**3GPP TSG RAN WG1 #122 R1-230XXXX**

**Bengaluru, India, Aug. 25th – 29th, 2025**

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

**Source:** Moderator (CATT)

**Title:** Moderator summary on improvement of SRS capacity and coverage: Round 1

**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.

|  |
| --- |
| 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.

Table 1. Summary of views on Issue 1

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 1-1 | Starting position pattern  | *K* is the number of frequency-domain starting positions.* $P\_{F}$*=2*

Support: *HW, CATT, Samsung, ZTE, Apple, MTK*Not support: *vivo, DCM** + *K*=2
		- [0, 1]: *HW, CATT, Samsung, ZTE, Apple, MTK*
		- [1, 0]: *HW*
* $P\_{F}$ =4

Support: *HW, CATT, MTK, Samsung, ZTE, Apple, vivo (K=2), DCM (K=2)** + *K*=2 : *vivo, DCM*
		- [0, 2]: *HW,CATT, ZTE, Apple, Samsung, MTK*
		- [1, 3], [2, 0] , [3, 1]: *HW*
	+ *K*=4
		- [0,2,1,3]: *HW, ZTE, CATT, Apple, Samsung, MTK*
		- [1, 3, 2, 0], [2, 0, 3, 1] and [3, 1, 0, 2]: *HW*
* *HONOR, DCM, Lenovo*

Equally spacing the RB gap among multiple frequency-domain starting offsets: * *QC*

Regarding how to config the “sub-hop” pattern, down-select one of the following two options:* Option 1: Config NsubHop sub-hops, each with different a different starting RB, within a legacy frequency hop of R symbols;
* Option 2: Config RsubHop consecutive symbols associated with a same starting RB, within a legacy frequency hop of R symbols;

wherein, legacy repetition factor R = NsubHop$⋅$RsubHop.* *Sharp, DCM*
	+ *configuring two StartRBIndex* $k\_{F1}$ *and* $k\_{F2}=\left(k\_{F1}+P\_{F}/2\right) mod P\_{F}$
* *Nokia, Sony*
	+ Case 1: $R/R\_{RPFS}$ is a positive integer
	+ Case 2: $R$ is not an integer multiple of $R\_{RPFS}$
* *NEC, xiaomi, Rakuten Mobile*
	+ $n\_{offset}^{RPFS}=N\_{SC}^{RB}{m\_{SRS,B\_{SRS}}\left(\left(k\_{F}+k\_{hop}+k\_{hop}^{'}\right)mod P\_{F}\right)}/{P\_{F}}$*.* And the new factor of hop $k\_{hop}^{'}$ is the RPFS frequecy offset within each SRS hop
 |
| 1-2 | 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
	+ *CATT, Samsung, ZTE, MTK, Sony*
* *QC*
	+ Phase coherence over SRS symbols is not required when RB position changes.
* *InterDigital*
	+ RAN4 requirement on DMRS bundling is not relevant for SRS frequency hopping with multiple starting positions. Do not consider RAN4 requirement on DMRS bundling for SRS frequency hopping with multiple starting positions.
* *Samsung*
	+ Introduce a separate UE capability whether phase continuity is satisfied
 |
| 1-3 | 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.* Interested companies: *MTK, Samsung, Ericsson*
 |
| 1-4 | Other issues | * *Qualcomm, Ericsson*
	+ Support periodic, semi-persistent, and aperiodic SRS.
* *OPPO*
	+ For UE supporting RPFH for non-FH cases, multiple frequency-domain starting positions across repetitions can also be supported.
 |

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

## P1-1: Starting position pattern

**Proposal 1-1**: For the SRS pattern with multiple frequency-domain starting positions within one hop

* The R repetitions are equally divided into K subgroups, each containing R/K consecutive symbols.
* FFS: whether non-consecutive symbols are supported for each subgroup.
* FFS: $R$ is not an integer multiple of *K.*
* Within each subgroup of R/K symbols, the SRS is transmitted at the same starting position in frequency domain.
* Support $K=2$ for $P\_{F}=2$ and $K=2$ or 4 for $P\_{F}=4$
* The starting position patterns across the K different frequency locations are pre-defined, e.g.,
* For PF=2 and K=2, support pattern {0,1}
	+ FFS: {1,0}
* For PF =4 and K=2, support pattern {0,2}
	+ FFS: {1,3}, {2,0}, {3,1}
* For PF =4 and K=4, support pattern {0,2,1,3}
	+ FFS: {1,3,2,0}, {2,0,3,1}, {3,1,0,2}
* Start position pattern is the same during the period for sounding all subbands (hopping period)

FFS: whether/how to support enabling legacy RPFS start RB index hopping and enhanced RPFS start RB index hopping simultaneously.

FFS: whether/how to support multiple frequency-domain starting positions for RPFS without FH.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| IDC | Support in principle but prefer to only support the case: $K=2$ or 4 for $P\_{F}=4$. |
| Samsung | Support in principle.Regarding “FFS: whether non-consecutive symbols are supported for each subgroup.”, we don’t see the necessity, so we would like to delete that.Regarding “FFS: $R$ is not an integer multiple of *K.*”, our understanding is that the intention maybe to start different partial subband position in the next period of same subband. This is possible by the second last FFS “FFS: whether/how to support enabling legacy RPFS start RB index hopping and enhanced RPFS start RB index hopping simultaneously.” |
| MediaTek | On the main bullet, we prefer to clarify in which case the following sub-bullets can be enabled, e.g.,*For SRS configured with RPFS (P­F>1) and multiple repetitions (R > 1), support* *multiple frequency-domain starting positions across SRS repetitions within one frequency hop based on the followings:*On the first sub-bullet, share the same view as Samsung. It is unclear to in which case the symbols in a group is non-consecutive.On the second sub-bullet, support with the following changes* *Within each subgroup of R/K consecutive symbols, the SRS is transmitted at the same starting position in frequency domain.*

On the third sub-bullet, support.On the fourth and fifth sub-bullet, we prefer to discuss the patterns later.In the last FFS ”whether/how to support multiple frequency-domain starting positions for RPFS without FH”, it seems out-of-scope. No? |
| ZTE | **Support in principle**For the main bullet, note that different frequency-domain starting positions can only be enabled to SRS repetition with R>1 consecutive symbols, it should be captured accordingly.For the first sub-bullet, the wording “R repetitions” seems ambiguous due to the factor R is to specify the symbol number of a given SRS repetition, hence we suggest to change it to “R>1 consecutive symbols of the SRS repetition”. Besides, “R/K” is added to the inline first FFS for clarification.For the second sub-bullet, the wording “consecutive” was suggested to be added to distinguish the case of R/K non-consecutive symbols.For the last second FFS, given that the legacy RPFS starting index hopping is enabled across multiple SRS frequency hops while the newly enhanced different frequency-domain starting position of SRS repetition is enabled within each SRS frequency hop as stated in the WID, it needs to be captured for clarification.In light of the above, we have the following suggested updates of the original Proposal 1-1.**Proposal 1-1**: For the ~~SRS~~ pattern of SRS repetition with R>1 consecutive symbols with multiple frequency-domain starting positions within one hop* The R>1 consecutive symbols of the SRS repetition~~s~~ are equally divided into K subgroups, each containing R/K consecutive symbols.
* FFS: whether R/K non-consecutive symbols are supported for each subgroup.
* FFS: $R$ is not an integer multiple of *K.*
* Within each subgroup of R/K consecutive symbols, the SRS is transmitted at the same starting position in frequency domain.
* Support $K=2$ for $P\_{F}=2$ and $K=2$ or 4 for $P\_{F}=4$
* The starting position patterns across the K different frequency locations are pre-defined, e.g.,
* For PF=2 and K=2, support pattern {0,1}
	+ FFS: {1,0}
* For PF =4 and K=2, support pattern {0,2}
	+ FFS: {1,3}, {2,0}, {3,1}
* For PF =4 and K=4, support pattern {0,2,1,3}
	+ FFS: {1,3,2,0}, {2,0,3,1}, {3,1,0,2}
* Start position pattern is the same during the period for sounding all subbands (hopping period)

FFS: whether/how to support enabling legacy RPFS start RB index hopping across multiple SRS frequency hops and enhanced RPFS start RB index hopping within each SRS frequency hop simultaneously.FFS: whether/how to support multiple frequency-domain starting positions for RPFS without FH.. |
| Apple | In principle, we support the proposal We do not see the need for the following two FFS (i.e., not support) * FFS: whether non-consecutive symbols are supported for each subgroup.
* FFS: $R$ is not an integer multiple of *K.*
 |
| vivo | 1. Support $P\_{F}=4$ and K=2.

For $P\_{F}=4$ and K=4 or $P\_{F}=2$ and K=2, corresponding hopping pattern can sound continuous subband over wideband. And, similar functionality can be achieved by legacy frequency hopping pattern configuration. In Rel-20 design should avoid duplicate functionalities which is already possible with legacy configuration.$P\_{F}=4$ and K=2 is different, although from the perspective of frequency-domain sounding, the legacy frequency hopping pattern with partial sounding can achieve the same frequency-domain granularity, the pattern with $P\_{F}=4$ and K=2 performs better from the perspective of frequency-domain interpolation. 1. Hence, Rel-20 enhancement should focus on inter-slot SRS hopping which is beneficial compared to legacy configuration.

For intra-slot hopping, the legacy hopping pattern can achieve similar frequency-domain interpolation since the hops for interpolation are few symbols away in time domain.1. Remove the ‘FFS: whether non-consecutive symbols are supported for each subgroup’, since the case with consecutive symbols is enough.
 |
| TCL | Support in principle.We believe that the first FFS is unnecessary. * FFS: whether non-consecutive symbols are supported for each subgroup.
 |
| IDC | We don’t think the following FFSs are necessary.* FFS: whether non-consecutive symbols are supported for each subgroup.
* FFS: $R$ is not an integer multiple of *K.*

Also, the following FFS don’t seem to be within the scope of the WID,FFS: whether/how to support enabling legacy RPFS start RB index hopping and enhanced RPFS start RB index hopping simultaneously.FFS: whether/how to support multiple frequency-domain starting positions for RPFS without FH. |
| Sony | We tend to support the proposal, with the following comments:- Regarding “FFS: whether non-consecutive symbols are supported for each subgroup,” this case be handled as a separate case on its own. For example, consider $P\_{F}=4$, $K=2$ with non-consecutive symbols can be seen as a $P\_{F}=4$, $K=2$ pattern with consecutive symbols. Hence, we do not see the need to consider it.- We support $K=2$ and $K=4$ for $P\_{F}=4$.- We support all starting positions. Thus, for $P\_{F} =2$ ,$K=2$, we support {0, 1}, {1, 0}; for $P\_{F}=4$, $K=2$, we support {0, 2}, {1, 3}, {2, 0}, {3, 1}; and for $P\_{F}=4$, $K=4$, we support {0, 2, 1, 3}, {1, 3, 2, 0}, {2, 0, 3, 1}, {3, 1, 0, 2}. The rational would be that different UEs can sound the same subband while hopping in lockstep.- Regarding “FFS: whether/how to support enabling legacy RPFS start RB index hopping and enhanced RPFS start RB index hopping simultaneously,” we feel this is related to the above point. If enhanced RPFS start RB index hopping is applied on top of legacy RPFS start RB index hopping, then only one of the hopping sequence above would be needed, e.g., {0, 1}, {0, 2}, {0, 2, 1, 3}. |
| Ericsson | On the first bullet, suggest removing “FFS: whether non-consecutive symbols are supported for each subgroup”. We don’t see the benefit of non-consecutive symbols. On the third bullet, we are fine with the proposed values of K. However, for PF = 4, it needs to be clarified for which values of R the different values of K can be configured. E.g., for PF = 4, is there a benefit of supporting K = 2 for R > 2 (such that not all RBs are sounded across the R symbols)? In our view, for PF = 4, K = 2 should at least be supported for the case R = 2.On the fourth bullet, we think it too early to specify the exact hopping pattern. The preferred pattern may depend, e.g., on whether UE can maintain phase coherency or not, which requires RAN4 input. Propose to revise the fourth bullet as follows:* The starting position patterns across the K different frequency locations are pre-defined
	+ FFS: Hopping pattern within the R repeated symbols

On the fifth bullet, we prefer to discuss this later. It may depend on whether legacy RPFS hopping and enhanced RPFS hopping can be configured at the same time or not. |
| ETRI | In principle, we agree with the updates from ZTE. We do not see the necessity of the first two FFS items in the first main bullet, and we are open to discussing the simultaneous enabling of legacy RPFS start RB index hopping across multiple SRS frequency hops and enhanced RPFS start RB index hopping within each SRS frequency hop. Lastly, we share Ericsson’s concern regarding specifying the hopping pattern at this stage. |
| NEC | Fine with the proposal. |
| Huawei, HiSilicon | Generally fine.Suggest to update the first sub-bullet as below:* The R repetitions are equally divided into K subgroups, each containing R/K ~~consecutive~~ symbols.
* FFS: whether the R/K symbols within each subgroup are consecutive and/or non-consecutive.
* ~~FFS: whether non-consecutive symbols are supported for each subgroup.~~

FFS: $R$ is not an integer multiple of *K.* |
| Fujitsu | Support. |
| CATT | Support in principle. Regarding on the pattern, support to introduce one pattern for each configuration combination from the perspective of standardization complexity. For example, For PF =2 and K=2, support pattern {0, 1}. For PF =4 and K=2, support pattern {0, 2}. For PF =4 and K=4, support pattern {0,2,1,3}.Support that the start position pattern is the same during the period for sounding all subbands (hopping period).Support enabling legacy RPFS start RB index hopping and enhanced RPFS start RB index hopping simultaneously.Support multiple frequency-domain starting positions for RPFS without FH. |
| SPRD | From our view, *R* should be an integer multiple of *K* so as to avoid excessive discussion on orphan symbols. Also, we don’t see the need for ‘FFS: whether non-consecutive symbols are supported for each subgroup’. |
| NTT Docomo | First bullet: support.Second bullet: supportThird bullet: Do not support. We support K=2 for PF=4. We suggest to further study K=2 for PF=2 and K=4 for PF=4. For K=2 for PF=4 we can understand the benefit of channel interpolation as explained in the WID. For other cases, we share same understanding as Vivo that similar functionality can be achieved by legacy frequency hopping pattern configuration, and the motivation to introduce new hopping pattern is not clear to us.Fourth bullet: can be discussed after the third bullet is decided.Fifth bullet: support.FFSs: support to study.  |
| OPPO | For the first bullet, we also think the two sub-bullets are not needed. For the starting position patterns, we think one pattern per configuration is sufficient.  |
| Sharp | Support. |
| Xiaomi | Support in principle.For the first bullet, the following FFS seems not needed.* FFS: whether non-consecutive symbols are supported for each subgroup.
 |
| Nokia | We are fine with the first part.Regarding to the third bullet, we prefer to support K=$P\_{F}$=2, K=$P\_{F}$=4 first. We can further check the option of K=2 and $P\_{F}$=2. Regarding to the forth bullet, the starting position, we observe that there is a proposal to use starting position and the patterns are combined. So, we prefer to discuss the principle of the mapping options. Other FFS can be discussed together. |
| Lenovo | We are general fine with this proposal. Some comments are as follows:#1: For the supported value of K, we understand K=2 should at least be supported and whether K=4 will be supported need further study. The reason is that the tradeoff between performance gain obtaining by repetition and the performance gain obtained by interpolation in the frequency domain.#2: We also think “FFS: whether non-consecutive symbols are supported for each subgroup” is not necessary.#3: The details in the fourth and fifth bullet can be postponed after we have clear conclusion on the first 3 bullet.  |
| Mod | According to views of interested companies, Proposal 1-1 is revised as shown below:@MTK, ZTE, ETRI: based on the above inputs, the main bullet is updated accordingly.The following FFS sub-bullets are removed, as majority companies don’t see the need for further study.* ~~FFS: whether non-consecutive symbols are supported for each subgroup.~~
* ~~FFS:~~ $R$ ~~is not an integer multiple of~~ *~~K.~~*

@Ericsson: in my understanding, the intention of the following sub-bullet is to clarify the possible values of K for each combination of PF and R. Is this correct?* $P\_{F}=2$ and $K=2$ or 4 for $P\_{F}=4$, FFS: for which values of R the different values of K can be configured

For the last FFS, as more than one company thought that it is out of the scope, it is removed.~~FFS: whether/how to support multiple frequency-domain starting positions for RPFS without FH.~~If companies think it’s still early to discuss the detailed pattern design, I suggest we divide Proposal 1-1 into two separate proposals.**Proposal 1-1-1**: For SRS configured with RPFS (P­F>1) and multiple repetitions (R > 1), support multiple frequency-domain starting positions across SRS repetitions within one frequency hop based on the followings:* For each hop, the starting position patterns across the K different frequency locations are pre-defined
* The R repetitions are equally divided into K subgroups, each containing R/K consecutive symbols.
* ~~FFS: whether non-consecutive symbols are supported for each subgroup.~~
* ~~FFS:~~ $R$ ~~is not an integer multiple of~~ *~~K.~~*
* Within each subgroup of R/K consecutivesymbols, the SRS is transmitted at the same starting position in frequency domain.
* Start position pattern is the same during the period for sounding all subbands (hopping period)

FFS: whether/how to support enabling legacy RPFS start RB index hopping across multiple SRS frequency hopping periods and enhanced RPFS start RB index hopping within each hop simultaneously.~~FFS: whether/how to support multiple frequency-domain starting positions for RPFS without FH.~~**Proposal 1-1-2**: Support $K=2$ for $P\_{F}=2$ and $K=2$ or 4 for $P\_{F}=4$, e.g., * For PF=2 and K=2, support pattern {0,1}
* *Concerned by: vivo,DCM*
* FFS: {1,0}
* For PF =4 and K=2, support pattern {0,2}
* FFS: {1,3}, {2,0}, {3,1}
* For PF =4 and K=4, support pattern {0,2,1,3}
* *Concerned by: vivo*
* FFS: {1,3,2,0}, {2,0,3,1}, {3,1,0,2}
* For $P\_{F}=2$ and $K=2$ or 4 for $P\_{F}=4$, FFS: for which values of R the different values of K can be configured
 |
| NTT Docomo  | Thank you for FL’s summary. For Proposal 1-1-2, we do not have concern on PF=4 and K=2. Our concern is same as Vivo, i.e., the first and third cases.  |
| Mod | Thanks DCM for correcting me. Proposal 1-1-2 is updated accordingly. |

## P1-2: Phase continuity

**Proposal 1-2**: Send LS to RAN4 to check the feasibility of maintaining the phase continuity within SRS repetitions with the RPFS start RB index hopping

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| IDC | Do not consider RAN4 requirement on DMRS bundling for SRS frequency hopping with multiple starting positions. |
| Samsung | Support |
| MediaTek | Support. Re the proposal from IDCC, it can be discussed in RAN4. |
| ZTE | **Support.**Given that SRS repetitions with different RPFS start RB index hopping is a new feature introduced in this release, it seems proper to evaluate the requirement of maintaining phase continuity involved by RAN4. |
| Apple | We are neutral on this. However, any new phase continuity requirement from RAN4 shall be UE optional  |
| vivo | Support |
| TCL | Support |
| Sony | We support this proposal. |
| Ericsson | Support sending an LS to RAN4. In our understanding, RAN4 requirements on phase difference for DMRS bundling applies only for signals in different slots. Hence, it is unclear if phase continuity can be maintained across different RB allocations in a same slot. Such LS should also ask what is the max bandwidth for which phase coherency (if any) can be assumed and if there is a limitation on the frequency gap between SRS transmissions. |
| ETRI | Support |
| NEC | Fine with the proposal. |
| Huawei, HiSilicon | Comprehend the intention, while the wording “feasibility” should be replaced by “condition” or “requirement”.Furthermore, we’re not sure whether companies have aligned their understanding on “RPFS start RB index hopping”. |
| Fujitsu | Support. |
| CATT | Support. |
| SPRD | Same view as Apple’s. |
| NTT Docomo | Support  |
| OPPO | Support  |
| Sharp | Support |
| Xiaomi | Same view with Apple. |
| Nokia | Support  |
| Lenovo | Support. |
| Mod | Thanks for the comments and suggestions. Proposal 1-2 is updated as shown below.**Proposal 1-2**: Send LS to RAN4 to study the requirement on maintaining phase continuity during SRS repetitions when enhanced RPFS start RB index hopping within each hop is applied..* Any new requirement on phase continuity, if needed, from RAN4 shall be UE optional
 |
|  |  |

## P1-3: Supported types of SRS

**Proposal 1-3:** Support enhanced RPFS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| IDCC | Support |
| Samsung | Support |
| MediaTek | Support |
| ZTE | Support |
| Apple | We are okay |
| vivo | Don’t support the enhancement for aperiodic SRS.As stated in proposal 1-1, we suggest limiting the enhancement only for inter-slot SRS hopping.  |
| TCL | Support |
| Sony | OK to support. |
| Ericsson | Support |
| ETRI | Support |
| NEC | Support |
| Huawei, HiSilicon | Support. |
| Fujitsu | Support. |
| CATT | Support. |
| SPRD | Support |
| NTT Docomo | Support  |
| OPPO | Fine.  |
| Sharp | Support |
| Xiaomi | support |
| Nokia | Support  |
| Lenovo | Support. |
| Mod | Seems at least P/SP are objected by nobody. So, Proposal 1-3 is revised as follows.**Proposal 1-3:** Support enhanced RPFS at least for ~~all SRS resource types, i.e., for~~ periodic~~,~~ and semi-persistent~~, and aperiodic~~ SRS.* FFS: whether to support enhanced RPFS for aperiodic SRS.
 |
|  |  |

## P1-4: Others

**Proposal 1-5**: TBD.

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

# 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

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 2-1 | Starting slot for SRS transmission | * For a cross-slot SRS resource, the slot offset refers to the first of the two slots spanned by the SRS resource.
	+ *Ericsson*
* For periodic/semi-persistent SRS, the candidate starting slots in which the configured SRS resource may be used for starting SRS transmission are the slots satisfying$\left(N\_{slot}^{frame,μ}n\_{f}+n\_{s,f}^{μ}-T\_{offset}\right) mod T\_{SRS}=0$
	+ *HW, vivo*
* For aperiodic SRS, higher layer parameter slotOffset and availableSlotOffset decide the starting slot of an SRS resource set.
	+ *HW*
 |
| 2-2 | Per slot resource offset for AP SRS | * *Samsung, MTK, Ericsson vivo, DCM, Sony, ZTE*
	+ Introduce per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set
* *ZTE*:
	+ Option-1: To configure the current slot-level offset (i.e., slot offset k and available slot offset t) per SRS resource for a given aperiodic SRS resource set in case of SRS transmission across two adjacent S+U slots.
	+ 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 for a given aperiodic SRS resource set in case of SRS transmission across two adjacent S+U slot.
 |
| 2-3 | Definition of available slot | * The definition of available slot can be extended to multiple consecutive slots satisfying there are UL or flexible symbol(s) for transmitting all the SRS resources in the resource set.
	+ *CATT, Samsung, MTK, HW, Ericsson, NEC*
* *ZTE*
	+ Option-1: Available slot is determined per SRS resource

An available slot is a slot 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.* + Option-2: Available slot is determined 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 available slot offset value 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.* + Option-3: Available slot is determined per SRS resource set

**The available slot(s) can include one or more slot(s)** 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.* *DCM*
	+ An available slot group is two adjacent slots consisting of UL or flexible symbol(s) for the time-domain location(s) for all the SRS resources in the AP SRS 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 | Possible scenarios for cross-slot SRS | * Scenario 1: an aperiodic SRS resource set which includes at least one SRS resource with time resource allocated in the first slot, and at least one another SRS resource with time resource allocated in the second slot.
	+ *Samsung, MTK, Ericsson, vivo, Sharp, DCM, Sony, Fujitsu, KDDI, ~~Xiaomi~~*
* Scenario 2: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time resource allocated across two slots.
	+ *Samsung, MTK, QC, Apple, NEC，NICT, Spreadtrum, Tejas Network Limited*
* Down select one from the above scenarios
	+ *OPPO*
 |
| 2-5 | Time domain location of cross-slot SRS | * *Samsung, Ericsson, Nokia, Apple, HONOR, Rakuten Mobile, TCL, xiaomi*
	+ Reuse legacy RRC parameters for time domain resource allocation (i.e., startPosition, nrofSymbols, and repetitionFactor) without restriction on “within a slot”
* *HW*
	+ Support $l\_{offset}$ to count symbols backwards from the end of the last slot of P/SP SRS resource or AP SRS resource set so as to accommodate cross-slot SRS transmission, the candidate value of which is extended to {0, 1, …, 27}.
	+ Support to derive $l\_{0}$ by $l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$ so as to accommodate cross-slot SRS transmission.
* *ZTE, Transsion Holdings:*
	+ Option-1: One set of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) is configured to the SRS resource transmitted across two adjacent S+U slots
	+ Option-2: Two sets of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) are configured for the SRS resource transmitted in S slot and U slot, respectively.
 |
| 2-6 | Maximum number of repetition and SRS symbols | * Maximum number of repetition and SRS symbols beyond 14.
	+ *Support:* *ZTE, vivo, Fujitsu, HONOR, KDDI, Lenovo, Spreadtrum, xiaomi*
	+ *Not support: CATT, Samsung, MTK, Qualcomm, Ericsson, Tejas Network Limited*
 |
| 2-7 | SRS transmission before PUSCH | * Support transmitting PUSCH after SRS in a slot
	+ *CATT, Samsung, MTK, HW, Ericsson, NTT DOCOMO, China Telecom, TCL*
 |
| 2-8 | 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, Tejas Network Limited*
	+ *Further study: OPPO*
 |
| 2.9 | Supported type and usage of cross-slot SRS | * At least BM and AS
	+ *MTK*
* Codebook, non-codebook, antenna switching, beam management
	+ *Spreadtrum*
* P/AP/SP SRS
	+ *Spreadtrum, Ericsson*
 |
| 2-10 | Other issues | * *QC*

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.
* *DCM*
	+ Whether WID precludes cross-slot on two adjacent U slots.
	+ Whether cross-slot SRS within one SRS resource is applicable for SRS without repetition.
* *NEC*:
	+ Further discuss a common timing advance (TA), a common UL spatial filter, and common transmit power
* *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.
* *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.
 |

## P2-1: Starting slot for SRS transmission

**Proposal 2-1:** For a cross-slot SRS resource, the slot offset refers to the first of the two slots spanned by the SRS resource.

|  |  |
| --- | --- |
| Company | Input |
| Mod | Please share your views on the above proposal. |
| Samsung | Generally fine, but one clarification question.Since the term “SRS resource” is used, and the proposal is related to slot offset, is this proposal for periodic/semi-persistent SRS only, and not applicable to aperiodic? |
| MediaTek | Same question as SS. This proposal should be limited to P/SP case, like:**Proposal 2-1:** 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 |
| ZTE | Similar to the question asked by companies, we also think it is needed to first clarify whether starting slot for cross-slot SRS resource needs to be additionally specified to P/SP/AP SRS. More precisely,* For P/SP SRS, we think the starting slot still can be determined by the legacy formula $\left(N\_{slot}^{frame,μ}n\_{f}+n\_{s,f}^{μ}-T\_{offset}\right) mod T\_{SRS}=0$ and where the periodicity  (in slots) and slot offset  are configured per SRS resource. Hence we don’t see any further spec changes.
* For AP SRS, the starting slot is determined by the slot level offset *k* and available slot offset *t* that configured per SRS resource set, which was in particular discussed in P2-2.

In light of the above, we don’t see the necessity of discussion on this issue. |
| Apple | We are okay  |
| vivo | OK for p/sp SRS.For aperiodic SRS, maybe we can update the proposal after the conclusion of proposal 2-2. |
| TCL | Support this proposal for p/sp SRS resource.  |
|  IDC | OK |
| Sony | Okay for P/SP SRS resources. |
| Ericsson | We agree with the above definition of slot offset for cross-slot SRS. To clarify what slot offset refers to for the case of SP/P and AP SRS, respectively, the proposal could be revised to state that slot offset is configured (by field periodicityAndOffset) per cross-slot SRS resource for P/SP SRS and configured (by field slotOffset) per SRS resource set containing the cross-slot SRS resource for AP SRS. In this way, it should be clear that slot offset is determined by legacy formulas for all resource types, and that slot offset refers to k (and not t) for aperiodic SRS. |
| ETRI | We agree with the updated version by MTK for P/SP SRS. For AP SRS, it would be preferable to discuss Proposal 2-2 first. |
| NEC | Support |
| Huawei, HiSilicon | Same question as Samsung. Support for P/SP SRS resource. |
| Fujitsu | Support. |
| CATT | We share the same view as Samsung for the clarification question. |
| SPRD | Fine with the proposal. |
| NTT Docomo | Support.  |
| OPPO | Fine for P/SP SRS. For AP SRS, can be discussed with the following proposals.  |
| Sharp | Support MediaTek’s proposal. |
| Xiaomi | OK |
| Nokia | Support |
| Lenovo | We share similar comments with Samsung and Media Tek that the resource type on periodic, semi-persistent, aperiodic should be captured in the proposal.Considering that slot offset for aperiodic SRS is configured in the SRS resource set other than SRS resource, thus we suggest the following update: **Proposal 2-1:** * 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.
* For AP cross-slot SRS resource, the slot offset configured to the SRS resource set refers to the first of the two slots spanned by the SRS resource set.
 |
| Mod | Thanks for the discussion and comments. Proposal 2-1 is updated according to MTK’s suggestion.**Proposal 2-1:** 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. |
|  |  |

## P2-2: Per slot resource offset for AP SRS

**Proposal 2-2:** For cross-slot SRS, per-SRS resource slot offset for each of SRS resources within an aperiodic SRS resource set is supported.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| IDC | Support |
| Samsung | Support. |
| MediaTek | To our understanding, per-SRS resource slot offset is only needed when there are more than SRS resources configured in the resource set. Otherwise, the slot offset configured per resource set should be sufficient.*For cross-slot SRS, when an aperiodic SRS resource set is configured with more than one SRS resources, per-SRS resource slot offset for each of SRS resources within the aperiodic SRS resource set is supported.** *FFS: How to indicate the per-SRS resource slot offset*
 |
| ZTE | Firstly, as mentioned in our comment of P2-1, it needs to be clarified in P2-2 the components of slot offset for AP SRS resource, i.e., slot level offset *k* and available slot offset *t*.Given that it is the first meeting, we think any other solutions can be considered. For example, one newly additional slot offset (denoted as *t*') can be configured per SRS resource on top of slot level offset *k* and available slot offset *t* that configured per SRS resource set as legacy, which incurs less spec change when considering the solution provided in P2-2 is to configure slot level offset *k* and available slot offset *t* that configured per SRS resource. Consequently, we have the following updates of the above:**Proposal 2-2:** For cross-slot SRS, down-select one of the following alternatives to determine the ~~per-SRS resource~~ slot offset for each of SRS resources within an aperiodic SRS resource set ~~is supported~~.* Alt 1: Configure slot level offset *k* and/or available slot offset *t* for each of SRS resources within an aperiodic SRS resource set.
* Alt 2: Introduce one newly additional slot offset *t*' for each of SRS resources within an aperiodic SRS resource set on top of slot level offset *k* and available slot offset *t* that configured per SRS resource set as legacy.
 |
| Apple | In principle, we are okay to allow AP-SRS resource within the same SRS resource set to span more than 1 slot |
| vivo | OK |
| TCL | Support |
| Sony | Similar to MediaTek, we understand that per-SRS resource slot offset *disambiguation* is only needed when an SRS resource set is configured with multiple SRS resources configured in the resource set. The disambiguation can be done is several ways. One such way that does not require the introduction of additional fields is to adopt a simple positional rule: SRS resources are transmitted in the same order their IDs appear in *srs-ResourceIdList.* We therefore would like to add Alt3 to ZTE amended proposal:**Proposal 2-2:** For cross-slot SRS, down-select one of the following alternatives to determine the ~~per-SRS resource~~ slot offset for each of SRS resource~~s~~ within an aperiodic SRS resource set ~~is supported~~.* Alt 1: Configure slot level offset *k* and/or available slot offset *t* for each of SRS resources within an aperiodic SRS resource set.
* Alt 2: Introduce one newly additional slot offset *t*' for each of SRS resources within an aperiodic SRS resource set on top of slot level offset *k* and available slot offset *t* that configured per SRS resource set as legacy.

Alt-3: 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. |
| Ericsson | Don’t support. We don’t see the benefit of introducing such additional slot offset (on top of k and t) for AP SRS. It is already possible to configure SRS resources in the slot after a cross-slot SRS. Hence, such new parameter would only provide duplicate configurations for an identical SRS transmission. |
| ETRI | Open to discuss whether to define per-resource slot offset. However, we prefer to retain the notion of per-resource set slot offset and/or available slot offset. |
| NEC | Open to discuss |
| Huawei, HiSilicon | Prefer to postpone until alternatives of **Proposal 2-5** are determined. |
| Fujitsu | Support the principle. From our understanding, the intention is that the legacy per-SRS-resource-set offset is still used. The per-SRS-resource offset is achieved on top of the legacy per-SRS-resource-set offset. If so, it is better to clarify that the per-SRS-resource offset does not replace the legacy per-SRS-resource-set offset. Details on how to achieve per-SRS-resource offset can be further discussed. |
| CATT | Support. |
| NTT Docomo | Support.  |
| OPPO | It needs to be clarified whether the per-SRS resource slot offset is based on the per set slot offset (e.g. with value of 0 or 1) or is used to override the per set slot offset. In our understanding, the former one could be right.  |
| Sharp | Open to discuss. |
| Nokia | We need more check if the offset is necessary. |
| Lenovo | We agree with Media Tek and prefer Media Tek’s versio. |
| Mod | According to discussion above, Proposal 2-2 is updated as follows.@ZTE @Sony @ETRI @ Fujitsu: I think the next level details on how to indicate can be discussed after we reach consensus on the main bullet. **Proposal 2-2:** For cross-slot SRS, when an aperiodic SRS resource set is configured with more than one SRS resources, per-SRS resource slot offset for each of SRS resources within the aperiodic SRS resource set is supported.* FFS: How to indicate the per-SRS resource slot offset
 |
|  |  |

## P2-3: Definition of available slot

**Proposal 2-3:** The available slot(s) can include one or two consecutive 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.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| Samsung | Support in principle. It would be better to use “two consecutive S and U slots” considering WID and precluding other possible cases.  |
| MediaTek | Same view as Samsung |
| ZTE | Given that it is the first meeting, we think any other solutions can be considered.Based on our views as provided in Issue#2-3 as above, the definition of available slot can also be determined per SRS resource (Alt 1) or per slot (Alt 2) in addition to per SRS resource set (Alt 0) as in P2-3. Consequently, it can be noted that Alt 1 provides the best flexibility of AP-SRS transmission, while Alt 0 is the most aligned with the legacy definition of “available slot”. For Alt 2, it can be the trade-off between SRS flexibility and specification impact.In light of the above, we suggest the following updates:**Proposal 2-3:** For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, support to down-select one of the following three options to determine “available slot”:* Alt-0: The available slot(s) can include one or two consecutive 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: The available slot is a slot 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: 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 available slot offset value 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.
 |
| Apple | We are okay. However, it is not clear why we need to combine this available slot introduced in later release for SRS. |
| vivo | Support and share similar views with Samsung. |
| TCL | Support the view of Samsung.  |
| IDC | We already have a clear definition of available slot from Rel-17, not clear why a new definition is needed,Suggest the following revision of the proposal,**Proposal 2-3:** For a given AP-SRS resource set in case of SRS transmission across two adjacent S+U slots, the definition of availability is per Rel-17 agreement.

|  |
| --- |
| **Agreement (#104)**Confirm the following working assumption with modificationsAn “available slot” is a slot 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.* From the first symbol carrying the SRS request DCI and the last symbol of the triggered SRS resource set, UE does not expect to receive SFI indication, UL cancellation indication or dynamic scheduling of DL channel/signal(s) on flexible symbol(s) that may change the determination of “available slot”.
* Note: Collision handling between the triggered SRS and any other UL channel/signal is performed after the determination of available slot.
* FFS: Rules to handle the case of multiple SRS resource sets with overlapping symbols and/or triggered by a same DCI
 |

 |
| Sony | Same view as Samsung. |
| Ericsson | Support in principle. Fine to clarify the scenario as proposed by Samsung. |
| ETRI | We have the same view as Samsung. |
| NEC | Same view as Samsung. |
| Huawei, HiSilicon | Support. |
| Fujitsu | Same view as Samsung. |
| CATT | Support. |
| NTT Docomo | Support and share same view as Samsung.  |
| OPPO | Same view as Samsung |
| Sharp | Same view as Samsung. |
| Xiaomi | support |
| Nokia | Support |
| Lenovo | Same view with Samsung. |
| Mod | Thanks for the comments. It’s better to have the clarification as mentioned by Samsung and other companies.@IDC: for SRS cross slot, the issue with current spec is that available slot is specified to be “a slot”.Update of Proposal 2-3:**Proposal 2-3:** The available slot(s) can include one 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. |
|  |  |

## P2-4: Possible scenarios for cross-slot SRS

**Proposal 2-4:** Possible scenarios for cross-slot SRS transmission include:

* Scenario 1: an aperiodic SRS resource set which includes at least one SRS resource with time resource allocated in the first slot, and at least one another SRS resource with time resource allocated in the second slot.
* Scenario 2: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time resource allocated across two slots.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| Samsung | Support. |
| MediaTek | Support with the following changes. This should be clarified first.**Proposal 2-4:** ~~Possible~~ Support the following scenarios for cross-slot SRS transmission including:* Scenario 1: an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource allocated in a first S slot, and at least one another SRS resource with time-domain resource allocated in a second U slot next to the first S slot.
* Scenario 2: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource allocated across two consecutive S and U slots.
 |
| ZTE | Support, we are also fine with the editorial updates from MTK to align with the WID statement. |
| Apple | We prefer to prioritize scenario 2. |
| vivo | OK. |
| TCL | Support |
| IDC | Support |
| Sony | Support scenario 2. Regarding scenario 1, we support the proposal with the understanding that the current wording also allows Alt-3 in P2-2. The following slight modification better captures this point:**Proposal 2-4:** ~~Possible~~ Support the following scenarios for cross-slot SRS transmission including:* Scenario 1: an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource ~~allocated~~ transmitted in a first S slot, and at least one another SRS resource with time-domain resource ~~allocated~~ transmitted in a second U slot next to the first S slot.

Scenario 2: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource ~~allocated~~ transmitted across two consecutive S and U slots. |
| Ericsson | Support Scenario 2. It is not clear what additional advantages Scenario 2 brings, as SRS resources in the second slot (belonging to a second SRS resource set) is already supported in existing NR. |
| ETRI | Support Alt2, and open to discuss Alt1. |
| NEC | Support scenario 2. |
| Huawei, HiSilicon | Support. |
| Fujitsu | Scenario 2 is preferred.  |
| CATT | We support both scenarios. |
| SPRD | Fine with the proposal. |
| NTT Docomo | Support.  |
| OPPO | Though the update from MTK makes the proposal much clearer, there is still ambiguity with the proposal. We are not sure whether the following is included in the two scenarios or not:an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource allocated in a first S slot, and at least one another SRS resource with time-domain resource allocated in a second U slot next to the first S slot, and at least one another SRS resource with time-domain resource allocated across two consecutive S and U slots. |
| Sharp | Support both scenraios. |
| Xiaomi | Fine with the proposal for clarification. Our understanding is scenario 2. |
| Nokia | Support, and prefer scenario 2. |
| Lenovo | We are fine with Metia Tek’s update to align with the WID statement. |
| Mod | From FL perspective, it would be better to align the understanding of possible scenarios and definition of cross-slot SRS. **Proposal 2-4:** ~~Possible~~ Support the following scenarios for cross-slot SRS transmission ~~including~~:* Scenario 1: an aperiodic SRS resource set which includes at least one SRS resource with time-domain resource ~~allocated~~ transmitted in a first S slot, and at least one another SRS resource with time-domain resource ~~allocated~~ transmitted in a second U slot next to the first S slot.

Scenario 2: a periodic, semi-persistent, or aperiodic SRS resource set which includes at least one SRS resource with time-domain resource ~~allocated~~ transmitted across two consecutive S and U slots. |
|  |  |

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

**Proposal 2-5:** To determine the time-domain location of cross-slot SRS, down select from the following alternatives:

* Alt 1：Reuse legacy RRC parameters for time domain resource allocation (i.e., startPosition, nrofSymbols, and repetitionFactor) without restriction on “within a slot”.
	+ For the index of each SRS symbol $l^{'}$, it is the same as legacy spec., i.e., $l^{'}=0, 1, …, N\_{symb}^{SRS}-1$.
	+ The offset$ l\_{offset}\in \left\{0,1,…,13\right\}$ counts symbols backwards from the end of the starting slot of the resource
		- For SRS resource across slot boundary, $1\leq l\_{offset}<N\_{symb}^{SRS}-1$
		- For SRS resource with in one slot, $l\_{offset}\geq N\_{symb}^{SRS}-1$
* Alt 2: modify the definitions of $ l\_{offset}$ and $l\_{0}$
	+ The offset$ l\_{offset}\in \left\{0,1,…,27\right\}$ counts symbols backwards from the end of the last slot of a SRS resource.
	+ $l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$.
* Alt 3: Two sets of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) are configured for the SRS resource transmitted in S slot and U slot, respectively
	+ For the index of each SRS symbol $l^{'}$, it should be that $l^{'}=0, 1, …, N\_{symb, S}^{SRS}-1$ in S slot and $l^{'}=N\_{symb, S}^{SRS}, N\_{symb, S}^{SRS}+1, …, N\_{symb, S}^{SRS}+N\_{symb,U}^{SRS}-1$ in U slot.
	+ $N\_{symb, S}^{SRS}$ and $N\_{symb, U}^{SRS}$ denoted as the number of consecutive SRS symbols configured in S slot U slot, respectively.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above alternatives. |
| Samsung | Considering 1st meeting, we are okay with listing multiple options,Among options, we support Alt1 which has minimum specification impact and reuse almost everything as is.Regarding “or SRS resource across slot boundary, $1\leq l\_{offset}<N\_{symb}^{SRS}-1$”, we think that the lower bound would be started from 0. $l\_{offset}=0$ means $l\_{0}=13$, which means that the SRS resource will be started from the last symbol of S slot which should be allowed. Hence we would like to modify as “$0\leq l\_{offset}<N\_{symb}^{SRS}-1$” |
| MediaTek | Support Alt1 to minimize spec impact. |
| ZTE | Basically, it should figured out that time domain resource allocation related parameters only needs to be changed for the case of one SRS resource with time resource allocated across two slot (aka Scenario-2 in P2-4), but not needed for the case of different SRS resources within an SRS resource set that allocated in different slots (aka Scenario 1 in P2-4).For Alt 1, in the main bullet, it should notice that the legacy configurations of time domain resource allocation for a given SRS resource can NOT be reused due to the corresponding candidate values or definitions need to be updated anyways. While, the description of main bullet in Alt 3 can be referred for comparison of alternatives. Consequently, the candidate values of consecutive OFDM symbols $N\_{symb}^{SRS}$ can be extended to up to 28, which is missing in this alternative. Besides, the modified definitions of $ l\_{offset}$ and $l\_{0}$ as provided in Alt 2 should be another option under Alt 1. In particular, the newly added value of R can be decided later based on the outcome of in P2-6.In light of the above, we suggest the following updates:**Proposal 2-5:** To determine the time-domain location of ~~cross-slot SRS~~ one SRS resource with time resource allocated across two slots, down select from the following alternatives:* Alt 1： ~~Reuse legacy RRC parameters for time domain resource allocation (i.e., startPosition, nrofSymbols, and repetitionFactor)~~ One set of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) is configured for the SRS resource without restriction on “within a slot”.
	+ For the number of consecutive OFDM symbols $N\_{symb}^{SRS}$, the maximum value of $N\_{symb}^{SRS}$ can be configured as 28.
		- FFS: Any other newly extended candidate values of $N\_{symb}^{SRS}$, e.g., from 15 to 27.
	+ For the index of each SRS symbol $l^{'}$, it is the same as legacy spec., i.e., $l^{'}=0, 1, …, N\_{symb}^{SRS}-1$.
	+ For the offset$ l\_{offset}$, down-select one of the following sub-alternatives:
		- Alt 1-1: The offset$ l\_{offset}\in \left\{0,1,…,13\right\}$ counts symbols backwards from the end of the starting slot of the resource, where $0\leq l\_{offset}<N\_{symb}^{SRS}-1$ and $l\_{0}=N\_{symb}^{slot}-1-l\_{offset}$ in the starting slot.
		- Alt 1-2: The offset$ l\_{offset}\in \left\{0,1,…,27\right\}$ counts symbols backwards from the end of the last slot of a SRS resource, where $l\_{offset}\geq N\_{symb}^{SRS}-1$ and $l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$.
	+ ~~The offset~~$ l\_{offset}\in \left\{0,1,…,13\right\}$ ~~counts symbols backwards from the end of the starting slot of the resource~~
		- ~~For SRS resource across slot boundary,~~ $1\leq l\_{offset}<N\_{symb}^{SRS}-1$
		- ~~For SRS resource with in one slot,~~ $l\_{offset}\geq N\_{symb}^{SRS}-1$
* ~~Alt 2: modify the definitions of~~ $ l\_{offset}$ ~~and~~ $l\_{0}$
	+ ~~The offset~~$ l\_{offset}\in \left\{0,1,…,27\right\}$ ~~counts symbols backwards from the end of the last slot of a SRS resource.~~
	+ $l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$~~.~~
* Alt 3: Two sets of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) are configured for the SRS resource transmitted in S slot and U slot, respectively
	+ For the index of each SRS symbol $l^{'}$, it should be that $l^{'}=0, 1, …, N\_{symb, S}^{SRS}-1$ in S slot and $l^{'}=N\_{symb, S}^{SRS}, N\_{symb, S}^{SRS}+1, …, N\_{symb, S}^{SRS}+N\_{symb,U}^{SRS}-1$ in U slot.
	+ $N\_{symb, S}^{SRS}$ and $N\_{symb, U}^{SRS}$ denoted as the number of consecutive SRS symbols configured in S slot U slot, respectively.
 |
| Apple | In principle, we support Alt1, i.e., reuse the legacy IEs |
| vivo | Support Alt 1, which is better compatible with the spec. |
| TCL | We prefer Alt1 and reuse the legacy parameters.  |
| IDC | Need to agree on one of the scenarios in 2-4 first |
| Sony | We support the FL’s Alt1.  |
| Ericsson | Support Alt 1, which allows re-use of legacy parameters. |
| ETRI | Support Alt1 |
| NEC | We are fine with either Alt 1 or Alt 2. |
| Huawei, HiSilicon | As mentioned in **Proposal 2-4**, there exists two possible scenarios for cross-slot SRS transmission. Alt 2 with following update can achieve unified solution for both scenarios without introduction of additional signaling.* Alt 2: modify the definitions of $ l\_{offset}$ and $l\_{0}$
	+ The offset$ l\_{offset}\in \left\{0,1,…,27\right\}$ counts symbols backwards from the end of the last slot of a P/SP SRS resource or an AP SRS resource set.

$l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$. |
| Fujitsu | We are fine with either Alt 1 or Alt 2. For Alt 1, the restriction “$1\leq l\_{offset}$” is not needed. Instead, the restriction $l\_{offset}<N\_{symb}^{SRS}-1$ alone seems to be sufficient.  |
| CATT | We prefer Alt1 for less specification impact. |
| SPRD | Support Alt 1. |
| NTT Docomo | Support Alt.1.  |
| OPPO | We support Alt 1 from FL. |
| Sharp | Support Alt 1. |
| Nokia | Prefer Alt 1. |
| Lenovo | We prefer the direction of Alt.1 based on the legacy parameters. But the details can be further studied. |
| Mod | Updated proposal 2-5 for further discussion.Please note that the range of loffst is revised according to Samsung’s comment.**Proposal 2-5:** To determine the time-domain location of cross-slot SRS, down select from the following alternatives:* Alt 1：Reuse legacy RRC parameters for time domain resource allocation (i.e., startPosition, nrofSymbols, and repetitionFactor) without restriction on “within a slot”.
	+ For the index of each SRS symbol $l^{'}$, it is the same as legacy spec., i.e., $l^{'}=0, 1, …, N\_{symb}^{SRS}-1$.
	+ The offset$ l\_{offset}\in \left\{0,1,…,13\right\}$ counts symbols backwards from the end of the starting slot of the resource
		- For SRS resource across slot boundary, $0\leq l\_{offset}<N\_{symb}^{SRS}-1$
		- For SRS resource with in one slot, $l\_{offset}\geq N\_{symb}^{SRS}-1$
* Alt 2: modify the definitions of $ l\_{offset}$ and $l\_{0}$
	+ The offset$ l\_{offset}\in \left\{0,1,…,27\right\}$ counts symbols backwards from the end of the last slot of a SRS resource.
	+ $l\_{0}=2N\_{symb}^{slot}-1-l\_{offset}$.
* Alt 3: Two sets of time-domain resource allocation related parameters (i.e., $N\_{symb}^{SRS}$, R and $l\_{offset}$) are configured for the SRS resource transmitted in S slot and U slot, respectively
	+ For the index of each SRS symbol $l^{'}$, it should be that $l^{'}=0, 1, …, N\_{symb, S}^{SRS}-1$ in S slot and $l^{'}=N\_{symb, S}^{SRS}, N\_{symb, S}^{SRS}+1, …, N\_{symb, S}^{SRS}+N\_{symb,U}^{SRS}-1$ in U slot.
	+ $N\_{symb, S}^{SRS}$ and $N\_{symb, U}^{SRS}$ denoted as the number of consecutive SRS symbols configured in S slot U slot, respectively.
 |
|  |  |

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

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

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

.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| Samsung | Support Alt1. We don’t see the use case and corresponding benefit from Alt2. |
| MediaTek | Slightly prefer Alt1. Alt2 is considered if there is clear need and supported by majority. |
| ZTE | We think this issue should be separately discussed as follows:* For the maximum number of symbols per cross-slot SRS resource, we support Alt 2, i.e., over 14 to 28. One potential and practical use case is to reduce the latency of SRS frequency hopping especially in case of lager bandwidth.
* For the maximum number of repetition factor, we slightly prefer Alt 2, and whether to enable R>14 can be up to NW scheduling based on traffic needs.
 |
| Apple | Either way works for us |
| vivo | We are open to extend the values for SRS symbols, since it increases the possibility of completing frequency hopping in a short time. And, the main motivation of the objective is to utilize few symbols (e.g. 2) in S slot, if it is limited to 14, then last 2 symbols in U slot become useless. |
| TCL | Support.  |
| IDC | Alt 1 is preferred. Alt2 is open ended, are we targeting any repetition >14? |
| Sony | Prefer Alt1.  |
| Ericsson | Support Alt 1. There are typically only a few, (e.g., 4) UL symbols in S slots. Increasing the number of SRS symbols beyond 14 (to, e.g., 14+4=18) yields only marginal SRS coverage gains and increases SRS overhead. |
| ETRI | We prefer Alt1, but we are open to discuss Alt2. |
| NEC | Alt 1 preferred |
| Huawei, HiSilicon | Share similar view with ZTE. |
| Fujitsu | Support Alt 1. |
| CATT | Considering the limited performance gain for extending the maximum number of symbols, we support Alt1. |
| SPRD | Slightly prefer Alt.2 |
| NTT Docomo | Support Alt.1.  |
| OPPO | Support Alt1. |
| Sharp | Support Alt 1. |
| Xiaomi | Similar view with ZTE |
| Nokia | We are open to Alt 2.  |
| Lenovo | We support Alt2. The reason is that the intention of cross-slot SRS resource repetition is to avoid the waste of the UL symbols in the S slot. If we use the legacy repetition number, it may cause the waste of the UL symbols in the second U slot. |
| Mod | For the sake of further discussion, the proponents and opponents of each alternative are listed below.**Proposal 2-6-1:** For the maximum number of symbols per cross-slot SRS resource and repetition factor, down select from the following alternatives:* Alt 1: limited to 14
	+ (12) SS, MTK, IDC, Sony, Ericsson, ETRI, NEC, Fujitsu, CATT, DCM, OPPO, Sharp,
* Alt 2: Support values over 14
	+ (7) ZTE, vivo, HW, SPRD, Xiaomi, Nokia, Lenovo
 |
|  |  |

## P2-7: SRS transmission before PUSCH

* **Proposal 2-7:** Support transmitting PUSCH and corresponding DMRS after SRS in a slot

.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| IDCC | Not support. There can be the guard OFDM symbol(s) between the two SRS resources which makes it possible to transmit PUSCH and corresponding DMRS before SRS in the second slot. |
| Samsung | Support, and this is based on UE capability and/or RRC configuration. |
| MediaTek | Support, but this should be limited to the case when there is an cross-slot SRS transmission in the beginning of the slot. |
| ZTE | Support.@IDCC, based on the current spec, the UE does not transmit any other signal on any symbols of the guard OFDM symbol(s), unless it was dropped due to collision handling. |
| Apple | The proposals is not very clear to us. Can we know which part of the specification that needs to be changed? |
| vivo | OK. |
| TCL | Support. |
| IDC | @ ZTE: Thank you for your explanation. We are open to further discuss. |
| Sony | Support. But the proposal must be limited to the case when the SRS transmission at the beginning of the slot is a cross-slot SRS transmission, as noted by MediaTek. |
| Ericsson | Support. Otherwise, the U slot after an S slot cannot be used for PUSCH. |
| ETRI | Support only the limited case noted by MTK. |
| NEC | OK |
| Huawei, HiSilicon | Support.@Apple, if our understanding is correct, this proposal relates to the paragraph in section 6.2.1 of 38.214 as attached:*If a PUSCH with a priority index 0 and SRS configured by SRS-Resource are transmitted in the same slot on a serving cell, the UE may only be configured to transmit SRS after the transmission of the PUSCH and the corresponding DM-RS.*  |
| Fujitsu | Support the principle. It may be further clarified whether the SRS refers to cross-slot SRS only, or it can be any SRS. |
| CATT | Support. |
| SPRD | OK |
| NTT Docomo | Support.  |
| OPPO | Fine if there is cross-slot SRS transmission. |
| Sharp | Support |
| Xiaomi | support |
| Nokia | Support |
| Lenovo | Same view with MediaTek. |
| Mod | Thanks ZTE and HW for detailed explanation. And thanks MTK, ETRI, Fujutsu for your suggestions.Updated Proposal 2-7:**Proposal 2-7:** When there is a cross-slot SRS transmission in the beginning of a U slot, support transmitting PUSCH and corresponding DMRS after SRS in a slot |
|  |  |

## P2-8: Multiple aperiodic SRS resource sets in a slot for usage of antenna switching

**Proposal 2-8:** For cross-slot SRS, support configuring/triggering multiple aperiodic SRS resource sets in a slot for usage of antenna switching.

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposal. |
| Samsung | Support. This proposal is beneficial at least for the case when multiple aperiodic SRS resource sets are triggered within S+U slots.  |
| MediaTek | Open to discuss |
| ZTE | Support |
| Apple | The proposals is not very clear to us. Can we know which part of the specification that needs to be changed? |
| vivo | Can be discussed if beneficial |
| TCL | Open to discuss. |
| IDC | Should discuss 2-9-1/2 first. |
| Sony | Okay to discuss. |
| Ericsson | We are not sure this is needed. Legacy specification prevents UE from being configured/triggered with more than one SRS resource set in the same slot. This condition would not be violated for cross-slot SRS with the definition of slot offset in Proposal P2-1. |
| ETRI | Open to discuss |
| NEC | Open to discuss |
| Huawei, HiSilicon | Open to discuss.@Apple, if our understanding is correct, this proposal relates to the paragraph in section 6.2.1.2 of 38.214 as attached:*For 1T2R, 1T4R, 2T4R, 1T6R, 1T8R, 2T6R, 2T8R, 4T8R, or 8T8R, 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.* |
| Fujitsu | Support the principle. It is worth clarifying that multiple aperiodic SRS resource sets should include a cross-slot SRS, if that is the intention. |
| CATT | Support. |
| SPRD | OK |
| NTT Docomo | Open to discuss.  |
| OPPO | Open to further discuss. |
| Sharp | Open to discuss. |
| Xiaomi | Open to discuss |
| Nokia | Open to discuss |
| Lenovo | Open to discuss. |
|  |  |

## P2-9: Supported type and usage of cross-slot SRS

**Proposal 2-9-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.

**Proposal 2-9-1:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above proposals. |
| Samsung | Support. |
| MediaTek | **Proposal 2-9-1:** This is for Scenario 1 or 2? It should be clarified.**Proposal 2-9-2:** This is for Scenario 1 or 2 or both? It should be clarified. |
| ZTE | Support |
| Apple | Okay for all types and usages  |
| vivo | OK. |
| TCL | Support. |
| IDC | Open to discuss. |
| Sony | OK |
| Ericsson | Support both proposals. |
| ETRI | Support both proposals |
| NEC | OK |
| Huawei, HiSilicon | Support. |
| Fujitsu | **Proposal 2-9-1:** Support. It seems this has some overlap with **Proposal 2-4**?**Proposal 2-9-2:** Support. |
| CATT | Support the two proposals. **Proposal 2-9-1:** Support cross-slot SRS for all SRS resource types, i.e., for periodic, semi-persistent, and aperiodic SRS.**Proposal 2-9-2:** Support cross-slot SRS for usages of codebook, non-codebook, antenna switching, beam management |
| SPRD | OK |
| NTT Docomo | Support  |
| OPPO | Generally fine. For antenna switching, it should be further clarified whether guard period across slot is also supported, since it is only applied to intra-slot SRS transmission in 38.214. |
| Sharp | Support |
| Xiaomi | support |
| Nokia | Support |
| Lenovo | Support. |
| Mod | We can discuss this issue after P2-4. |
|  |  |

## P2-10: Others

**Proposal 2-10:** TBD

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the other issues. |
| NTT Docomo | We would like to clarify the understanding on the WID scope: whether cross-slot SRS is applicable for one SRS without repetition. The yellow highlighted part in WID only mentions SRS with repetition, so we would like to clarify. In our understanding, cross-slot SRS should not be limited to SRS with repetition. *“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”* |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Other issues

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

Table 3. Summary for other issues

|  |  |  |
| --- | --- | --- |
| **#** | **Issue** | **Companies’ views** |
| 3-1 |  | *
 |

## P3-1:

**Proposal 3-1**: TBD

|  |  |
| --- | --- |
| **Company** | **Input** |
| Mod | Please share your views on the above issues. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

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

## 4.1 Round 1

# References

1. RP-251856 New WID: NR MIMO Phase 6 Samsung (Moderator)
2. R1-2505164 Discussion on improvement of SRS capacity and coverage Spreadtrum, UNISOC
3. R1-2505209 Improvement of SRS capacity and coverage Huawei, HiSilicon
4. R1-2505242 NR MIMO Phase 6: SRS Enhancement InterDigital, Inc.
5. R1-2505274 Discussion on improvement of SRS capacity and coverage ZTE Corporation, Sanechips
6. R1-2505286 Discussion on improving of SRS capacity and coverage TCL
7. R1-2505288 Improvement of SRS capacity and coverage MediaTek Inc.
8. R1-2505302 On improvement of SRS capacity and coverage CATT
9. R1-2505408 Discussion on improvement of SRS capacity and coverage vivo
10. R1-2505455 Discussion on the improvement of SRS capacity and coverage Xiaomi
11. R1-2505512 Discussion on SRS capacity and coverage improvement China Telecom
12. R1-2505576 Views on improvement of SRS capacity and coverage Samsung
13. R1-2505635 Improvement of SRS capacity and coverage Tejas Network Limited
14. R1-2505749 Discussion on enhancement of SRS capacity and coverage for MIMO phase 6 OPPO
15. R1-2505812 Improvement of SRS capacity and coverage Lenovo
16. R1-2505905 On Rel-20 MIMO SRS capacity and coverage improvement Apple
17. R1-2505936 Discussion on improvement of SRS capacity and coverage NEC
18. R1-2505946 Enhancements for SRS capacity and coverage Transsion Holdings
19. R1-2505965 Discussion on improvement of SRS capacity and coverage Fujitsu
20. R1-2505987 Improvement of SRS Capacity and Coverage Nokia
21. R1-2505997 Discussion on improvement of SRS capacity and coverage HONOR
22. R1-2506110 Discussion on improvements of SRS capacity and coverage Sony
23. R1-2506144 Discussion on Improvement of SRS Capacity and Coverage Rakuten Mobile, Inc
24. R1-2506210 SRS enhancements in 5G MIMO Phase 6 Qualcomm Incorporated
25. R1-2506267 Improvement of SRS capacity and coverage Sharp
26. R1-2506297 Discussion on Improvement of SRS capacity and coverage NTT DOCOMO, INC.
27. R1-2506367 On Rel-20 improvement of SRS capacity and coverage Ericsson
28. R1-2506369 Discussion on improvement of SRS capacity and coverage NICT
29. R1-2506381 Views on enhancements for Improvement of SRS capacity and coverage KDDI Corporation