**3GPP TSG RAN WG1 #122bis R1-250xxxx**

**Prague, Czech, October 13th – 17th, 2025**

**Agenda item:** **10.2.1**

**Source: Moderator (CATT)**

**Title: Moderator summary on improvement of SRS capacity and coverage: Round3**

**Document for:** **Discussion and Decision**

# **Introduction**

In RAN #108, the Rel-20 WID of NR MIMO Phase 6 was approved [1]. In the approved WID, enhancement of SRS capacity and coverage is a part of RAN1 objectives.

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| The detailed objectives are as follows:  **RAN1:**   1. On enhancing UL capacity and coverage, specify the following enhancements:    1. For SRS, reusing the legacy port numbering for SRS resource, comb design, SRS sequence, SRS power control, symbol-level dropping rules (when SRS collides with another UL signal), TCI/UL-spatial-relation frameworks, and SRS bandwidth configuration for SRS frequency hopping, with the maximum number of SRS resources per set following the legacy specification:       * Multiple frequency-domain starting positions for SRS repetition symbols within each SRS frequency hop for RB-level partial frequency sounding         + Note: On phase continuity, the applicable conditions and requirements from the legacy RAN4 spec for DMRS bundling should be retained as much as possible.       * Cross-slot SRS between one U slot and one adjacent S slot within a single SRS resource set         + When used for one SRS with repetition, cross-slot SRS symbol mapping is limited to within one SRS resource, with a common timing advance (TA), a common UL spatial filter, and common transmit power for the SRS resource across the two consecutive slots |

This summary includes the following:

* Summary of companies’ views on each of open issues raised by interested companies
* Observations and recommended proposals based on the summary of companies’ views

# **Issue 1: Multiple frequency-domain starting positions for SRS repetition symbols within each SRS frequency hop for RB-level partial frequency sounding**

Open issues on multiple frequency-domain starting positions for SRS repetition and company views are summarized below.

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| **#** | **Issue** | **Companies’ views** |
| 1-1 | Configuration combinations of PF and K | **Whether to support the following configuration combinations**   * PF=2 and K=2 * PF =4 and K=2 * PF =4 and K=4   Support: *Huawei, CATT, ZTE, Ericsson, Samsung, InterDigital, MediaTek, NTT DOCOMO, Sony, TCL, Apple, ETRI, Fujistu, Xiaomi, Tejas Networks Ltd, Sharp*  *Nokia*: support PF=K, further consider support of  *HONOR:* support PF=4 |
| 1-2 | Whether non-consecutive symbols are supported within each sub-group of R/K symbols | * Support only consecutive symbols：*CATT, ZTE, Samsung, China Telecom, MediaTek, Sharp* * Support only non-consecutive symbols：*Huawei* * Support both consecutive and non-consecutive symbols: *Qualcomm, Nokia (for , support UL SRS PFS with intra-repetition hopping with cyclic mapping(non-consecutive))* * Down select one: *NTT DOCOMO, OPPO(prefer non-consecutive),* |
| 1-3 | Starting position patterns for configuration combinations | * For PF=2 and K=2,   + support pattern {0,1} only: *CATT, MTK, OPPO, TCL, ETRI, Xiaomi, Nokia, Apple, Ericsson, NTT DOCOMO*   + support patterns {0,1} and {1,0}: *ZTE, Huawei* * For PF =4 and K=2,   + support pattern {0,2} only: *CATT, MTK, OPPO, TCL, ETRI, Xiaomi, Nokia, Apple ({0,2} or {1,3}), NTT DOCOMO*   + support patterns {0, 2}, {2, 0}, {1, 3} and {3, 1}: *ZTE, Huawei*   + support pattern {0,1}: *Ericsson* * For PF =4 and K=4,   + support pattern {0,2,1,3} only: *CATT, MTK, OPPO, TCL, ETRI, Xiaomi, Nokia ({0,2,1,3} or {0,2,3,1}), Apple, NTT DOCOMO*   + support patterns {0, 2, 1, 3}, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}: *ZTE, Huawei*   + support pattern {0,1,2,3}: *Ericsson*   **Formulas of starting position patterns**  *Nokia:*   * support determining starting frequency position frequency offset determination by following formula   /  *NTT DOCOMO:*   * If a new RRC parameter enables multiple FD positions within an SRS frequency hop, the first starting RB index can be indicated by legacy RRC parameter startRBIndexAndFreqScalingFactor4-r17, and the second starting RB index can be determined by predefined rule.   + E.g., for and K=2 or and K=2, .   + E.g., for and K=4, , where for ,   *Sony:* RAN1 should modify the quantity   as follows  where is the number of starting positions and  with .  *xiaomi, Rakuten Mobile*  *.* And the new factor of hop is the RPFS frequecy offset within each SRS hop  *Samsung:* To enable multiple frequency positions within repetition, RPFS hopping formula can be modified considering following aspects:   * Considering different frequency starting position during same nSRS and different l’ * Considering different value combinations of (=1,2,4,8,10,12,14), R (=1,2,4,5,6,7,8,10,12,14) and PF (=2,4) * Considering configuration of legacy RPFS hopping and/or new RPFS hopping during repetition * Considering time resource granularity of new RPFS hopping during repetition   **Whether to support intra-repetition hopping when R is not the integer multiple of *K***   * Support intra-repetition hopping when R is not the integer multiple of *K: Nokia, Samsung* * Support intra-repetition hopping when R is the integer multiple of *K: ETRI, Spreadtrum* |
| 1-4 | Enhanced RPFS start RB index hopping + legacy RPFS start RB index hopping (enableStartRBHopping= “true”) | **Whether/how to support legacy RPFS start RB index hopping and enhanced RPFS simultaneously.**  Support：*CATT, ZTE, vivo, Samsung, China Teleom, MediaTek, ETRI, Fujistu, Spreadtrum, xiaomi*(only for PF =4 and K=2,), NTT Docomo (for PF=4 K=2)  Do not support: *Qualcomm, OPPO, InterDigital*  *HONOR*: Introducing a group of default parameter combination which can fall back the enhanced RPFS to legacy RPFS |
| 1-5 | Supported resource types of SRS | * Support periodic, semi-persistent, and aperiodic SRS   + *Ericsson, CATT, ZTE, OPPO, NTT DOCOMO, ETRI, Sharp* * Do not Support aperiodic SRS   + *vivo* |
| 1-6 | Phase continuity | Send LS to RAN4 to check the feasibility of maintaining the phase continuity within SRS repetitions with the RPFS start RB index hopping   * + *Samsung, NTT DOCOMO, Sony, Transsion Holdings*   *ZTE, ETRI*: study the events which may cause phase continuity not to be maintained  *QC:* Fully reuse existing RAN4 requirement on DMRS bundling specified in Clause 6.4.2.5 of TS 38.101-1, Phase coherence over SRS symbols is not required when RB position changes.  *Samsung:* Introduce a separate UE capability whether phase continuity is satisfied |
| 1*-7* | Other issues | * *ETRI：*For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement) * *Xiaom：Within* each subgroup of R\*s/K symbols, the SRS is transmitted at the same starting position in frequency domain, where s = 2 when nrofSRS-Ports-n8 is set to ports8tdm is configured and s = 1 otherwise. * *Qualcomm:* FFS how to support Rel-20 RPFS enhancement for 8-Tx SRS with ports spanning over two consecutive symbols. |

Companies are encouraged to show views/comments/suggestions in the following tables.

## P1-1: Starting position pattern

### Round 1

**Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol), the following configuration combinations and starting position patterns are supported

* when PF=K=2, support pattern {0,1}
  + FFS: {1,0}
* when PF=4 and K=2, support pattern {0,2}
  + FFS: {0,1}, {2, 0}, {1, 3} and {3, 1}
* when PF=K=4, support pattern {0,2,1,3}
  + FFS: {0,1,2,3}, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}

**Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol), support the following configuration combinations and [down select from the following] starting position patterns

* when PF=K=2,
  + option 1 (consecutive mapping): support pattern {0,…,0,1,…,1}
    - FFS: {1,…,1, 0,…,0}
  + option 2 (non-consecutive mapping): support pattern {0,1,,…,0,1}
    - FFS: {1,0,…,1, 0}
* when PF=4 and K=2,
  + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2}
    - FFS: {0,..,0,1,,…,1}, {2, …,2,0,…,0}, {1,…, 1,3,…,3} and {3,…,3,1,…,,1}
  + option 2 (non-consecutive mapping): {0,2,…,0,2}
    - FFS: {0,1,,…,0,1}, {2, 0,…,2,0}, {1, 3,…1,3} and {3, 1,…,3,1}
* when PF=K=4,
  + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2,1,…,1,3,…,3}
    - FFS: {0,…,0,1,…,1,2,…2,3,…,3}, {2,…,2, 0, …,0,3, …,3,1,…,1}, {1,…1,3,…, 3, 2,…,2,0,…,0} and {3,…,3, 1,…,1, 0,…,0, 2,…,2}
  + option 2 (non-consecutive mapping): support pattern {0,2,1,3,…,0,2,1,3}
    - FFS: {0,1,2,3,…,0,1,2,3}, {2, 0, 3, 1,…, 2, 0, 3, 1}, {1, 3, 2, 0,…, 1, 3, 2, 0} and {3, 1, 0, 2,…, 3, 1, 0, 2}

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | First things first, to make the discussion efficient, we think it could better to separately discuss P1-1 as:   * Proposal 1-1-1 on candidate patterns for each case of K<=R * Proposal 1-1-2 on support of consecutive or non-consecutive symbols within each sub-group of R/K (when K<R) symbols.   Regarding candidate patterns for each case of K<=R, we think the mechanism of legacy RPFS patterns need to be referred, i.e., basic pattern plus configurable start RB index. Consequently, the following candidate patterns should be supported:   * when PF=K=2, support patterns {0,1} and {1,0} * when PF=4 and K=2, support patterns {0,2}, {2, 0}, {1, 3} and {3, 1} * when PF=K=4, support pattern {0,2,1,3}, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}   Besides, it can be open to FFS on other candidate patterns with further evaluation.  Therefore, we suggest the following updated Proposal 1-1-1.  **Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop ~~and K=R (i.e., each subgroup includes symbol)~~, the following configuration combinations and starting position patterns are supported   * when PF=K=2, support patterns {0,1} and {1,0}   + FFS: {1,0} * when PF=4 and K=2, support pattern {0,2}, {2, 0}, {1, 3} and {3, 1}   + FFS: {0,1}~~, {2, 0}, {1, 3} and {3, 1}~~ * when PF=K=4, support pattern {0,2,1,3}, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}   + FFS: {0,1,2,3}~~, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}~~   Regarding consecutive or non-consecutive symbols within each sub-group of R/K (when K<R) symbols, we think at least the majority preference on “consecutive” can be prioritized, and it can be open to FFS on “non-consecutive” with further evaluation.  Therefore, we suggest the following new Proposal 1-1-2.  **Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, at least support consecutive symbols within each sub-group of R/K (when K<R) symbols.   * FFS: Whether to additionally support non-consecutive symbols within each sub-group of R/K (when K<R) symbols. |
| Apple | In principle, we are okay. We prefer to only support one option in Proposal 1-1-2 |
| Fujitsu | **Proposal 1-1-1**: Support.  **Proposal 1-1-2**: Support. Option 1 (consecutive mapping) is preferred. |
| HONOR | OK with both proposals.  Non-consecutive mapping pattern in proposal 1-1-2 is preferred as this option can ensure at least one entire pattern being transmitted in some cases. |
| NEC | Support the two proposals. |
| MediaTek | We would prefer ZTE’s suggestion. |
| Spreadtrum | **Proposal 1-1-1**: regarding the three FFS, they are closely related to proposal 1-2. Once proposal 1-2 is supported, all the FFS are naturally supported. Thus, we propose to postpone proposal 1-1-1 until we have a conclusion for proposal 1-2.  **Proposal 1-1-2**: Support. From our view, both consecutive mapping and non-consecutive mapping can work with no doubt. The latter one may have even better performance due to the shifting positions among consecutive symbols. |
| Qualcomm | We are generally OK with both proposals.  One minor about 8-Tx SRS with 2 back-to-back symbols, R/K should mean number of pairs of back-to-back “super-symbol”.  Therefore, editorial suggestion:   |  | | --- | | **Proposal 1-1-1**: “… K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), …”  **Proposal 1-1-2**: “… K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), …“ | |
| OPPO | Fine with Proposal 1-1-1. The interpolation performance between different patterns is similar and one pattern is preferred.  For Proposal 1-1-2, we are fine to down select either one of the patterns, but there is no technical benefit to support both. We prefer single pattern for each configuration. |
| ETRI | **Proposal 1-1-1**: Support in principle. We need clarification on the definition of starting position pattern. Does it mean a basic pattern applied on top of start RB index? If yes, we don't need to enumerate cyclic shifted versions of each basic pattern, as they can be derived using the start RB index in RPFS.  **Proposal 1-1-2**: We think that both options need to be supported by NW configuration of either option. Non-consecutive symbol mapping is beneficial for hybrid beamforming operations, as it reduces the frequency of beam changes compared to consecutive mapping when each set of time-consecutive symbols, each associated with a different subgroup, is received with the same beam, and different sets are received with different beams. On the other hand, consecutive symbol mapping is advantageous for achieving higher repetition gains in channel estimation over time-varying channels when SRS is received using a single beam. |
| Mod | @ZTE Thanks for the comments and suggestions. The intention of discussing the two cases (i.e., K=R and K<R) separately was that at least for K=R, as there is only one symbol in each sub-group, we don’t need to consider the issue of consecutive or non-consecutive, and then, we could try to reach some level of consensus in the first step for K=R. The reason for including some patterns for further study is based on positions of companies. As can be observed from proposals in contributions, more companies tended to support only one pattern for each combination of PF and K. Also, Spreadtrum pointed out that “regarding the three FFS, they are closely related to proposal 1-2. Once proposal 1-2 is supported, all the FFS are naturally supported.” So, I prefer to keep those patterns for further study first.  @ Spreadtrum By the way, even though the 3 FFS could be related to P1-2, since they are list for further study, it would be better not to defer the discussion on main issues presented in proposal 1-1-1. And if companies think it’s necessary, we can anyway discuss related issues in proposal 1-2.  @ZTE As shown in proposals in contributions and also in the discussion last meeting, it’s controversial whether both consecutive and non-consecutive options or one single option should be supported for each combination of PF and K. However, the contention only exists in the case of K<R. So, we can discuss whether to support consecutive or non-consecutive or both in proposal 1-1-2. I understand people’s feeling about legacy. This could be one of reasons to defend legacy-like patterns. But it seems that we could not preclude those non-legacy options before technical discussion.  @QC Thank you for your suggestions. The following updates are made.  **Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and starting position patterns are supported   * when PF=K=2, support pattern {0,1}   + FFS: {1,0} * when PF=4 and K=2, support pattern {0,2}   + FFS: {0,1}, {2, 0}, {1, 3} and {3, 1} * when PF=K=4, support pattern {0,2,1,3}   + FFS: {0,1,2,3}, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}   **Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and [down select from the following] starting position patterns   * when PF=K=2,   + option 1 (consecutive mapping): support pattern {0,…,0,1,…,1}     - FFS: {1,…,1, 0,…,0}   + option 2 (non-consecutive mapping): support pattern {0,1,,…,0,1}     - FFS: {1,0,…,1, 0} * when PF=4 and K=2,   + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2}     - FFS: {0,..,0,1,,…,1}, {2, …,2,0,…,0}, {1,…, 1,3,…,3} and {3,…,3,1,…,,1}   + option 2 (non-consecutive mapping): {0,2,…,0,2}     - FFS: {0,1,,…,0,1}, {2, 0,…,2,0}, {1, 3,…1,3} and {3, 1,…,3,1} * when PF=K=4,   + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2,1,…,1,3,…,3}     - FFS: {0,…,0,1,…,1,2,…2,3,…,3}, {2,…,2, 0, …,0,3, …,3,1,…,1}, {1,…1,3,…, 3, 2,…,2,0,…,0} and {3,…,3, 1,…,1, 0,…,0, 2,…,2}   + option 2 (non-consecutive mapping): support pattern {0,2,1,3,…,0,2,1,3}     - FFS: {0,1,2,3,…,0,1,2,3}, {2, 0, 3, 1,…, 2, 0, 3, 1}, {1, 3, 2, 0,…, 1, 3, 2, 0} and {3, 1, 0, 2,…, 3, 1, 0, 2} |
| vivo | **Proposal 1-1-1**  Generally fine. However, we don’t think ‘FFS’ is needed, since only one basic pattern for each combination of PF and K is enough and other patterns can be obtained via the basic patterns {0,1} for PF=K=2, {0,2} for PF=4 and K=2, {0,2,1,3} for PF=K=4.  **Proposal 1-1-2**  First, we support down-selection from option 1 and option 2, to avoid redundant design.  Then, option 1 is preferred. At least for the case where phase continuity across continuous SRS symbols with different frequency positions is not assumed, consecutive mapping can provide repetition gain from consecutive symbols |
| Huawei, HiSilicon | **Proposal 1-1-1**: Seems the main divergence between us (and ZTE) and other companies comes from the definition of ‘starting position pattern’, i.e., whether it refers to the actual transmitted pattern (can be derived from adding starting position index to a ‘basic pattern’) or the ‘basic pattern’. We support the proposal only if the latter understanding is shared.  **Proposal 1-1-2**: Regarding the selection between non-consecutive (i.e., cyclic) mapping and consecutive (i.e., sequential) mapping, we believe non-consecutive mapping should be supported given the following rationales elaborated in [7]:   * When SRS partial dropping happens, non-consecutive mapping can ensure there still exists different frequency-domain starting positions, which facilitates channel interpolation/joint channel estimation. * Non-consecutive mapping can ease multiplexing among UEs configured with different . * Non-consecutive mapping requiring less analog beam switching under HBF architecture is more friendly to gNB implementation. * Even if laying aforementioned benefits aside, Non-consecutive mapping performs similarly to consecutive mapping, as proved by the figure below. |
| Sony | **Proposal 1-1-1**  We support this proposal in principle. For and , we support the patterns{0, 2} and {1, 3} on alternating frequency hops—for frequency hops with the same . For example, {0, 2} can be used for even frequency hops, and {1, 3} for odd ones. There is no reason why only half the frequencies should be sounded. Thus, we propose the amendment:   * when PF=4 and K=2, support the patterns {0,2} and {1,3} in an alternating fashion.   **Proposal 1-1-2**  We support in principle, and our preference is Option 1, i.e., consecutive mapping. Also, we propose the following modification, by reasons similar as the ones given above for Proposal 1.1.1:   * when PF=4 and K=2,   + option 1 (consecutive mapping): support patterns {0,…,0,2,…,2} and {1,…,1,3,…,3} in an alternating fashion. |
| TCL | **Proposal 1-1-1**  We are confused about the term ‘starting position pattern’ and need further clarification. Does it mean ‘basic pattern’ or something else?  **Proposal 1-1-2**  We have the same confusion as proposal 1-1-1, and we prefer non-consecutive mapping. |
| NTT Docomo | Support the proposals. |
| Mod | @vivo @Huawei @TCL The following proposals are revised according to comments from you.  @Sony As stated by vivo and Huawei, we can focus on basic pattern for each combination of PF and K here, and other patterns can be obtained via the basic patterns.  **Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported   * when PF=K=2, support pattern {0,1}   + ~~FFS: {1,0}~~ * when PF=4 and K=2, support pattern {0,2}   + FFS: {0,1}~~, {2, 0}, {1, 3} and {3, 1}~~ * when PF=K=4, support pattern {0,2,1,3}   + FFS: {0,1,2,3}~~, {2, 0, 3, 1}, {1, 3, 2, 0} and {3, 1, 0, 2}~~   **Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and [down select from the following] basic starting position patterns   * when PF=K=2,   + option 1 (consecutive mapping): support basic pattern {0,…,0,1,…,1}     - ~~FFS: {1,…,1, 0,…,0}~~   + option 2 (non-consecutive mapping): support basic pattern {0,1,,…,0,1}     - ~~FFS: {1,0,…,1, 0}~~ * when PF=4 and K=2,   + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2}     - FFS: {0,..,0,1,,…,1}~~, {2, …,2,0,…,0}, {1,…, 1,3,…,3} and {3,…,3,1,…,,1}~~   + option 2 (non-consecutive mapping): {0,2,…,0,2}     - FFS: {0,1,,…,0,1}~~, {2, 0,…,2,0}, {1, 3,…1,3} and {3, 1,…,3,1}~~ * when PF=K=4,   + option 1 (consecutive mapping): support pattern {0,…,0,2,…,2,1,…,1,3,…,3}     - FFS: {0,…,0,1,…,1,2,…2,3,…,3}~~, {2,…,2, 0, …,0,3, …,3,1,…,1}, {1,…1,3,…, 3, 2,…,2,0,…,0} and {3,…,3, 1,…,1, 0,…,0, 2,…,2}~~   + option 2 (non-consecutive mapping): support pattern {0,2,1,3,…,0,2,1,3}     - FFS: {0,1,2,3,…,0,1,2,3}~~, {2, 0, 3, 1,…, 2, 0, 3, 1}, {1, 3, 2, 0,…, 1, 3, 2, 0} and {3, 1, 0, 2,…, 3, 1, 0, 2}~~ |
| Samsung | Support updated proposals 1-1-1 and 1-1-2. |
| Nokia | **Proposal 1-1-1**: We are generally fine with the proposal but we prefer to discuss the principle of the framework.  There are two approaches.  Option 1: define basic starting position pattern and apply different offset to different UEs  Option 2: define multiple starting position patterns and configure one of multiple patterns.  We think they are similar, but we slightly prefer option 1.  **Proposal 1-1-2**: We think cyclic mapping is useful for maintaining alignment between different UEs with different repetitions. Also, it is useful to support any R value without any restriction of integer multiple of K. We support option 2. We want to reformulate the proposal as   * Option 1: sequential mapping * Option 2: cyclic mapping |
| Transsion | **Proposal 1-1-1**: Support. One pattern is preferred.  **Proposal 1-1-2**: Support. We prefer Option 1 (consecutive mapping). |
| Sharp | Proposal 1-1-1: We support all the configuration combinations. Is the starting position pattern an offset relative to kF? If so, we support Proposal 1-1-1.  Proposal 1-1-2: Support Option 1 that is simpler than Option 2. The repetition gain from consecutive transmissions is theoretically better than that from non-consecutive transmissions. |
| Xiaomi | Generally fine with the FL updated proposals. One issue is that since we already have the definition of ***S*** in the current spec for SRS which was introduced in R18 especially for TDMed 8-port SRS,we think the proposal should consider to reuse the S not as like “a pair of “ . Thus it is needed only to revise the previous agreement as below which would solve the issue including the TDMed 8-port SRS case and avoid introducing any new descriptions which may cause confusion.   * *Within* each subgroup of R\*s/K symbols, the SRS is transmitted at the same starting position in frequency domain, where s = 2 when nrofSRS-Ports-n8 is set to ports8tdm is configured and s = 1 otherwise. |
| Lenovo | **Proposal 1-1-1**:  We understand the starting position patterns in the main bullet is the basic pattern in legacy. And we think the value in each of the subbullet should be enough. there is no need to discuss the candidate values in FFS.  **Proposal 1-1-2**:  Firstly, similar with Proposal 1-1-1, we also think the pattern in each subbullet is enough.  Regarding to the two options on consecutive or non-consecutive mapping, we think consecutive mapping should at least be supported. For the non-consecutive mapping, we may need to check with RAN4 whether the UE can guarantee the phase continuity across different symbols. |
| Ericsson | We prefer to support only one pattern per pair of and and, in particular, for , we prefer the “incremental” hopping pattern ({0,1} for and {0,1,2,3} for ), which achieves better NMSE compared to “pseudo-random” pattern ({0,2} for and {0,2,1,3} for ), as shown in our tdoc (see, e.g., figure below). In short, sounding contiguous RBs in adjacent symbols allow NW to concatenate the hops before performing channel estimation, which improves NMSE.    Another important consideration is phase continuity. If phase continuity for intra-repetition hopping cannot be preserved across frequency hops, it is preferred to sound contiguous RBs in adjacent symbols, to allow NW to estimate/compensate for the phase continuity.  As a first step we propose to confirm the value combinations of and , but leave the pattern for further discussion.  For and , support one of the following patterns:   * Alt1: {0, 1} * Alt2: {0, 2}   For and , support one of the following patterns:   * Alt1: {0, 1 ,2, 3} * Alt2: {0, 2, 1, 3} |
| China Telecom | Support the updated proposals. |
| Mod | Thanks for the inputs from interested companies. The following proposals are revised for further discussion.  **Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported   * when PF=K=2, support pattern {0,1} * when PF=4 and K=2, support one of the following patterns:   + Alt 1: {0,2}   + Alt 2: {0,1} * when PF=K=4, support one of the following patterns:   + Alt 1: {0,2,1,3}   + Alt 2: {0,1,2,3}   **Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns   * when PF=K=2, support one or both of the following basic patterns:   + Alt 1 (consecutive mapping): {0,…,0,1,…,1}   + Alt 2 (non-consecutive mapping): {0,1,,…,0,1} * when PF=4 and K=2, down select from the following basic patterns:   + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}   + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}   + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}   + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1} * when PF=K=4, down select from the following basic patterns:   + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}   + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}   + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}   + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3} |
| Tejas | Support the updated proposals.  **Proposal 1-1-1**:  For PF=4 and K=2, we support pattern {0,2}. And not support 0,1 as it is not favourable for the interpolation options. However, we also prefer to have {1,3} in the FFS.  **Proposal 1-1-2**:  We support alternatives with consecutive mapping. |
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#### Agreements of round-1 online discussion

**Agreement**:

For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported

* when PF=K=2, support pattern {0,1}
* when PF=4 and K=2, select one of the following patterns:
  + Alt 1: {0,2}
  + Alt 2: {0,1}
* when PF=K=4, select one of the following patterns:
  + Alt 1: {0,2,1,3}
  + Alt 2: {0,1,2,3}

Note: exact pattern(s) are deduced from the basic patterns. FFS details.

**Agreement**:

For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns

* when PF=K=2, select at least one of the following basic patterns:
  + Alt 1 (consecutive mapping): {0,…,0,1,…,1}
  + Alt 2 (non-consecutive mapping): {0,1,,…,0,1}
* when PF=4 and K=2, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}
  + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}
  + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}
  + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1}
* when PF=K=4, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}
  + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}
  + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}
  + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3}

Note: exact patterns are deduced from the basic patterns. FFS details.

### Round 2/3 (High priority)

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| Mod | For the following alternatives, please show your preferences and technical reasons.  For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported   * when PF=K=2, support pattern {0,1} * when PF=4 and K=2, select one of the following patterns:   + Alt 1: {0,2}   + Alt 2: {0,1} * when PF=K=4, select one of the following patterns:   + Alt 1: {0,2,1,3}   + Alt 2: {0,1,2,3}   Note: exact pattern(s) are deduced from the basic patterns. FFS details.  For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns   * when PF=K=2, select at least one of the following basic patterns:   + Alt 1 (consecutive mapping): {0,…,0,1,…,1}   + Alt 2 (non-consecutive mapping): {0,1,,…,0,1} * when PF=4 and K=2, down select from the following basic patterns:   + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}   + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}   + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}   + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1} * when PF=K=4, down select from the following basic patterns:   + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}   + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}   + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}   + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3}   Note: exact patterns are deduced from the basic patterns. FFS details. |
| Sony | For K=R, our preferences are Alt 1 for PF=4 and K=2, and Alt 1 for PF=4 and K=4.  For K<R, our preferences are Alt 1 for PF=K=2, Alt 1-1 for PF=4 and K=2, and Alt 1-1 for PF=4 and K=4.  For PF=4 and K=2, we prefer the legacy pseudorandom sequence, i.e., {0, 2}, rather than the incremental one, i.e., {0, 1}, since it allows for interpolation, which should result in better channel estimation performance. Naturally, then we also prefer the legacy sequence {0, 2, 1, 3} for PF=4 and K=4.  Regarding consecutive versus non-consecutive mapping, it has not been shown that non-consecutive performs better than consecutive. Thus, for simplicity, we prefer the consecutive mapping. We could also accept supporting both mappings, the network configuring one of them. |
| Apple | We prefer Alt 1.  Regarding consecutive vs non-consecutive mapping, we prefer to down select one (we do not have strong preference on which one is selected). |
| ZTE | **For symbol/pair, we support Alt-1 in second and third cases.**  Regarding Alt-2, in PF=4 and K=2, it seems questionable on how to practically interpolate {2,3} upon SRS sounding of {0,1}. In PF=4 and K=4, performance of candidate patterns {1,2,3,0} and {3,0,1,2} seems even worse between {3,0}.  **For symbol/pair, we support Alt-1 in first, second and third cases.**  Regarding consecutive vs non-consecutive, we support consecutive based on its advantages, e.g., 1) The gain of repetition combination can be acquired by the consecutive symbols with the same frequency location; 2) From the perspective of UE implementation complexity, “consecutive” pattern is more feasible over “non-consecutive” pattern; 3) From the perspective of NW scheduling, the respective regular structure of “consecutive” pattern is more scheduler-friendly than the chaotic resource fragmentation caused by “non-consecutive” pattern, especially when considering the feasibility of inter-UE multiplexing; 4) Given that the mechanism of the legacy intra-slot frequency hopping for PUSCH/PUCCH is to transmit the first hop and the second hop in consecutive symbols, it is natural to reuse the same mechanism on intra-repetition hopping for SRS. In terms of resource efficiency, it can be beneficial and friendly to implement the multiplexing of PUSCH/PUCCH with intra-slot frequency hopping and the SRS with intra-repetition hopping on same symbols.  Regarding the basic pattern, we support the same to symbol/pair. |
| OPPO | For K=R, our preference is Alt 1 for both configurations. Alt 1 can achieve higher interpolation gain than Alt 2.  For K<R, we support non-consecutive mapping (Alt 2 and Alt 2-1). Non-consecutive mapping can reuse the same pattern for different number of R (which is easier to implement), and it is possible to multiplex UEs configured with different values of . |
| Nokia | For the basic pattern, we support Alt 1.  For the consecutive(sequential) vs non-consecutive(cyclic), we support non-consecutive(cyclic).  Cyclic mapping is very simple by repeating the basic pattern in a row. Sequential mapping cause some misalignment in time domain when multiplexing UEs with different R values.  Phase continuity is not critical. If this is critical, we even cannot use SRS FH hopping for codebook/non-codebook because we don’t support subband precoding in UL. Also, the use case of PFS is coverage extension, then we can assume rank=1, and the sounding is rather related to determine MCS. Only gain mentioned for sequential mapping is about phase continuity, while there are several advantages provided for cyclic mapping.  We have strong preference on the cyclic mapping. |
| ETRI | Support in principle.  We suggest changing 'exact' to 'final' in the notes for better capturing the intended meaning.  We also suggest changing 'down select from' to 'select at least one of' in the two bullets each for PF=4 and K=2 and for PF=K=4 in the second part of the proposal. |
| Mod | @ETRI Thanks for your comments, the suggestions sound reasonable to me as well. However, as they have already been captured in agreements, I suggest we focus on the parts to be determined at this stage. |
| ETRI2 | @Mod: Thanks for your consideration. I understand the situation for now.  For the basic pattern, we support Alt 1.  For the mapping type, we support both consecutive and non-consecutive mapping types, configurable by NW according to its operational mode preference. |
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### Round 4

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## P1-2: Enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously

### Round 1/2/3

**Proposal 1-2**: Support enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously.

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| **Company** | | **Input** | |
| Mod | | Please share your views on the above proposal. | |
| ZTE | | In principle, we think it is beneficial to support start RB hopping across different hopping periods for intra-repetition  Nevertheless, we also noticed some worthwhile assessments from companies, For example, as elaborated in the following figures in [15], it can be noted the legacy RPFS start RB index hopping pattern 0,2,1,3 may not outperform over the proposed start RB index hopping pattern 0,1,2,3 in case of PF=4 and K=2, in which all RBs can be sounded fast and efficiently.    Figure 1. Start RB hopping pattern 0,2,1,3. Figure 2. Start RB hopping pattern 0,1,2,3.  In light of above, we suggest the following updates of  **Proposal 1-2**: Support ~~enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and~~ start RB hopping across different hopping periods for intra-repetition hopping for SRS repetition symbols within each SRS frequency hop ~~simultaneously~~.   * FFS on the candidate patterns of start RB hopping across different hopping periods. | |
| Apple | | We are okay | |
| InterDigital | | Don’t support. We don’t see a clear benefit to enable legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods. Besides, this discussion may even be out of the scope of Rel. 20. | |
| Fujitsu | | We are fine with the principle, but prefer the revised version from ZTE. Since the first issue is whether to support start RB hopping across different hopping periods, we can first agree on that and FFS the details. | |
| NEC | | We prefer ZTE’s version. | |
| MediaTek | | Support the proposal. However, the legacy patterns for start RB hopping across different hopping periods should be supported as baseline, and new patterns can be FFS.  **Proposal 1-2**: Support enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously.   * FFS: Support new pattern(s) of start RB hopping across different hopping periods. | |
| Spreadtrum | | Fine with the proposal. | |
| Qualcomm | | We prefer not to support both configured. | |
| OPPO | | We cannot see the benefit to support both, considering interference randomization was already supported by current specification. SRS resources supporting both intra-repetition hopping and RPFH still could not be scheduled together with legacy SRS supporting RPFH with same repetition factor. Keeping backward compatibility seems not beneficial. | |
| ETRI | | Support. For PF=4 and K=2, full hopping bandwidth can be sounded by enabling both intra-repetition hopping and start RB index hopping. | |
| vivo | | Support at least for PF=4 and K=2. | |
| Huawei, HiSilicon | | Support.  The gain of R17 start RB hopping and R20 intra-repetition hopping stem from different aspects, i.e., interference randomization and channel interpolation/joint channel estimation, respectively. We see no reason to prevent the system from harvesting the benefit of both sides, especially considering that no extra spec impact will be introduced. Furthermore, without reaching a consensus, the natural consequence should be depending on UE capability reporting (i.e., if a UE supports both R17 start RB hopping and R20 intra-repetition hopping, gNB can enable both features for the UE simultaneously). | |
| Sony | | Support for PF=4 and K=2. As noted by ETRI, this can enable sounding all the resources of a frequency hop by using alternating patterns. For PF=4 and K=2 and , the patterns {0, 2} and {1, 3} can alternate over frequency hops, e.g., {0, 2} on even frequency hops and {1, 3} on even ones; for PF=4 and K=2 and , the patterns {0, …, 0, 2, …, 2} and {1, …, 3, …, 3} can be used for alternating.  For PF=2 and K=2, and for PF=4 and K=4, we do not see a strong benefit. Thus, for simplicity, our preference would be to discuss PF=4 and K=2 within P1-1, according to our proposed amendments to P1-1. | |
| TCL | | Support  We believe it should depend on the UE capability. It can only be implemented when the UE simultaneously reports support for both start RB hopping and intra-repetition hopping, | |
| NTT Docomo | | Support for PF=4 and K=2. For PF=2 and K=2, and for PF=4 and K=4, it is not needed.  We share similar view as ZTE that the start RB index hopping pattern should be further studied. As shown in the figure below, if legacy start RB index hopping pattern is reused, the frequency positions across SRS frequency hopping periods are the same, which it is not beneficial. | |
| Mod | | @ZTE @MediaTek I tend to agree with MediaTek that the legacy patterns for start RB hopping across different hopping periods should be supported as baseline, if we’re going to introducing the scheme of combined start RB hopping across different hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop. New pattern(s) of start RB hopping across different hopping periods could be discussed in the next step.  Seems it’s more agreeable for PF=4 and K=2, the proposal is updated as follows. @ETRI @vivo @Sony  **Proposal 1-2**: At least for PF=4 and K=2, support enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously.  FFS: For PF=2 and K=2, and for PF=4 and K=4, whether to support enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously. | |
| Samsung | | Support the updated Proposal 1-2 from FL which seems more reasonable. | |
| Nokia | | We prefer discuss this proposal after completion of the basic Rel-20 feature. |
| Transsion | | Support for PF=4 and K=2. |
| Sharp | | Support updated Proposal 1-2 from FL. |
| Xiaomi | Support the updated proposal.We think at least for PF=4 and K=2, the configuration jointly with legacy RPFS start RB index hopping can improve the sounding performance. | | | |
| Lenovo | | We are fine with the latest proposal 1-2. | |
| Ericsson | | We support that different RBs are sounded across slots with intra-repetition hopping to avoid gaps in the frequency domain. However, if the same pattern {0, 2} are used for the intra-repetition hopping and the legacy RPFS hopping, it seems that the gaps will still never be sounded. Indeed, for , the first slot will sound {0, 2} and the second slot will sound {2, 0}.  A solution to this problem could be to support incremental hopping intra-repetition hopping. In this way, the first slot will sound {0, 1} and the second slot will sound {2, 3}.  Another solution would be to directly design the intra-repetition hopping in such a way that there are no gaps across slots, without having to configure legacy RPFS. | |
| China Telecom | | Share the view with ZTE, Fujitsu and Docomo, if legacy RPFS start RB index hopping pattern is reused across multiple legacy SRS frequency hopping periods, different RBs can’t be sounded in the minimum time as shown in their figure for PF=4 and K=2. The patterns of start RB index hopping across multiple legacy SRS frequency hopping periods are preferred to be further discussed. | |
| OPPO | | We could be open to the updated FL proposal. However, we should not modify the legacy RPFS start RB index hopping pattern across multiple SRS frequency hopping periods. It is not within scope of the WID. The WID only refers to multiple frequency-domain starting positions for SRS repetition symbols within one SRS frequency hop. | |
| Nokia2 | | We don’t support it. We share view with IDC. It is out of scope by WID. Also, the gain is unclear. What is the motivation to change the frequency location in the independent hopping. | |
| ETRI | | Support the Mod’s updated proposal. | |
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### Round 4

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## P1-3: Supported types and usages of SRS (Closed)

### Round 1/2

**Proposal 1-3-1:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency, support periodic, semi-persistent and aperiodic SRS.

**Proposal 1-3-2:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement)

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support both Proposal 1-3-1 and Proposal 1-3-2. |
| Apple | We are okay |
| InterDigital | Support Proposals 1-3-1 and 1-3-2. |
| Fujitsu | Support both proposals. |
| HONOR | Support both. |
| NEC | Support the two proposals. |
| MediaTek | Support both proposals |
| Spreadtrum | Fine with Proposal 1-3-1 and Proposal 1-3-2. |
| Qualcomm | Support both proposals. |
| OPPO | Support both proposals. |
| ETRI | Support both Proposal 1-3-1 and Proposal 1-3-2. |
| vivo | **Proposal 1-3-1**  Not support aperiodic SRS. For aperiodic SRS, we don’t think R20 intra-repetition hopping has enough advantage than legacy hopping pattern.  For aperiodic SRS, full hopping cycle is completed within a slot. Takes the following figures as an example, full hopping cycle is completed within 8 symbols.    It can be observed that:   1. The number of symbols and bandwidth for each hop for legacy hopping can be configured equal to the T/F granularity of intra-repetition hopping. 2. Both intra-repetition and legacy hopping patterns achieve continuous sub-band sounding across the wideband, and a key difference is that the intra-repetition hops are more concentrated within a specific time and frequency regions. 3. Even under the assumption of phase continuity, for SRS resource configured with frequency hopping completed within a slot, the channel coherent combination performance for intra-repetition hopping pattern and legacy hopping pattern is expected to be similar. This is because coherent processing performance depends on channel variation between hops in the time domain and in this scenario, all hops occur within a very short duration where the channel remains essentially unchanged. Thus, even legacy frequency hopping can achieve comparable performance. In contrast, for SRS resources configured with frequency hopping across different periods (e.g., periodic SRS or semi-persistent SRS), the intra-repetition hopping pattern may enable better coherent processing than the legacy pattern. This is because hops under the legacy scheme are more dispersed in time, and the performance will be affected by channel variations and phase jumps.   Therefore, for aperiodic SRS which only supports frequency hopping within a slot or two consecutive slots, intra-repetition hopping does not provide significant gains over legacy frequency hopping.  **Proposal 1-3-2**  OK |
| Huawei, HiSilicon | Support both proposals. |
| Sony | We are supportive of these proposals. |
| TCL | Support both proposals. |
| NTT Docomo | Support |
| Samsung | Support proposals 1-3-1 and 1-3-2. |
| Nokia | Support |
| Transsion | Support both proposals. |
| Sharp | Support both proposals. |
| Xiaomi | Support both proposals |
| Lenovo | Support both proposals. |
| Ericsson | Support both proposals. On aperiodic SRS: With incremental hopping, as shown in our tdoc, a hopping pattern that is different (and achieves better NMSE) compared to legacy FH and RPFS can be achieved with intra-repetition hopping. |
| China Telecom | Support |
| Tejas | Support both proposals. |
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#### Agreements of round-2 online discussion

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## P1-4: Phase continuity

### Round 1/2/3

**Proposal 1-4**: TBD.

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
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## P1-5: Other issues

**Proposal 1-5**: TBD

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| **Company** | **Input** |
| Mod | Please share your views on the other issues. |
| ZTE | Regarding phase continuity on intra-repetition hopping for SRS in Rel-20, which may be discussed in P1-4, we think RAN1 needs to study events which may cause the phase continuity not to be maintained, analogous to that specified for DMRS bundling in 38.214 as follows.   |  | | --- | | 6.1.7 UE procedure for determining time domain windows for bundling DM-RS  ...  Events which cause power consistency and phase continuity not to be maintained across PUSCH transmissions of PUSCH repetition type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or PUCCH transmissions of PUCCH repetition, within the nominal TDW, are:  - A downlink slot or downlink reception or downlink monitoring based on *tdd-UL-DL-ConfigurationCommon* and *tdd-UL-DL-ConfigurationDedicated* for unpaired spectrum.  - For the UE indicating the capability *dmrs-BundlingNonBackToBackTX* or *dmrs-BundlingNonBackToBackTX-PerBC* in [13, TS 38.306], the gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, exceeds 13 symbols for normal cyclic prefix or exceeds 11 symbols for extended cyclic prefix.  - For the UE not indicating either of the capabilities *dmrs-BundlingNonBackToBackTX* or *dmrs-BundlingNonBackToBackTX-PerBC* in [13, TS 38.306], a non-zero symbol gap is scheduled between any two consecutive PUSCH transmissions or between any two consecutive PUCCH transmissions.  - The gap between any two consecutive PUSCH transmissions, or the gap between any two consecutive PUCCH transmissions, does not exceed 13 symbols but other uplink transmissions are scheduled between the two consecutive PUSCH transmissions or the two consecutive PUCCH transmissions.  - For PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B or TB processing over multiple slots, a dropping or cancellation of a PUSCH transmission according to clause 9, clause 11.1 and clause 11.2A of [6, TS 38.213] or due to cell DRX operation.  - For PUCCH transmissions of PUCCH repetition, a dropping or cancellation of a PUCCH transmission according to clause 9, clause 9.2.6 and clause 11.1 of [6, TS 38.213] or due to cell DRX operation.  - For any two consecutive PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, and when neither *multipanelSchemeSDM* nor *multipanelSchemeSFN* is configured and two SRS resource sets are configured in *srs-ResourceSetToAddModList* or *srs-ResourceSetToAddModListDCI-0-2* with higher layer parameter *usage* in *SRS-ResourceSet* set to 'codebook' or 'nonCodebook', a different SRS resource set association is used for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, according to Clause 6.1.2.1.  - For any two consecutive PUCCH transmissions of PUCCH repetition, and when a PUCCH resource used for repetitions of a PUCCH transmission by a UE includes first and second spatial relations or first and second sets of power control parameters, as described in [10, TS 38.321] and in clause 7.2.1 of [6, TS 38.213], different spatial relations or different power control parameters are used for the two PUCCH transmissions of PUCCH repetition, according to Clause 9.2.6 of [6, TS 38.213].  - Uplink timing adjustment in response to a timing advance command according to clause 4.2 of [6, TS 38.213].  - Frequency hopping.  - For reduced capability half-duplex UEs,  - a dropping or cancellation of a PUSCH or PUCCH transmission according to clause 17.2 of [6, TS 38.213] or  - an overlapping of the gap between two consecutive PUSCH or two consecutive PUCCH transmissions and any symbol of downlink reception or downlink monitoring  The UE shall maintain power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to frequency hopping, or in response to the use of a different SRS resource set association for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, or in response to the use of different spatial relations or different power control parameters for the two PUCCH transmissions of PUCCH repetition, or in response to any event not triggered by DCI or MAC-CE. The UE maintains power consistency and phase continuity within an actual TDW, across PUSCH transmissions of PUSCH repetition Type A scheduled by DCI format 0\_1, 0\_2 or 0\_3, or PUSCH repetition Type A with a configured grant, or PUSCH repetition type B or TB processing over multiple slots, or across PUCCH transmissions of PUCCH repetition, in case the actual TDW is created in response to an event triggered by DCI other than frequency hopping or the use of a different SRS resource set association for the two PUSCH transmissions of PUSCH repetition type A, or PUSCH repetition type B, or the use of different spatial relations or different power control parameters for the two PUCCH transmissions of PUCCH repetition, or in response to an event triggered by MAC-CE, subject to UE capability. of *dmrs-BundlingRestart* [13, TS 38.306] and when *pusch-WindowRestart* or *pucch-WindowRestart* is enabled. | |
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# **Issue 2: Cross-slot SRS between one U slot and one adjacent S slot**

Open issues on cross-slot SRS between one U slot and one adjacent S slot and company views are summarized below.

Table 2. Summary of views on Issue 2

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| **#** | **Issue** | **Companies’ views** |
| 2-1 | Supported scenario(s) for cross-slot SRS | * Scenario 2: an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one another SRS resource with time-domain resource transmitted in a second consecutive U slot.   + Support: *Samsung, CATT, Huawei, ZTE, vivo, Nokia, China Telecom, InterDigital, NTT DOCOMO, TCL, Fujistu, NICT, Sharp, Panasonic(can be supported if it does not require significant additional specification effort compared to Scenario 1)*   + Do not support: *Qualcomm, Ericsson, OPPO, HONOR, Lenovo, MediaTek, Sony, Spreadtrum* |
| 2-2 | Starting slot of an aperiodic cross-slot SRS resource set | * For an aperiodic cross-slot SRS resource set, the slot offset configured to the SRS resource set refers to the first of the two slots spanned by the SRS resource set   + *Huawei, Ericsson, Apple, NTT DOCOMO* |
| 2-3 | Per slot resource offset for AP SRS | * Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   + *Samsung, ZTE, CATT, Huawei, vivo, ChinaTelecom, NTT DOCOMO, ETRI, xiaomi, Sharp, OPPO, Nokia* * Per resource slot offset is not needed for AP SRS   + *Ericsson, Nokia, Panasonic*   *ZTE, Sony*: For a given aperiodic SRS resource set in case of SRS transmission across two adjacent S+U slot.   * + Option-1: To configure the current slot-level offset (i.e., slot offset k and available slot offset t) per SRS resource   + Option-2: Introduce a newly additional slot offset (denoted as t') per SRS resource on top of slot offset k and available slot offset t that is configured   + Option-3(Sony): Adopt the rule that SRS resources are transmitted following the order in which their IDs appear in the srs-ResourceIdList field of the SRS resource set. No additional per-SRS resource slot offset is introduced.   *NTT DOCOMO:*   * When *availableSlotOffsetList-r17* is not provided, to support cross-slot aperiodic SRS resource set, consider following options for configuration of transmission slot per SRS resource.   + Option 1: RRC parameter *slotOffset* is configured per SRS resource.   + Option 2: the first slot of the SRS resource set is configured by RRC parameter *slotOffset*. 1-bit flag is configured per SRS resource to indicate whether the SRS resource is transmitted on the first slot or the second slot. * When *availableSlotOffsetList-r17* is provided,   + support Alt-0 to determine “available slot” for cross-slot aperiodic SRS resource set.     - Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.   + DCI indicates the cross-slot aperiodic SRS resource set is transmitted on (t+1)-th available slot group counting from the slot configured by *slotOffset*.   + RRC configures per SRS resource whether the SRS resource is transmitted on first slot or second slot. |
| 2-4 | Definition of available slot | * Alt0: *CATT, Huawei,Qualcomm, Ericsson, vivo, Samsung, Nokia,OPPO, China Telecom, Lenovo, MediaTek, NTT DOCOMO, Sony, Apple, ETRI, Fujistu, NICT, Tejas Networks Ltd, Sharp, Spreadtrum, NEC(second preference)* * Alt1: *HONOR, InterDigital* * Alt2: *ZTE, NEC(first preference)* |
| 2-5 | Time domain location of cross-slot SRS | *Qualcomm*  For cross-slot SRS, for group or sequence hopping equation of , down-selection from the following two alternatives:   * Alt1: Change the to be in the equation, and define as the slot index where the symbol is located in; * Alt2: No change to existing equations, and define as the slot index of the first slot of the SRS resource.   + Note: The only exceptional case for Alt2 to be different than legacy is, when the SRS resource is across a frame boundary, which should not be typical for S+U slot, although.   *vivo:*   * + ‘’ should be interpreted as the starting symbol of the starting slot for an SRS resource.   + ‘’ should be interpreted as the symbol index in a slot or two consecutive S and U slots relative to the starting position of the starting slot for an SRS resource.   *vivo,* *Nokia, TCL, Transsion Holdings :*   * + The restriction ‘’ should be removed. |
| 2-6 | Maximum number of repetition and SRS symbols | * Maximum number of repetition symbols beyond 14.   + *Support:*  *vivo, China Telecom, HONOR, KDDI, Lenovo, Xiaomi,*   Reason: enhance the coverage   * + Not support: *CATT, Samsung, MediaTek, Qualcomm, Ericsson, Panasonic, Tejas Network Limited, Sharp* * Maximum number of SRS symbols beyond 14.   + *Support:* *ZTE, vivo, China Telecom, Apple, HONOR, KDDI, Lenovo, Xiaomi,*   Reason: enhance the coverage   * + Not support: *CATT, Samsung, MediaTek, Qualcomm, Ericsson, Panasonic, Tejas Network Limited, Sharp* |
| 2-7 | Transmission of SRS before PUSCH | * *HW*: Allow SRS to be configured to transmit before the same-slot transmission of PUSCH and corresponding DMRS. * *OPPO*: Transmitting PUSCH with a priority index 0 and corresponding DMRS after non-cross-slot SRS resource is not supported. * *Nokia*: Support transmitting PUSCH with a priority index 0 and corresponding DMRS after any SRS resource in the same U slot when the SRS resource is in the same SRS resource set with the cross-slot SRS resource. * *Ericsson*: Support transmitting normal SRS in the U slot after a cross-slot SRS (starting in an S slot and ending in the U slot) and before PUSCH in the U slot. |
| 2-8 | Supported types and usages of cross-slot SRS | * Codebook, non-codebook, antenna switching, beam management   + *Spreadtrum, CATT, ZTE,*   + *Apple:* Not supported for antenna switching * P/SP/AP SRS   + *Spreadtrum, ZTE, CATT* |
| 2-9 | Multiple aperiodic SRS resource sets in a slot for usage of antenna switching | * For cross-slot SRS, support configuring/triggering multiple aperiodic SRS resource sets in a slot for usage of antenna switching.   + Support: *CATT, Samsung, OPPO, China Telecom, Panasonic* |
| 2-10 | Other issues | * *NTT DOCOMO*    + Support cross-slot SRS for SRS resource with repetition and without repetition. * *QC*   + For cross-slot SRS, basic UE feature has starting symbol as the last 4 symbols: .     - Pre-requisite FG is FG 2-52.   + For cross-slot SRS, according to WID, UE does not expect the following conditions changed between the two consecutive slots: TA, UL spatial filter, and transmit power.     - RAN1 clarifies that phase continuity is not required for UE, if any of the above conditions are not satisfied. * *Xiaomi*   + Support only PUSCH mapping Type B for PUSCH transmission. * *ZTE*   + The transmission occasion for SRS transmission should be defined by the total of consecutive SRS symbols * *Lenovo*   + The transmit power for the SRS transmission is calculated based on the parameters determined in the first slot for the SRS transmission.   + Consider the following options on the enhancement for RPFS:   Option 1: The first half of the repetitions use the legacy start RB index, and the second half of the repetitions use another start RB index.  Option 2: Introduce additional sounding RBs with new start RB index for each hop.  Option 3: Divide the legacy sounding RBs into two parts, where each part is assigned a separate start RB index   * *HONOR*   + If cross-slot SRS in S slot is overlapped, at least the last symbol in S slot is overlapped, its remaining part in adjacent U slot should be dropped to save the uplink resources. * *China Telecom*   + Study the update of the interpretation of as the slot number of first S slot for a cross-slot SRS resource in both adjacent slots in cyclic shift hopping, group hopping, sequence hopping, comb offset hopping, frequency hopping formulas. * *Panasonic*   + For cross-slot SRS, a guard period for antenna switching should be relaxed to be applied between SRS resources within the SRS resource set in different slots * *OPPO*   + For frequency hopping only or combination of frequency hopping and repetition across (U+S) slots, current formula to determine n\_SRS can be fully reused via appropriate definition of slot offset. |

## P2-1: Supported scenario(s) for cross-slot SRS

### Round 1/2/3 (High priority)

**Proposal 2-1**: For cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one another SRS resource with time-domain resource transmitted in a second consecutive U slot (i.e., scenario 2).

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support.  As elaborated in details in our tdoc [10], Scenario-2 is critical and needed to be supported to ensure the consistency and efficiency of xTyR based SRS antenna switching for DL CSI acquisition by transmitting multiple SRS resources in the consecutive symbols across S+U slots. Besides, it should be allowed to transmit USCH with a priority index 0 and corresponding DMRS after the SRS in the U slot in the serving cell in Scenario.  Therefore, we suggest the following updates of Proposal 2-1.  **Proposal 2-1**: For cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one another SRS resource with time-domain resource transmitted in a second consecutive U slot (i.e., scenario 2).   * In Scenario-2, PUSCH with a priority index 0 and corresponding DMRS can be transmitted after the SRS in the U slot in the serving cell. |
| Apple | Since antenna switching already allows more than one AP SRS resource sets being configured, at least separate discussion is needed for antenna switching SRS |
| InterDigital | Support |
| Fujitsu | Support |
| HONOR | Better to discuss the details of this issue after the enhancement of available slot and slot offset are determined. It may have no spec impact if per SRS resource configuration of slot offset and/or available slot offset is determined. |
| MediaTek | Seems not neccesary |
| Spreadtrum | Not support, it is clearly out scope of WID. |
| Qualcomm | Prefer not to support Scenario 2.  We agree with some companies during last meeting that this is a duplication of existing function. |
| OPPO | We cannot see the use cases to further support scenario 2. According to WID, the extension of coverage of SRS is mainly achieved by utilizing more contiguous symbols, leading to the cross-slot SRS resource instead of multiple SRS resources spanning a few symbols. This scenario can be supported within one U slot following legacy rule. |
| Mod | @ZTE Thanks for the comment and suggested update. The newly added section, i.e., “details of this issue “ as mentioned by HONOR, can be discussed separately in P2-7. |
| Huawei, HiSilicon | Support. |
| Sony | We do not see why this enhancement is needed. As noted by Apple, legacy allows configuring AP SRS-AS, which appears to be the main use case, over two resource sets, such as a first resource set in the S symbol, and a second resource set in the U symbol. |
| TCL | Support |
| NTT Docomo | Support |
| Samsung | Support Scenario 2. We think that the only difference between Scenario 1 and 2 is whether across-slot SRS resource is included or not, hence spec impact wise Scenario 2 is better than 1 which should consider across-slot SRS resource. |
| Nokia | Support |
| Transsion | Support |
| Panasonic | If the spec impact is small, we support Scenario 2. |
| Xiaomi | We think the case for AS SRS needs further discussion. For other usages, we don’t see a strong need currently. |
| Lenovo | We tend to agree with QC and OPPO that the function behind this proposal can be achieved by the current spec. |
| Ericsson | We don’t think Scenario 2 is needed as it does not provide any new functionality. |
| China Telecom | Support |
| ZTE2 | Regarding the concern of Scenario 2 raised by companies, we’d like to highlight that it cannot be feasible to 1T2R and 2T4R SRS antenna switching (the most common cases in the real field so far) by current spec. More precisely, in Rel-15, only up to one AP SRS resource set can be configured in such cases as following excerpts, where two UL symbols in the tail of S slot cannot be sufficient for the transmission of two SRS resources due to one-symbol guard period is always requested.  TS 38.214, section 6.2.1.2   |  | | --- | | ...  - otherwise, for 1T2R, up to two SRS resource sets configured with a different value for the higher layer parameter *resourceType* in *SRS-ResourceSet* set, where each set has two 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 second resource in the set is associated with a different UE antenna port than the SRS port of the first resource in the same set, or  ...  - otherwise, for 2T4R, up to two SRS resource sets configured with a different value for the higher layer parameter *resourceType* in *SRS-ResourceSet*, where each SRS resource set has two SRS resources transmitted in different symbols, each SRS resource in a given set consisting of two SRS ports, and the SRS port pair of the second resource is associated with a different UE antenna port pair than the SRS port pair of the first resource, or  ... |   Although it can also be noted that two aperiodic SRS resource sets can be configured for 1T2R and 2T4R SRS antenna switching as in Rel-17, it is optionally subject to UE capability *srs-ExtensionAperiodicSRS*, which may not be the prerequest FG to across-slot SRS enhancement in Rel-20. Besides, even though two SRS resource sets can be configured via Rel-17 functionality and allocated in S slot and U slot respectively as following excerpts, it will just negatively lead to 1) Majority of remaining symbols in U slot cannot be used for PUSCH and corresponding DMRS, or 2) Consistency of SRS antenna switching for DL CSI acquisition cannot be ensured fairly, as illustrated in Figures (a) and (b). For clarification, these two sufferings are existed to all cases of two SRS resource sets configured in S slot and U slot for SRS antenna switching.   |  | | --- | | For 1T2R, 1T4R, 2T4R, 1T6R, 1T8R, 2T6R, 2T8R, 3T6R, or 4T8R, the UE shall not expect to be configured or triggered with more than one SRS resource set with higher layer parameter *usage* set as '*antennaSwitching*' in the same slot. For 1T=1R, 2T=2R, 3T=3R, 4T=4R, or 8T=8R, the UE shall not expect to be configured or triggered with more than one SRS resource set with higher layer parameter *usage* set as '*antennaSwitching*' in the same symbol. |      1. Suffering-1: Majority of remaining symbols in U slot cannot be used for PUSCH and corresponding DMRS      1. Suffering-2: Consistency of SRS antenna switching for DL CSI acquisition cannot be ensured fairly   In this sense, we do see the necessity of supporting Scenario 2 for the practical usage of SRS transmission in the current TDD system. |
| Nokia 2 | Agree with ZTE’s assessment. Also, it is beneficial for using one SRS resource set for the consecutive SRS resources instead of two SRS resource sets. |
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### Round 4

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## P2-2: Starting slot of an aperiodic cross-slot SRS resource set

### Round 1

**Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support. |
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| Apple | I guess this is assuming P2-1 is agreed. In principle, we are okay. |
| Fujitsu | Support. |
| HONOR | Support. |
| NEC | Support. |
| MediaTek | Support |
| Spreadtrum | Support |
| Qualcomm | Support |
| OPPO | We are fine with the proposal. |
| ETRI | Support |
| vivo | OK |
| Huawei, HiSilicon | Support. |
| Sony | Support. |
| TCL | Support |
| NTT Docomo | Support |
| Samsung | Support. |
| Nokia | Support |
| Transsion | Support |
| Sharp | Support. |
| Panasonic | Support. |
| Xiaomi | Support |
| Lenovo | Support |
| Ericsson | Support |
| China Telecom | Support the principle.  Does the slot offset mean both the configured *slotOffset* and *availableSlotOffsetList*? |
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### Round 2/3 (High priority)

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| Mod | Let’s start with the version in round-1 offline discussion.  **Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.  Note: for the resource in the second slot how to use this slot offset configured for the SRS resource set is discussed separately. |
| Sony | Generally support, but we don’t think the note is needed. |
| Apple | We are okay. But the note is not very clear, we prefer not to have the note |
| OPPO | Support. |
| Nokia | Proposal 2-2 is a kind of simple clarification. Cross-slot SRS resource set is indicating the case where SRS resource(s) of the SRS resource set are transmitted through S+U slots. The proposal says that, in this case, the slot offset in aperiodic SRS triggering indicate the S slot. There is no point on SRS resource offset. |
| ETRI | Support |
| Mod | It seems that companies still have different understandings on the definition of scenario1. As shown below, the divergence of understanding lies in whether only interpretation 1 or both interpretations align with the definition of Scenario 1  C:\Users\suxin\AppData\Local\Temp\企业微信截图_17604270443671.png  So, can we revise the note in the following update of proposal 2-2?  From my understanding, the main bullet is needed anyway, regardless whether interpretation 1 or both 1 and 2 are supported. However, as the interpretation of scenario 1 is related to some other issues as well, with the following notes it could be helpful for us to align the understanding of scenario 1 later.  **Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.  Note 1: Whether only interpretation 1 or both interpretation 1 and 2 are aligned with the definition of scenario 1 is discussed separately.  Note 2: If both interpretation 1 and 2 are aligned with the definition of scenario 1, for the resource in the second slot, how to use this slot offset configured for the SRS resource set is discussed separately.  Note 3: For interpretation 1 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.  Note 4: For interpretation 2 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a second U slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot. |
| Mod | **Proposal 2-2-1**: For an aperiodic cross-slot SRS resource set in scenario 1, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.  Note 1: Whether only interpretation 1 or both interpretation 1 and 2 are aligned with the definition of scenario 1 is discussed separately.  Note 2: If both interpretation 1 and 2 are aligned with the definition of scenario 1, for the resource in the second slot, how to use this slot offset configured for the SRS resource set is discussed separately.  **Proposal 2-2-2**: For scenario 1, further discuss the following interpretations   * *Scenario 1: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.*    + For interpretation 1 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.   + For interpretation 2 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a second U slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot. |
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### Round 4

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## P2-3: Per slot resource offset for AP SRS

### Round 1/2/3

**Proposal 2-3**: Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support.  Given that the slot offset is determined by *slotOffset* and *availableSlotOffset* together as in legacy, we suggest the following update of Proposal 2-3.  **Proposal 2-3**: Introduce per-SRS resource slot offset determined by *slotOffset* and *availableSlotOffset* for each of SRS resources within an aperiodic SRS resource set |
| Apple | Again this is assuming P2-1 is agreed. In principle, we are okay. |
| Fujitsu | Support. Based on Proposal 2-2 and Proposal 2-3, there are a per-SRS-resource-set slot offset and a per-SRS-resource slot offset for aperiodic SRS. |
| MediaTek | Same view as Apple. This can be combined with Proposal 2-1 |
| Qualcomm | If we don’t have Scenario 2 resource set, seems we don’t need this per-source offset parameter –for Scenario 1, whether set offset +0 or +1 can be implicitly determined by whether the resource is across-slot or not |
| OPPO | Support in principle. Since the slot for resources within an AP resource set would be only current slot or the next slot, we think one bit indication per resource for the slot is sufficient. We don’t need a redundant per-SRS resource offset similar to the legacy one (i.e. *slotOffset* and *availableSlotOffset*). |
| ETRI | Support. We suggest the following update to Proposal 2-3, based on ZTE’s version:  **Proposal 2-3**: Introduce per-SRS resource slot offset determined by *slotOffset* and *availableSlotOffset* (if configured) for each of SRS resources within an aperiodic SRS resource set |
| Mod | @ZTE @OPPO @ETRI Regarding how to configure/indicate per resource offset for AP SRS, thank you for providing more detailed alternatives of implementation. However, the prerequisite of discussing the next-level design is that we are able to support per resource offset first.  **Proposal 2-3**: Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   * FFS: whether the offset is configured by legacy mechanism (e.g., *slotOffset* and *availableSlotOffset* (if configured))or indicated by 1-bit signaling.   @QC FYI, as shown in the following, Samsung provided an example of ambiguity on slot position of AP SRS resource. @Samsung appreciate your nice painting!.    Figure 9. Ambiguity on slot position of SRS resource |
| vivo | We are fine to introduce mechanism to distinguish S-slot SRS resource and U-slot SRS resource. However, based on this proposal, does it mean that other method (e.g, 1 bit flag) to distinguish S-slot SRS resource and U-slot SRS resource are excluded? |
| Huawei, HiSilicon | Can be postponed after companies reach consensus on **Proposal 2-1**. |
| Sony | First, we’d like to point out that in our understanding, this proposal applies as well to scenario 1, as illustrated by Samsung’s figure above. Thus, it does not solely depend on Proposal 2-1.  Then, we agree that a mechanism to distinguish between a S-slot’s SRS resource and a U-slot’s one is needed. However, we do not think that a new field needs to be introduced. This mechanism can also be *implicit*. In our contribution, we propose that the order of the SRS resources within the SRS resource set, i.e., as given by the field *srs-ResourceIdList* of the SRS resource set, shall determine the order of the SRS resources. This has the advantage that overhead due to SRS-Resources is not increased.  With reference to Samsung’s figure above, the network configures *SRS-ResourceSet.srs-ResourceIdList* = {2, 1} if it wants to configure interpretation 1, and *SRS-ResourceSet.srs-ResourceIdList* = {1, 2} to configure interpretation 2. In both cases, the SRS resources are configured as in the figure with *SRS-Resource1.srs-ResourceId* = 1, and *SRS-Resource1.srs-ResourceId* = 2.  We therefore propose the following modification:  **Proposal 2-3**: Down-select between the following alternatives:   * Alt-1: Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   + FFS: whether the offset is configured by legacy mechanism (e.g., *slotOffset* and *availableSlotOffset* (if configured))or indicated by 1-bit signaling. * Alt-2: Adopt the following rule: An SRS resource linked by srs-ResourceIdList[i] is transmitted before another SRS resource linked by srs-ResourceIdList[j] whenever i < j. |
| TCL | We are okey for revised Proposal 2-3. |
| NTT Docomo | availableSlotOffset should be removed from the e.g. in the FFS. In our understanding, according to proposal 2-4, the availableSlotOffset should be per SRS resource set.  FFS: whether the offset is configured by legacy mechanism (e.g., slotOffset ~~and availableSlotOffset (if configured)~~) or indicated by 1-bit signaling. |
| Mod | @ZTE @ETRI @OPPO @vivo @Sony @DCM Thanks for providing solutions for supporting per-resource offset configuration/indication in this proposal. Next level details on how to determine the offset can be further studied.  **Proposal 2-3**: Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   * FFS: details on how to determine the offset for each of SRS resources within an aperiodic SRS resource set. |
| Samsung | Support. |
| Nokia | Generally fine but we share view with HW. We can discuss later together with other parameters. |
| Transsion | We are fine with revised Proposal 2-3. |
| Sharp | Support. |
| Xiaomi | Fine with the proposal |
| Lenovo | Suggest postponing this proposal until we have a conclusion on P2-1. |
| Ericsson | Do not support. Not needed unless we support Scenario 2, which, as mentioned above, does not offer new functionality compared to Scenario 1. |
| China Telecom | Fine with the updated proposal. |
| Sony | We are mainly fine with the updated proposal. However, the current wording gives the impression that a new field should be introduced in the SRS resource IE. To be clear that the whole determination might in fact need no additional fields, i.e., implicit determination, we propose the following update:  **Proposal 2-3**: Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   * FFS: details on how to determine the offset for each of SRS resources within an aperiodic SRS resource set.   + Note: The introduced per-SRS resource offset for each SRS resource within an aperiodic SRS resource set can be implicit or explicit.   Alternatively, we are also fine with:  **Proposal 2-3**: Introduce determination of per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   * FFS: details on how to determine the offset for each of SRS resources within an aperiodic SRS resource set. |
| Mod | @Sony Thanks for the suggestion. Proposal 2-3 is updated accordingly.  **Proposal 2-3**: Introduce mechanism to determine per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set   * FFS: details on how to determine the offset for each of SRS resources within an aperiodic SRS resource set. |
| ZTE2 | **Support.** |
| OPPO | We are general fine with the updated proposal. However, we think this could be only applied to AP SRS resource set with cross-slot SRS resource before agreement on scenario 2.  **Proposal 2-3**: Introduce mechanism to determine per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set with cross-slot SRS.  FFS: details on how to determine the offset for each of SRS resources within an aperiodic SRS resource set. |
| Nokia2 | OK for FL’s latest update. For removing confusion, we propose to use different number for the updated proposal, e.g. Proposal 2-3a, 2-3b etc… |
| ETRI | Support the Mod’s updated proposal. |
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## P2-4: Definition of available slot

### Round 1/2/3

**Proposal 2-4**: For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, the following alternative is adopted to determine “available slot”:

* Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Not support.  By Alt-0, any AP-SRS resource configured in the set can only be triggered in each pair of two adjacent S+U slots with the availability, which may lead to the serious issue in the current TDD system, where one typical configuration of slot allocation in the subframe, i.e., D slot : S slot : U slot = 7 : 1 : 2 and only one pair of two adjacent S+U slots can be used in the subframe.  We support either Alt-1 or Alt-2 for the above issue caused by Alt-0, and we slightly prefer Alt-2 due to it is in fact the same as the legacy rule of SRS antenna switching. For example, four SRS resources configured in two SRS resource sets and transmitted in two slots for the case of 1T4R. If it happens that SRS resources in one set cannot be transmitted in one slot, SRS resources in the other SRS resource set still can be transmitted in another slot. |
| Apple | Support Alt 0 |
| InterDigital | Support |
| Fujitsu | Support |
| HONOR | Generally agree with ZTE’s point. |
| NEC | We prefer Alt 2, while can accept Alt 0 if majority supports. Maybe we can additionally support Alt 1 or Alt 2 with UE capability? |
| MediaTek | Support the proposal |
| Spreadtrum | Support |
| Qualcomm | Support |
| OPPO | Support the proposal. |
| ETRI | Support |
| vivo | Support |
| Huawei, HiSilicon | Support. |
| Sony | Support. |
| TCL | Support |
| NTT Docomo | Support |
| Samsung | Support |
| Nokia | Support |
| Transsion | Support |
| Sharp | Support. |
| Panasonic | Support |
| Xiaomi | we are fine to support Alt0 if it is the majority’s view. |
| Lenovo | Support |
| Ericsson | Support |
| China Telecom | Support |
| ZTE2 | Regarding Alt-0, the main reason seems to just follow the legacy rule, which we cannot agree. Given that the legacy “available slot” is specified per set per slot, it seems even between Alt-0 vs Alt-2. As we commented above, Alt-0 may negatively lead to the serious issue in the current TDD system in terms of efficiency/availability for cross-slot SRS transmission, which definitely deviates from the motivation in WID statement, hence we reckon Alt-0 has the lowest priority. |
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## P2-5: Time domain location of cross-slot SRS （Closed）

### Round 1/2

**Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,

* ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource.
* ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots relative to the starting position of the starting slot for an SRS resource.
* The restriction ‘’ is removed.

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support. |
| Apple | We are okay |
| Fujitsu | We are fine with the intention, although we think the agreement on the time-domain location of cross-slot SRS from the last meeting has already reflected Proposal 2-5. |
| MediaTek | Support |
| Qualcomm | Support |
| OPPO | Fine. |
| ETRI | Okay |
| vivo | Support |
| Huawei, HiSilicon | Share similar view with Fujitsu.  Furthermore, the ‘relative to the starting position of the starting slot for an SRS resource’ in the second sub-bullet should be deleted to avoid ambiguity. |
| Sony | Agree with Fujitsu. Does this agreement add anything to the agreement on the determination of the time-domain location of cross-slot SRS from RAN1#122? |
| TCL | Support |
| NTT Docomo | Support |
| Mod | @ETRI @Sony Regarding the question raised by ETRI and Sony, as shown below, vivo has good explanations in their contribution.  Regarding time domain location of cross-slot SRS, the following agreements were achieved in RAN1#122.   |  | | --- | | **Agreement:**  For a P/SP cross-slot SRS resource, the slot offset configured to the SRS resource refers to the first of the two slots spanned by the SRS resource.  **Agreement:**  To determine the time-domain location of cross-slot SRS,   * One set of time-domain resource allocation related parameters (i.e., startPosition, nrofSymbols, and repetitionFactor) is configured for the SRS resource without restriction on “within a slot”.   + For the index of each SRS symbol , it is the same as legacy spec., i.e., .  * + The offset counts symbols backwards from the end of the starting slot of the resource |   **SRS time domain mapping**  There are still some remaining issues to be solved for SRS time domain mapping.   * **The restriction ‘’ in TS38.211 should be removed for cross-slot SRS resource**  |  | | --- | | **TS38.211 Clause 6.4.1.4.1 SRS resource**  , the starting position in the time domain given by where the offset counts symbols backwards from the end of the slot and is given by the field *startPosition* contained in the higher layer parameter *resourceMapping* and . |   In the current specification, ‘’ is the starting symbol for an SRS resource within a slot. In Rel-20, ‘’ should be interpreted that the starting symbol of the starting slot for an SRS resource. In addition, for the purpose of single-slot SRS resource transmission, the specification restricts the offset ‘’. However, in Rel-20, with the support of cross-slot SRS mapping, this restriction is no longer needed.   * **The interpretation of ‘’ for an SRS resource should be updated**  |  | | --- | | **TS38.211 Clause 6.4.1.4.3 Mapping to physical resources**  When SRS is transmitted on a given SRS resource, the sequence for each OFDM symbol and for each of the antenna ports of the SRS resource shall be multiplied with the amplitude scaling factor in order to conform to the transmit power specified in [5, 38.213] and mapped in sequence starting with to resource elements in a slot for each of the antenna ports according to |   In the current specification, SRS resource is mapped to resource elements in a slot, where the symbol index within a slot is ‘’ which is represented by ‘’. In Rel-20, SRS resource can be mapped to resource elements in a slot or two consecutive S and U slots. In addition, ‘’ should be interpreted as the symbol index relative to the starting position of the starting slot.  @Huawei Thanks for the suggestion. Proposal 2-5 is updated accordingly.  **Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,   * ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource. * ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots ~~relative to the starting position of the starting slot for an SRS resource~~. * The restriction ‘’ is removed. |
| Samsung | Support the updated proposal 2-5. |
| Nokia | Support |
| Transsion | In the third sub-bullet, for cross-slot SRS resource, the time domain restriction can be relaxed so that . |
| Sharp | Support. l’+l0 should be an index within an SRS resource and ns,f should be the first slot of two consecutive slots. |
| Xiaomi | Support |
| Lenovo | Support the latest **Proposal 2-5.** |
| China Telecom | Fine |
| Mod | @Transsion Thanks for the comment. Proposal 2-5 is updated accordingly.  **Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,   * ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource. * ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots. * ~~The restriction ‘’ is removed~~. |
| ZTE2 | **Support.** |
| OPPO | Fine. |
| Nokia2 | We still prefer keeping the last bullet as it is. The proposal is removing the restriction for cross slot SRS resource instead of changing the assumption. |
| ETRI | Support the Mod’s updated proposal. |
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#### Agreements of round-2 online discussion

XXX

## P2-6: Maximum number of repetition and SRS symbols

### Round 1/2/3

**Proposal 2-6-1:** For the maximum number of symbols per cross-slot SRS resource, down select from the following alternatives:

* Alt 1: limited to 14
* Alt 2: Support values over 14

**Proposal 2-6-2:** For the maximum number of repetition factor, down select from the following alternatives:

* Alt 1: limited to 14
* Alt 2: Support values over 14

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Regarding Proposal 2-6-1, we support Alt-2. One practical and critical use case is to consistently sound the whole bandwidth by SRS repetitions with frequency hopping as promptly as possible (e.g., in case of CSRS = 63 and BSRS=1 in Table 6.4.1.4.3-1 in 38.211, where 1-symbol SRS needs to be repeatedly transmitted 17 times to sound the whole bandwidth for DL), and the more symbols can be used for SRS frequency hopping, the more sub-bandwidths can be sounded timely.  Regarding Proposal 2-6-1, we prefer Alt-1 unless the use case can be clarified. |
| Apple | We are okay to consider Alt 2 |
| Fujitsu | For both proposals, Alt 1 is preferred. |
| HONOR | Alt2 is preferred to further enhance the coverage within two slots. |
| NEC | Alt 1 is preferred for both proposals. |
| MediaTek | It seems we don’t need these proposals for down-selection. If RAN1 cannot reach consensus on Alt2, then Alt1 will be the outcome naturally. |
| Spreadtrum | Proposal 2-6-1: support Alt 2.  Proposal 2-6-2 should be postponed after the decision of proposal 2-6-1. |
| Qualcomm | We support Alt 1, we also agree with MediaTek’s assessment. |
| OPPO | For both two proposals, we think the current value (14, Alt-1) is sufficient. |
| ETRI | Proposal 2-6-1: Support Alt 2. We share similar view as ZTE.  Proposal 2-6-2: Support Alt 1. |
| vivo | Support Alt 2 for both. Extending the values can increase the possibility of completing frequency hopping in a short time. |
| Huawei, HiSilicon | **Proposal 2-6-1:** Support Alt 2.  **Proposal 2-6-2:** Prefer Alt 2. |
| Sony | We prefer Alt 1, for both proposals. |
| TCL | We support Alt 1 for both proposals. |
| NTT Docomo | Support Alt.1 for both proposals. |
| Transsion | Support Alt 1 for both proposals. |
| Sharp | Support Alt 1 for both proposals. |
| Panasonic | Support Alt 1 for both proposals |
| Xiaomi | We prefer Alt.2 to make full use of the resources. |
| Lenovo | Support Alt2 for both proposal. |
| Ericsson | Support Alt 1 for both proposals, the SRS overhead required to see significant SRS coverage gains would be too large (e.g., 14 extra symbols for 3 dB gain). |
| China Telecom | Support Alt 2 for both not to leave two or four unused symbols at the end of U slot. |
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## P2-7: Transmission of SRS before PUSCH

### Round 1/2/3

**Proposal 2-7**: Support transmitting normal SRS resource in the U slot after a cross-slot SRS resource (starting in an S slot and ending in the U slot) and before transmitting PUSCH with a priority index 0 and corresponding DMRS

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support. |
| Apple | We are okay |
| InterDigital | Support |
| Fujitsu | We are fine with the proposal. |
| MediaTek | We can understand the intension, but is it within the scope? |
| Spreadtrum | Support |
| Qualcomm | We are fine. |
| OPPO | Not support. For cross-slot SRS resource, whose slot index refers to previous slot, we can allow it to be before PUSCH with a priority index 0 and corresponding DMRS (as agreed). However, for a normal SRS resource in the same slot, we propose not to break the legacy rule introduced by URLLC. URLLC data should have higher priority than SRS, that is why the restriction was introduced. We cannot simply remove the rule introduced by other features without reasonable technical reason. |
| ETRI | We are okay if the normal SRS resource and the cross-slot SRS resource are within a same SRS resource set. |
| vivo | OK |
| Huawei, HiSilicon | Fine, while we believe the restriction should be further relaxed as below to optimize the physical resource, as elaborated in [7].  **Proposal:** Support transmitting SRS resource before the same-slot transmission of PUSCH with priority index 0 and corresponding DMRS. |
| Sony | Same view as ETRI, agree as long as both the cross-slot SRS resource and the normal SRS resource, the latter wholly contain in the U slot, belong to the same SRS resource set. |
| TCL | We do not support it. We agree with OPPO’s view, meanwhile, we believe it is out of scope. |
| NTT Docomo | Support.  In our understanding, this restriction was introduced in Rel-15 to ensure that no collision happens between PUSCH with priority index 0 and SRS. This restriction is valid in Rel-15 because Rel-15 SRS can only be transmitted at the last 6 symbols of a slot. In Rel-20, given that SRS can be transmitted in the first symbols in a slot we don’t see the reason to keep this restriction. |
| Samsung | Support. |
| Nokia | Support. In addition, we prefer to clarify the normal SRS is included in the same SRS resource set as the cross-slot SRS resource. |
| Transsion | Same view as ETRI. |
| Sharp | Support. |
| Xiaomi | We are fine. |
| Lenovo | Fine with this proposal. |
| Ericsson | Support. Regarding OPPO’s concern, in our understanding, URLLC data always have priority and would not be affected by this proposal. |
| China Telecom | Same view as ETRI. |
| Mod | @ETRI Thanks for the comment. Update of proposal 2-7 is shown as follows.  **Proposal 2-7**: Support transmitting normal SRS resource in the U slot after a cross-slot SRS resource (starting in an S slot and ending in the U slot) and before transmitting PUSCH with a priority index 0 and corresponding DMRS, if the normal SRS resource and the cross-slot SRS resource are within a same SRS resource set. |
| ZTE2 | **Support.** |
| Nokia2 | Support the FL updated proposal. |
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## P2-8: Supported types and usages of cross-slot SRS (Closed)

### Round 1/2

**Proposal 2-8-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-8-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support both Proposal 2-8-1 and Proposal 2-8-2. |
| Apple | For P2-1, we need to separate discuss antenna switching.  For a single SRS resource in two slots, we are okay |
| InterDigital | Support |
| Fujitsu | Support. |
| HONOR | Support. |
| NEC | Support the two proposals. |
| MediaTek | Support both proposals |
| Spreadtrum | Support |
| Qualcomm | Support |
| OPPO | Fine. |
| ETRI | Support both Proposal 2-8-1 and Proposal 2-8-2. |
| vivo | OK |
| Huawei, HiSilicon | Support both proposals. |
| Sony | Okay. |
| TCL | Support |
| NTT Docomo | Support |
| Samsung | Support |
| Nokia | Support |
| Transsion | Support |
| Sharp | Support both proposals. |
| Panasonic | Support |
| Xiaomi | Support |
| Lenovo | Support |
| Ericsson | Support |
| China Telecom | Support |
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#### Agreements of round-2 online discussion

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## P2-9: Multiple aperiodic SRS resource sets in a slot for usage of antenna switching

### Round 1/2/3

**Proposal 2-9**: ‌If a slot contains only one resource from another resource set for usage of antenna switching, and this resource spans consecutive S and U slots, then another resource set for usage of antenna switching is allowed to be configured/triggered in that slot.‌

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| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| ZTE | Support. |
| Apple | This is low priority. We should not make the specification so complicated because in the end, many of the features if agreed, won’t have any deployment and it only creates workload in 3GPP for the CR review, UE feature discussion, etc. |
| Fujitsu | We are fine with the proposal. |
| MediaTek | Not necessary |
| Qualcomm | We tend to think unnecessary.  Do we really need to squeeze two resource sets into 18 or 16 UL symbols?   * Can’t it be configured as one resource set fully occupying all the 18 or 16 symbols? * If one set really doesn’t need all the 18 or 16 symbols, the remaining symbol can still be used for PUSCH; * If we need more than 18 or 16 symbols, it can also be set1: S+U, set2: The next U |
| OPPO | Generally fine. However, there are two “another resource set” which make the proposal difficult to understand. Some modification on the wording:  **Proposal 2-9**: ‌If a slot contains only one resource from one ~~another~~ resource set for usage of antenna switching, and this resource spans consecutive S and U slots, then another resource set for usage of antenna switching is allowed to be configured/triggered in that slot.‌ |
| ETRI | Okay. We agree with OPPO’s update. |
| Huawei, HiSilicon | Seems unnecessary given that scenario 1 has already been supported for cross-slot SRS transmission. |
| Sony | We don’t see what the use case is. |
| TCL | Not necessary |
| Mod | Proposal 2-9 is updated based on OPPO’s suggestion. @OPPO Thanks.  **Proposal 2-9**: ‌If a slot contains only one resource from one ~~another~~ resource set for usage of antenna switching, and this resource spans consecutive S and U slots, then another resource set for usage of antenna switching is allowed to be configured/triggered in that slot.‌  @Huawei @Sony As raised at least by Samsung in their contribution and shown below, there is a restriction on SRS antenna switching that UE only expects up to 1 SRS resource set can be configured or triggered in a slot in current spec..   |  | | --- | | **Clause 6.2.1.2 in TS38.214**  For 1T2R, 1T4R, 2T4R, 1T6R, 1T8R, 2T6R, 2T8R, 3T6R, or 4T8R, the UE shall not expect to be configured or triggered with more than one SRS resource set with higher layer parameter usage set as 'antennaSwitching' in the same slot. | |
| Samsung | Support the updated Proposal 2-9. |
| Nokia | We don’t see the benefit of this proposal. Instead, supporting transmission of SRS resources in a SRS resource set across S+U slot. |
| Transsion | Not necessary. |
| Sharp | Support the updated Proposal 2-9. |
| Xiaomi | We think this may be not necessary. |
| Lenovo | Seems not necessary. |
| Ericsson | We think this may not be necessary, by RAN1#122 agreement and above Proposal P2-2, it should be clear which slot SRS resources and SRS resource sets are associated with. |
| China Telecom | There is also similar issue to be discussed for scenario 2, if P2-1 can be agreed. |
| ETRI | Okay if Proposal 2-1 is agreed. I have one clarification question on whether other normal resource(s) can follow the cross-slot resource in the same resource set in U slot, as the condition of the proposal looks like the case where only the cross-slot resource is in U slot. |
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## P2-10: Other issues

**Proposal 2-10**: TBD

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| **Company** | **Input** |
| Mod | Please share your views on the other issues. |
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# **Other issues**

Open issues on enhancement of SRS capacity and coverage are summarized below.

Table 3. Summary for other issues

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| **#** | **Issue** | **Companies’ views** |
| 3-1 |  | *OPPO*:   * It seems no additional specification impact to support multiple frequency-domain starting positions for RPFH in multiple symbols across (U+S) slots. |
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## P3-1:

**Proposal 3-1**: TBD

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above issues. |
| NEC | We are fine with OPPO’s observation. |
| Nokia | We don’t know yet without completion of the design. We can discuss later . |
|  |  |
|  |  |
|  |  |
|  |  |

# **Issues to be discussed in online/offline sessions**

## 4.1 Offline discussion round 1 (Monday)

### P1-1: Basic patterns(offline consensus)

**Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported

* when PF=K=2, support pattern {0,1}
* when PF=4 and K=2, support one of the following patterns:
  + Alt 1: {0,2}
  + Alt 2: {0,1}
* when PF=K=4, support one of the following patterns:
  + Alt 1: {0,2,1,3}
  + Alt 2: {0,1,2,3}

Note: exact pattern(s) are deduced from the basic patterns. FFS details.

**Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns

* when PF=K=2, support one or both of the following basic patterns:
  + Alt 1 (consecutive mapping): {0,…,0,1,…,1}
  + Alt 2 (non-consecutive mapping): {0,1,,…,0,1}
* when PF=4 and K=2, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}
  + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}
  + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}
  + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1}
* when PF=K=4, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}
  + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}
  + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}
  + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3}

Note: exact patterns are deduced from the basic patterns. FFS details.

### P2-2: Starting slot of an aperiodic cross-slot SRS resource set

**Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.

Note: for the resource in the second slot how to use this slot offset configured for the SRS resource set is discussed separately.

### P2-5: Time domain location of cross-slot SRS

**Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,

* ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource.
* ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots.

### P1-3: Supported types and usages of SRS for RPFS enhancements

**Proposal 1-3-1:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency, support periodic, semi-persistent and aperiodic SRS.

**Proposal 1-3-2:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement)

### P2-8: Supported types and usages of cross-slot SRS

**Proposal 2-8-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-8-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

### P2-4: Definition of available slot

**Proposal 2-4**: For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, the following alternative is adopted to determine “available slot”:

* Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.

## 4.2 Online discussion round 1 (Monday)

### P1-1: Basic patterns(offline consensus)

**Proposal 1-1-1**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported

* when PF=K=2, support pattern {0,1}
* when PF=4 and K=2, support one of the following patterns:
  + Alt 1: {0,2}
  + Alt 2: {0,1}
* when PF=K=4, support one of the following patterns:
  + Alt 1: {0,2,1,3}
  + Alt 2: {0,1,2,3}

Note: exact pattern(s) are deduced from the basic patterns. FFS details.

**Proposal 1-1-2**: For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns

* when PF=K=2, support one or both of the following basic patterns:
  + Alt 1 (consecutive mapping): {0,…,0,1,…,1}
  + Alt 2 (non-consecutive mapping): {0,1,,…,0,1}
* when PF=4 and K=2, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}
  + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}
  + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}
  + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1}
* when PF=K=4, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}
  + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}
  + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}
  + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3}

Note: exact patterns are deduced from the basic patterns. FFS details.

### P2-2: Starting slot of an aperiodic cross-slot SRS resource set

**Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.

Note: for the resource in the second slot how to use this slot offset configured for the SRS resource set is discussed separately.

### P2-5: Time domain location of cross-slot SRS

**Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,

* ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource.
* ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots.

### P1-3: Supported types and usages of SRS for RPFS enhancements

**Proposal 1-3-1:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency, support periodic, semi-persistent and aperiodic SRS.

**Proposal 1-3-2:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement)

### P2-8: Supported types and usages of cross-slot SRS

**Proposal 2-8-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-8-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

### P2-4: Definition of available slot

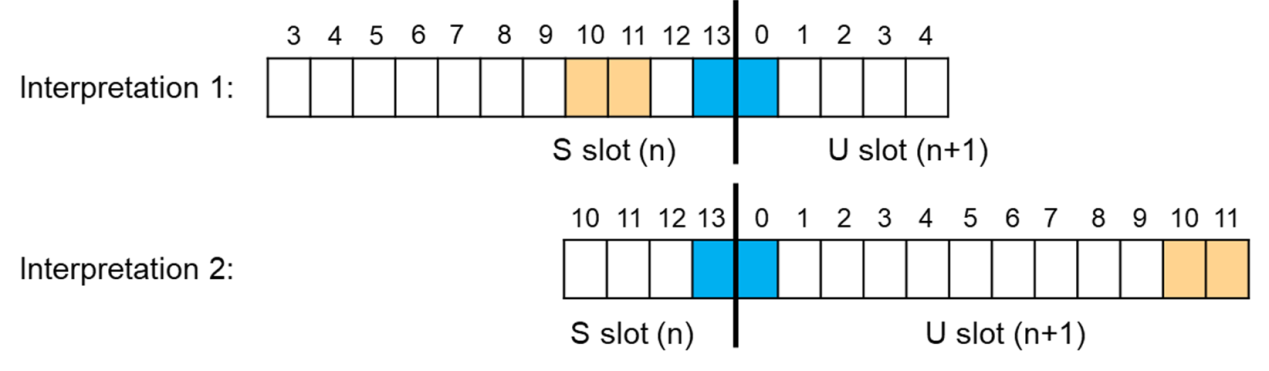
**Proposal 2-4**: For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, the following alternative is adopted to determine “available slot”:

* Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.

## 4.3 Offline discussion round 2 (Tuesday)

### P2-2: Starting slot of an aperiodic cross-slot SRS resource set

It seems that companies still have different understandings on the definition of scenario1. As shown below, the divergence of understanding lies in whether only interpretation 1 or both interpretations align with the definition of Scenario 1



So, can we revise the note in the following update of proposal 2-2?

From my understanding, the main bullet is needed anyway, regardless whether interpretation 1 or both 1 and 2 are supported. However, as the interpretation of scenario 1 is related to some other issues as well, with the following notes it could be helpful for us to align the understanding of scenario 1 later.

**Proposal 2-2**: For an aperiodic cross-slot SRS resource set, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.

Note 1: Whether only interpretation 1 or both interpretation 1 and 2 are aligned with the definition of scenario 1 is discussed separately.

Note 2: If both interpretation 1 and 2 are aligned with the definition of scenario 1, for the resource in the second slot, how to use this slot offset configured for the SRS resource set is discussed separately.

Note 3: For interpretation 1 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.

Note 4: For interpretation 2 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a second U slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.

### P2-5: Time domain location of cross-slot SRS

**Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,

* ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource.
* ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots.
* ~~The restriction ‘’ is removed.~~

### P1-3: Supported types and usages of SRS for RPFS enhancements

**Proposal 1-3-1:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency, support periodic, semi-persistent and aperiodic SRS.

**Proposal 1-3-2:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement)

### P2-8: Supported types and usages of cross-slot SRS

**Proposal 2-8-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-8-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

### P2-4: Definition of available slot

**Proposal 2-4**: For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, the following alternative is adopted to determine “available slot”:

* Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.

## 4.4 Online discussion round 2 (Tuesday)

### P2-5: Time domain location of cross-slot SRS(offline consensus)

**Proposal 2-5**: To determine the time-domain location of a cross-slot SRS resource,

* ‘’ is interpreted as the starting symbol in the starting slot for an SRS resource.
* ‘’ is interpreted as the symbol index in a slot or two consecutive S and U slots.
* The restriction ‘’ is removed.

### P1-3: Supported types and usages of SRS for RPFS enhancements(offline consensus)

**Proposal 1-3-1:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency, support periodic, semi-persistent and aperiodic SRS.

**Proposal 1-3-2:** For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, support all SRS usages (i.e., codebook, nonCodebook, antennaSwitching and beamManagement)

### P2-8: Supported types and usages of cross-slot SRS(offline consensus)

**Proposal 2-8-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-8-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

### P1-1: Starting position pattern

**To be discussed:**

For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K=R (i.e., each subgroup includes symbol (or 1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*))), the following configuration combinations and basic starting position patterns are supported

* when PF=K=2, support pattern {0,1}
* when PF=4 and K=2, select one of the following patterns:
  + Alt 1: {0,2}
  + Alt 2: {0,1}
* when PF=K=4, select one of the following patterns:
  + Alt 1: {0,2,1,3}
  + Alt 2: {0,1,2,3}

Note: exact pattern(s) are deduced from the basic patterns. FFS details.

**To be discussed:**

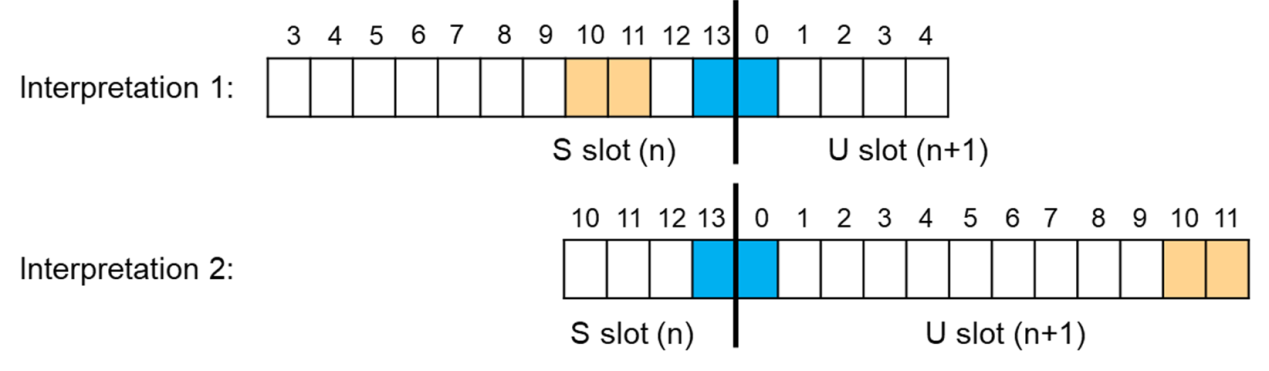
For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop and K<R (i.e., each subgroup includes symbol (or >1 pair of consecutive symbols for 8-Tx SRS with *ports8tdm*)), support the following configuration combinations and basic starting position patterns

* when PF=K=2, select at least one of the following basic patterns:
  + Alt 1 (consecutive mapping): {0,…,0,1,…,1}
  + Alt 2 (non-consecutive mapping): {0,1,,…,0,1}
* when PF=4 and K=2, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping):{0,…,0,2,…,2}
  + Alt 1-2 (consecutive mapping):{0,...,0,1,…,1}
  + Alt 2-1 (non-consecutive mapping):{0,2,…,0,2}
  + Alt 2-2 (non-consecutive mapping): {0,1,…,0,1}
* when PF=K=4, down select from the following basic patterns:
  + Alt 1-1 (consecutive mapping): {0,…,0,2,…,2,1,…,1,3,…,3}
  + Alt 1-2 (consecutive mapping): {0,…,0,1,…,1,2,…2,3,…,3}
  + Alt 2-1 (non-consecutive mapping): {0,2,1,3,…,0,2,1,3}
  + Alt 2-2 (non-consecutive mapping): {0,1,2,3,…,0,1,2,3}

Note: exact patterns are deduced from the basic patterns. FFS details.

### P2-2: Starting slot of an aperiodic cross-slot SRS resource set

It seems that companies still have different understandings on the definition of scenario1. As shown below, the divergence of understanding lies in whether only interpretation 1 or both interpretations align with the definition of Scenario 1



So, can we revise the note in the following update of proposal 2-2?

From my understanding, the main bullet is needed anyway, regardless whether interpretation 1 or both 1 and 2 are supported. However, as the interpretation of scenario 1 is related to some other issues as well, with the following notes it could be helpful for us to align the understanding of scenario 1 later.

**Proposal 2-2-1**: For an aperiodic cross-slot SRS resource set in scenario 1, the slot offset of the SRS resource set refers to the first of the two slots spanned by the SRS resource set.

Note 1: Whether only interpretation 1 or both interpretation 1 and 2 are aligned with the definition of scenario 1 is discussed separately.

Note 2: If both interpretation 1 and 2 are aligned with the definition of scenario 1, for the resource in the second slot, how to use this slot offset configured for the SRS resource set is discussed separately.

**Proposal 2-2-2**: For scenario 1, further discuss the following interpretations

* *Scenario 1: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.* 
  + For interpretation 1 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.
  + For interpretation 2 of cross-slot SRS transmission, support an aperiodic SRS resource set to include at least one SRS resource with time-domain resource transmitted in a second U slot, and at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.

## 4.5 Offline discussion round 3 (Wednesday)

## 4.6 Online discussion round 3 (Wednesday)

## 4.7 Offline discussion round 4 (XXXday)

## 4.6 Online discussion round 4 (XXXday)

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19. R1-2507438 Improvement of SRS capacity and coverage Lenovo
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25. R1-2507669 On Rel-20 MIMO SRS capacity and coverage improvement Apple
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28. R1-2507805 Discussion on Improvement of SRS capacity and coverage NTT DOCOMO, INC.
29. R1-2507880 On Rel-20 improvement of SRS capacity and coverage Ericsson
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31. R1-2507908 Discussion on improvement of SRS capacity and coverage NICT

# **Annex: agreements from previous meetings**

## RAN1 #122

***Agreement****:*

*For SRS configured with RPFS (P­F>1) and multiple repetitions (R > 1), support multiple frequency-domain starting positions across SRS repetition symbols within each SRS frequency hop based on the followings:*

* *For SRS repetition symbols within each SRS frequency hop, the starting position patterns across the K different frequency locations are determined by network configuration*
* *The R repetition symbols are equally divided into K subgroups*
  + *K is number of starting positions for SRS repetition symbols within each SRS frequency hop*
* *Within each subgroup of R/K symbols, the SRS is transmitted at the same starting position in frequency domain.*
* *Start position pattern for SRS repetition symbols within each SRS frequency hop is the same during the legacy SRS frequency hopping period (for a same value of )*

*FFS: whether/how to support enabling legacy RPFS start RB index hopping across multiple legacy SRS frequency hopping periods and intra-repetition hopping for SRS repetition symbols within each SRS frequency hop simultaneously.*

***Agreement:***

*For intra-repetition hopping for SRS repetition symbols within each SRS frequency hop, study the following configuration combinations:*

* *PF=2 and K=2*
* *PF =4 and K=2*
* *PF =4 and K=4*

***Agreement:***

*For a P/SP cross-slot SRS resource, the slot offset configured to the SRS resource refers to the first of the two slots spanned by the SRS resource.*

***Agreement:***

*When there is a cross-slot SRS resource in the end of a S slot and the beginning of a U slot in a serving cell, support transmitting PUSCH with a priority index 0 and corresponding DMRS after this cross-slot SRS in the U slot in the serving cell.*

***Agreement:***

*Support at least the following scenario~~s~~ for cross-slot SRS transmission:*

* *Scenario 1: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource transmitted across a first S slot and a second consecutive U slot.*
* *FFS whether Scenario 2 below is supported.*
  + *Scenario 2: an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource transmitted in a first S slot, and at least one another SRS resource with time-domain resource transmitted in a second consecutive U slot.*

***Agreement:***

*For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, study the following alternatives and down-select one to determine “available slot” in the next meeting:*

* *Alt-0 (per SRS resource set): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.*
* *Alt-1 (per SRS resource): The available slot(s) can include one slot or two consecutive S and U slots satisfying there are UL or flexible symbol(s) for the time-domain location(s) for at least one of the SRS resources in the resource set and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.*
* *Alt-2 (per slot): An available slot is a slot satisfying there are UL or flexible symbol(s) for the time-domain location(s) for a subset of SRS resource(s) with same slot offset in the SRS resource set, and it satisfies UE capability on the minimum timing requirement between triggering PDCCH and all the SRS resources in the resource set.*

***Agreement:***

*To determine the time-domain location of cross-slot SRS,*

* *One set of time-domain resource allocation related parameters (i.e., startPosition, nrofSymbols, and repetitionFactor) is configured for the SRS resource without restriction on “within a slot”.* 
  + *For the index of each SRS symbol , it is the same as legacy spec., i.e., .*
  + *The offset counts symbols backwards from the end of the starting slot of the resource*