multiple of 4) can only be $K\_{TC}=$ 8, and maxCS for legacy UE in this case is also $n\_{SRS}^{cs,max}=$6. But for RPFS UE, $K\_{TC}=2$ will also lead to 30-length sequence, if no update of maxCS, for RPFS UE, $n\_{SRS}^{cs,max}=8$, then multiplexing between RPFS UEs or between RPFS UE and legacy UE are impossible. Actually multiplexing between RPFS UE and legacy UE based on a same root sequence with different CS values is impossible.The issue will significantly reduce the usability of RPFS. We hope RPFS can be applied without so much restriction of configuration and capacity reduction. |
| Nokia/NSB | Support FL’s proposal. |
| OPPO | We understand the technical issue raised by NEC. From our preference, a simpler solution is preferred as below*When P\_F = 2 or 4,** $n\_{SRS}^{cs,max}=12$ *~~if P\_F is 2 and K\_TC = 2, otherwise~~* $n\_{SRS}^{cs,max}=6$*.*

We are also open to solve this issue by gNB implementation although it is not perfect solution |
| Samsung | We are fine either FL proposal or OPPO’s suggestion. |
| vivo | Not support.Main use case of partial sounding is to quickly sweep the whole frequency band with larger subband and shorter hopping cycle. Configuring small subband with RPFS doesn’t make sense. Thus, we suggest,***FL Proposal 4-3-B: The number of minimal sequence length for comb 2/4 is 12.*** |
| Intel | Question for clarification, does this proposal apply to all the sequence length?We prefer to address this issue by implementation. |
| Huawei, HiSilicon | As we commented in the previous round, the issue mentioned above could be addressed by gNB implementation.  |
| *FL* | Based on companies’ input, now we have three alternative proposals on table, although my understanding on vivo’s proposal is that it contradicts a bit with the conclusion of having no restriction on the number of RBs for RPFS. OPPO’s proposal may overkill a bit as in some cases we can have 12 CSs to increase the overall capacity.I’d like to check companies’ further views on the alternative proposals from OPPO and vivo. ***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* $n\_{SRS}^{cs,max}=6$*.*

***FL Proposal 4-3A:*** *When P\_F = 2 or 4,* $n\_{SRS}^{cs,max}=6$*.****FL Proposal 4-3-B:*** *The number of minimal sequence length for comb 2/4 is 12.*If we cannot achieve consensus on these three proposals, the only thing we can do is to leave this to implementation.  |

# 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.  |
| Futurewei | Thank you for the discussion. The 212 clause only specifies how to determine the SOI bit width, but it does not describe the UE behavior of following R15/16 or R17 for the slot offset determination. Note that the SOI bit width cannot determine whether the UE should follow R15/16 or not, as 0 bit may be for zero available slot offset (then use R15/16) or max 1 available slot offset (then use R17). Thus the UE cannot decide the correct behavior only based on 212. The UE cannot infer the correct behavior from 214 as well, as “in a component carrier” uses the indefinite article “a” without any additional limitation, so in the case of multiple component carrier, it is unclear which CC it is referring to. The text in 214 also uses the term “the triggered cell” or “the triggering cell”, so we are also fine with changing to “across all configured BWPs in a component carrier of the triggered cell” or the like.The agreement and current spec texts are provided below. The agreement clearly says “in a CC for SRS transmission” but the red part is missing from 214. All we ask is to accurately reflect the agreement. If we missed anything please let us know.**Agreement**For a CC with t value configured, SOI bit width depends on the maximum number of t values configured for all the resource sets across all configured BWPs in a CC for SRS transmission.* For the CCs without any t value configured, follow Rel-15/16 mechanism to determine the SRS slot offset, where SOI bit width is 0

212:- SRS offset indicator – 0, 1 or 2 bits. - 0 bit if higher layer parameter *AvailableSlotOffset* is not configured or any aperiodic SRS resource set in the scheduled cell, or if higher layer parameter *AvailableSlotOffset* is configured for at least one aperodic SRS resource set in the scheduled cell and the maximum number of entries of *AvailableSlotOffset* configured for all aperiodic SRS resource set(s) is 1;- otherwise, $\left⌈log\_{2}(K)\right⌉$ bits are used to indicate available slot offset according to Table 7.3.1.1.2-37 and Clause 6.2.1 of [6, TS 38.214], where K is the maximum number of entries of *AvailableSlotOffset* configured for all aperiodic SRS resource set(s) in the scheduled cell;214:- 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 except when SRS is configured with the higher layer parameter *SRS-PosResource*, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in the (*t* + 1)-th available slot counting from slot if ca-SlotOffset is configured, otherwise the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in the (t + 1)-th available slot counting from slot $\left⌊n⋅\frac{2^{μ\_{SRS}}}{2^{μ\_{PDCCH}}}\right⌋+k$, where…*- t* is configured via higher layer parameter *availableSlotOffset* with up to four different 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.- If the UE receives the DCI triggering aperiodic SRS in slot *n* and none of the resource sets is configured with parameter *availableSlotOffset* across all configured BWPs in a component carrier, and if the UE is configured with ca-SlotOffset for at least one of the triggered and triggering cell, except when SRS is configured with the higher layer parameter *SRS-PosResource*, the UE transmits aperiodic SRS in each of the triggered SRS resource set(s) in slot , otherwise, the UE transmits aperiodic SRS in each of the triggered resource set(s) in slot $K\_{s}=\left⌊n⋅\frac{2^{μ\_{SRS}}}{2^{μ\_{PDCCH}}}\right⌋+K\_{2}+K\_{offset}⋅\frac{2^{μ\_{SRS}}}{2^{μ\_{K\_{offset}}}}$, if the UE is configured with the higher layer parameter *CellSpecific\_Koffset*, *Ks* =, otherwise, and where … |
| DOCOMO | Seems we showed our position not clearly. We are actually fine with the TP2-1.  |
| Qualcomm | We think the UE behavior is clear.The rest of the text in 38.214 describes that PDCCH is received in a cell and SRS is triggered another cell. Then, the SRS configuration with availableSlotOffset refers to the cell where SRS is transmitted.

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| *- k* is configured via higher layer parameter *slotOffset* for each triggered SRS resources set and is based on the subcarrier spacing of the triggered SRS transmission, *µSRS* and *µPDCCH* are the subcarrier spacing configurations for triggered SRS and PDCCH carrying the triggering command, respectively;*-* $N\_{slot, offset, PDCCH}^{CA}$ and $μ\_{offset,PDCCH}$ are the $N\_{slot, offset}^{CA}$ and the, respectively, which are determined by higher-layer configured ca-SlotOffset for the cell receiving the PDCCH, $N\_{slot, offset, SRS}^{CA}$ and $μ\_{offset,SRS}$ are the $N\_{slot, offset}^{CA}$ and the, respectively, which are determined by higher-layer configured ca-SlotOffset for the cell transmitting the SRS, as defined in [4, TS 38.211] clause 4.5. |

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| Nokia/NSB | We share the same view as QC. |
| OPPO | We support the TP since it is friendlier to readers. |
| CATT | The TP is acceptable if the majority think it is helpful for reading. |
| Samsung | Since it seems that current spec is already clear, we think that the proposed TP is not needed. |
| vivo | It seems spec is not broken, we are fine with majority views |
| Intel | Agree with FL and Qualcomm’s view. |
| Huawei, HiSilicon | OK with the TP. |
| LGE | Agree with FL’s assessment and Qualcomm’s view. |
| *FL* | The status so far is:Supported by OPPO, Lenovo/MotM, Spreadtrum, Futurewei, Apple, Ericsson, Xiaomi, Huawei/HiSilicon, NTT DOCOMOConcern:, Qualcomm, InterDigital, Nokia/NSB, Intel, LGE, SamsungMore companies can be OK, but some companies still think the TP is not needed. Let’s continue the discussion to see whether companies may change their views. |

## 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. |
| Futurewei | We are generally flexible in this. As the agreement does not specify “different”, we slightly prefer to remove “different”. |
| DOCOMO | We are open to discuss, but have the following questions:* Without this TP, would it be possible for RRC parameter “availableSlotOffset” to have multiple entries which indicate the same value?
* If the answer to above is yes, and if RAN1 does not prefer such case, could another possible way be to indicate RAN2 via RRC parameter list that “availableSlotOffset” can configure multiple values, which have to be different each other? Since the parameter seems RAN2 matter, could the approach be more straightforward?
 |
| Qualcomm | We think that if *availableSlotOffset* list is larger than one, then different values should be configured.  |
| Nokia/NSB | It remains unclear for us why network would like to configure multiple entries in availableSlotOffset with same value. Hence, we agree with QC. |
| OPPO | Could some proponent(s) like to clarify what the use case or motivation to configure multiple same values is?  |
| CATT | Support the TP. Multiple entries with same value should be allowed. Since ‘t’ values for each SRS resource sets are configured separately, even if 2 ‘t’ values configured for a SRS resource set are the same, the sets of ‘t’ values for the SRS resource sets that triggered simultaneously can be different. For example, if SRS resource set 1 and SRS resource set 2 are triggered simultaneously, and the ‘t’ values configured for SRS resource set 1 and SRS resource set 2 are {2, 2} and {1,3} respectively. Then the set of ‘t’ values for the two SRS sets are{ 2 for SRS set 1, 1 for SRS set 2} when SRS offset indicator indicates “0”, and the set of ‘t’ values for the two SRS sets are{ 2 for SRS set 1, 3 for SRS set 2} when SRS offset indicator indicates “1”. |
| Samsung | We think that configuring different offset values is a natural way from gNB side. |
| Intel | Fine with the TP. |
| Huawei, HiSilicon | OK with the TP. Since no agreement constrain that the values of t must be different and the scenario mentioned by CATT seems reasonable. |
| LGE | We are also open to discuss, but the same values of available slot offset for a single SRS resource set is valid only for when multiple sets are triggered simultaneously with ‘usage’ of antenna switching. It seems not essential at this stage. |
| *FL* | Status so far:Supported by CATT, Intel, vivo, CMCC, Huawei/HiSilicon, InterDigital, Futurewei, Concern: Qualcomm, LGE, Apple, Ericsson, Xiaomi, OPPO, Nokia/NSB, SamsungA number of companies still think the TP is not needed. Let’s continue the discussion to see whether companies may change their views. |

## 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? |
| DOCOMO | Support as captured by FL.  |
| Qualcomm | We think it is better to algin the specification description of 1T8R with same language used for other SRS switching configuration (1T6R, 2T8R, 2T6R) and use two different bullets for periodic and semi-persistent sets configuration.

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| * For 1T8R, zero or one SRS resource set configured with resourceType in SRS-ResourceSet set to ‘periodic’, where in the case of one resource set has eight SRS resources transmitted in different symbols, each SRS resource in a given set consisting of a single SRS port, and the SRS port of the resource in the set is associated with a different UE antenna port, and
* For 1T8R, zero or one SRS resource sets configured with resourceType in SRS-ResourceSet set to ‘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 resourceType in SRS-ResourceSet set to ‘semi-persistent’ 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 has eight SRS resources transmitted in different symbols, each SRS resource in a given set consisting of a single SRS port, and the SRS port of the resource in the set is associated with a different UE antenna port, and
 |

 |
| Nokia/NSB | Support FL proposal.  |
| OPPO | We are general fine with the TP. But a better on is QC’s suggest (we also suggest the same thing in the first round). |
| CATT | Fine with the TP. |
| Samsung | We can live with either FL proposal or Qualcomm’s suggested TP. |
| vivo | Either above TP or modification from QC is fine |
| Intel | Thanks FL for the explanation. We think Qualcomm’s suggestion is better. |
| CMCC | Thanks for FL’s clarification. That exactly is our intention.We are open for discussion. If the group think the description with more sections, as QC proposed above, is more clear, we have no problem. |
| Huawei, HiSilicon | OK with the TP or Qualcomm’s suggestion. |
| LGE | Fine with the TP, and QC’s version is more preferred for the consistency. |
| *FL* | Happy to see we start to converge to QC’s suggestion. I put forward a new TP based on this.***TP 3-1A:*** *Endorse the following TP to section 6.2.1.2 of TS 38.214, to be included in editor’s CR*

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| 6.2.1.2 UE sounding procedure for DL CSI acquisition<Unchanged parts are omitted>- For 1T6R, zero or one or two or three SRS resource sets configured with *resourceType* in *SRS-ResourceSet* set to 'aperiodic', where in the case of one resource set a total of six SRS resources transmitted in different symbols, each SRS resource in a given set consisting of a single SRS port, and the SRS port of each resource in the set is associated with a different UE antenna port. In the case of two resource sets a total of six SRS resources transmitted in different symbols of two different slots, and where the SRS port of each SRS resource in the given two sets is associated with a different UE antenna port. In the case of three resource sets a total of six SRS resources transmitted in different symbols of three different slots, and where the SRS port of each SRS resource in the given three sets is associated with a different UE antenna port, or- For 1T8R, zero or one SRS resource set configured with resourceType in SRS-ResourceSet set to ‘periodic’, where in the case of one resource set has eight SRS resources transmitted in different symbols, each SRS resource in a given set consisting of a single SRS port, and the SRS port of the resource in the set is associated with a different UE antenna port, and- For 1T8R, zero or one SRS resource sets configured with resourceType in SRS-ResourceSet set to ‘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 resourceType in SRS-ResourceSet set to ‘semi-persistent’ 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 has eight SRS resources transmitted in different symbols, each SRS resource in a given set consisting of a single SRS port, and the SRS port of the resource in the set is associated with a different UE antenna port, and<Unchanged parts are omitted> |

Let’s see whether companies have concern on TP 3-1A. |

## 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.

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| 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.  |
| DOCOMO | Support as captured by FL.  |
| Qualcomm | Agree that the current spec needs further editorial clarification for nTnR. For the TP suggested by Huawei, the wording ‘up to’ should not be removed.  |
| Nokia/NSB | Support FL’s proposal. |
| OPPO | The TP cannot address the issue from Huawei’s further clarification. First sentence indicates up to 2 sets (without mentioning time domain behavior) and the second sentences indicates up to 2 sets for SP and up to 1 set for P. Thus, if gNB configures 2 sets for SP, then it is still confusing whether an additional set for AP can be configured or not.  Thus, we suggest the following modification: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 not indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets], or up to one SRS resource set configured with *resourceType* in *SRS-ResourceSet* set to '*aperiodic*' and 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*' if the UE is indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets], where each SRS resource set has one SRS resource with the same number of SRS port(s), the number of SRS port(s) 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 |
| CATT | Thanks for Huawei’s explanation. Huawei’s TP is acceptable.In order to address the issues raised by OPPO, one alternative is to change “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.” to “For 1T=1R, or 2T=2R, or 4T=4R, ~~up to~~one or 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.” |
| Samsung | Support FL proposal with not removing ‘up to’ as Qualcomm suggested. |
| Intel | We are open on this. |
| Huawei, HiSilicon | @QC: The reason why the wording “up to” is removed is to make sure the configurations before and after “*If the UE is indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets]*” are mutually exclusive with each other.@ OPPO: The relationship between the first sentence and second sentence is “or” as we’ve explained. By the way, by your modification, a UE indicating a capability for [maximum 2 semi-persistent and maximum 1 periodic SRS resource sets] even cannot support 2AP.@CATT: Thanks for understanding. Generally modifying behavior of legacy UE is not preferable.  |
| *FL* | Based on the elaboration above from Huawei,@QC, Samsung, is it okay for you to remove “up to”?@OPPO, is it okay for you to accept this TP as Huawei suggeusted? |

## 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. |
| Futurewei | Support |
| DOCOMO | We are fine with TP4-2 with FL’s update.  |
| Qualcomm | Support. |
| Nokia/NSB | Support FL’s updated TP. |
| OPPO | Support |
| CATT | Support |
| Samsung | Support |
| vivo | support |
| Intel | Fine with the TP.  |
| Huawei, HiSilicon | Support the TP with FL’s update. |
| LGE | OK |
| Ericsson | OK |