**3GPP TSG-RAN WG2 Meeting #125bisR2-240xxxx**

**Changsha, China, April 15th – 19th, 2024**

**Agenda item:** 7.2.6

**Source:** ZTE Corporation

**Title:** [Post125bis][401][POS] Aggregated SP-SRS activation/deactivation MAC CE (ZTE)

**Document for:** Discussion and Agreement

# 1 Introduction

* [Post125bis][401][POS] Aggregated SP-SRS activation/deactivation MAC CE (ZTE)

 Scope: Discuss the design of the new MAC CE for activation/deactivation of SP-SRS with aggregation.

 Intended outcome: Report to next meeting

 Deadline: Long

Based on RAN2 agreement, a new MAC CE should be introduced to activate/deactivate aggregated SP-SRS:

|  |
| --- |
| RAN2#125 agreementFor activation/deactivation of SP positioning SRS with multiple carrier indications, design a new MAC CE for activation/deactivation of SP positioning SRS across multiple carriers. |

This document is to discuss the design of the new MAC CE.

# 2 Discussion

## 2.1 Up to 32 aggregated combinations provided by RRC

In the LS [1], RAN1 indicates the up to 32 SRS linage combinations can be provided to UE:

|  |
| --- |
| AgreementRAN1 understands that the current RRC ASN.1 only supports single “aggregated combination”, in which only one SRS resource set from each of the 2 or 3 carriers are aggregated, e.g. CC#1 SRS resource set 1 + CC#2 SRS resource set 2 + CC#3 SRS resource set 3. RAN1 suggests to extend the number of such “aggregated combinations” to up to 32. Send an LS to RAN2 and RAN3. |

The related RAN1 discussion is copied here:

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **FL Proposal 4-1 in RAN1#116 meeting**From RAN1 perspective, up to 2 (the number of carrier combinations) × 16 (the number of resource sets) = 32 aggregated combinations can be supported, i.e. the maximum number of SRS -PosResourceSetLinkedForAggBWList-r18 can be 32.Send an LS to RAN2 and RAN3

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| v ivo | OK |
| Qualcomm | OK |
| CATT | OK |
| X iaomi | Ok |
| H uawei , HiSilicon | We understand the logic, however, we believe directly sending it to RAN2 could cause a lot of trouble in RAN2 understanding. In addition, our understanding is that SRS -PosResourceSetLinkedForAggBWList refers to a single “aggregated conmbination ”, which contains up to 3 CCs .For example, it could be written as follows:RAN1 understands that the current RRC ASN.1 only supports single “aggregated combination”, in which only one SRS resource set from each of the 2 or 3 carriers are aggregated, i.e. CC#1 SRS resource set 1 + CC#2 SRS resource set 2 + CC#3 SRS resource set 3.However, RAN1 believe it should be useful to extend number of such “aggregated combinations” to up to 32, |
| Apple | OK |
| Nokia, NSB | Ok |

 |

An example is provided to explain the meaning of 32 aggregated combinations:



Figure 1. up to 32 aggregated combinations per UE, RRC configuration

In the figure, one red circle is one aggregated combination, each aggregated combination contains 2 or 3 SRS resource sets from 2 or 3 carriers that are linked.

**Q1: Do companies agree with the meaning of aggregated combination which is given in the RAN1’s LS, i.e., each aggregated combination contains 2 or 3 linked SRS resource sets from 2 or 3 linked carriers?**

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, hiSilicon | Agree, but | But we wonder what is the impact to the MAC CE design, if the MAC CE just indicates the linkage.Also, it should not be possible that a linkage includes 3 resource sets within 2 linked CCs? |
| Qualcomm | Yes | For DL-PRS with 4 PFLs, we can have "2 group combinations" allowing aggregation of 2+2 PFLs. For UL-PRS, RAN1 seems to assume the same: 2 group combinations. However, RAN1 doesn't say that each group can only have 2 CCs. So it seems correct that each group could have up to 3 cc's. |
| Samsung | Yes |  |
|  |  |  |
|  |  |  |
|  |  |  |

During the RAN2#125-bis discussion, companies think there can be two options to reflect the relationship between MAC and RRC :

* Option 1: One MAC CE can activate/deactivate only one aggregated combination within 32 aggregated combinations
* Option 2: One MAC CE can activate/deactivate more than one aggregated combinations within 32 aggregated combinations

From Rapporteur perspective, option 1 can be adopted, since option 2 will cause complex design of aggregation indication and spatial relation info for each aggregated combinations, and this will lead to a huge size of the MAC CE.

**Q2: Do companies agree with option 1, i.e., one MAC CE can activate/deactivate only one aggregated combination within 32 aggregated combinations? I.e., introduce a 5 bit field for aggregated combination?**

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | See comment… | Option 2 would be preferred, but O.K. with Option 1 if this is majority view. It is not clear why Option 2 is more complex. Is it because of the spatial relations? (no analysis was provided, there is only a claim that "this will lead to a huge size of the MAC CE)". What is "huge"? |
| Samsung | Agree | There was no requirement on activation/deactivation of multiple combinations by one MAC CE from RAN1. Option 1 seems enough. |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.2 Aggregation indication within each aggregated combination

RAN1 achieved the following agreement in RAN1#114-bis (the following agreement has also been sent to RAN2 in the LS):

|  |  |
| --- | --- |
| RAN1#114-bis AgreementConfirm the following WA:

|  |
| --- |
| **Working assumption**For semi-persistent positioning SRS for bandwidth aggregation, a single MAC CE can activate or deactivate:* SRS resource set(s) in one or two or three of three aggregated carriers
* SRS resource set(s) in one or two of two aggregated carriers.

Note: the single spatial relation is indicated by the MAC CE for each of two or three aggregated SRS resources. |

 |

This means, the function that RAN1 wants to achieve is to let MAC CE adjusting the aggregation indication more frequently. For example, RRC provides a 3-carrier-linage, CC1+CC2+CC3. MAC CE can activate CC1+CC2 at one time, and the MAC CE can activate CC2+CC3 for the same RRC aggregated combination at next time.



Figure 2. Aggregation indication within each aggregated combination

**Q3: Do companies agree to include the aggregation indication in the new MAC CE, where the aggregation indication is to activate/deactivate specific carriers within each aggregated combination?**

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, HiSilicon | Agree |  |
| Qualcomm | Agree, but… | …it is not clear how a UE could use/know this indication. The RRC configuration seems transparent to CCs and "group combinations":SRS-PosResourceSetLinkedForAggBWList-r18 ::= SEQUENCE (SIZE(1..maxNrOfLinkedSRS-PosResourceSet-r18)) OF SRS-PosResourceSetLinkedForAggBW-r18-- Maximum number of linked SRSPosResourceSets that can be aggregatedmaxNrOfLinkedSRS-PosResourceSet-r18 INTEGER ::= 32How would a UE know to which RRC configuration the "carrier indication" refers to? The UE "sees" only up to 32 *SRS-PosResourceSetLinkedForAggBW-r18.* There seems no linkage between "SRS Resource Sets" and "carriers" visible in RRC. |
| Samsung | Agree | For QC’s concern, we can simply include 5bits ID to indicate one of the 32 aggregated combinations configured by RRC (i.e., one of the 32 *SRS-PosResourceSetLinkedForAggBWList-r18* configured in *SRS-PosResourceSetAggBWCombinationList-r18*). |
|  |  |  |
|  |  |  |
|  |  |  |

For activation one carrier out of a 2-carrier-RRC-linage or 3-carrier-RRC-linage, rapporteur thinks the legacy SP SRS MAC CE can be reused (TS38.321, 6.1.3.36).

For a 2-carrier-RRC-linage, A/D field can be used to indicate whether the 2-carrier-linkage is activated or not.

For a 3-carrier-RRC-linage (e.g., CC1+CC2+CC3), there can only be **3** aggregation status, since the Rel-18 WID [2] restricts the linked carriers to be intra-frequency continuous carriers:

|  |
| --- |
| * Specify bandwidth aggregation for positioning measurements across up to three intra-band contiguous carriers [RAN1, RAN2, RAN4].
	+ Specify signalling and procedures to support aggregation of PRS/SRS (respectively) resources across PFLs/carriers (respectively) for positioning measurements under the assumption that the signals over aggregated resources are transmitted and received (respectively) using a single RF chain (same antenna) [RAN1, RAN2].
		- NOTE: The support of bandwidth aggregation for positioning measurements applies only to timing related measurements (e.g., RSTD, RTOA, and UE/gNB Rx-Tx time difference).
	+ Specify RRM requirements with measurement gaps in connected mode, and in inactive mode, including PRS measurement period/reporting [RAN4].
 |

* CC1+CC2; (ok)
* CC2+CC3; (ok)
* CC1+CC3 (cannot be supported since this is not continuous carriers)
* CC1+CC2+CC3; (ok)

So totally there should be **3** aggregation status in this new MAC CE, i.e. 2 bit is enough.

**Q4: Do companies agree that the aggregation indication is 2 bits, in order to indicate 3 aggregation status per aggregated combination**?

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, HiSilicon | Disagree | 2bit is fine, but not clear why there are only 3 aggregation status. From RAN2 point of view, we don’t need to care about whether the two ccs are intra-band or inter-band, as long as we support all the C\_3^2 +C\_3^3 combinations in the indication, it should be fine. |
| Qualcomm | See comment | We don't think this is necessarily true:" For activation one carrier out of a 2-carrier-RRC-linage or 3-carrier-RRC-linage, rapporteur thinks the legacy SP SRS MAC CE can be reused"The carrier can be outside of any active BWP, that's why RAN1 explicitly mentions also 1 carrier for the aggregation case.If RRC can configure up to 32 *SRS-PosResourceSetLinkedForAggBW-r18*, it seems sufficient for MAC-CE to point to one or more *RRC SRS-PosResourceSetLinkedForAggBW-r18* elements.The carrier and "component groups" seem implicit in RRC. See also comment under Q3. |
| Samsung | See comment | Agree with QC that the MAC CE can be also used to activate/deactivate of one carrier out of a 2/3 carriers linked for a certain aggregated combination configured by RRC.As in our response to Q2, the MAC CE can indicate one of the 32 aggregated combinations configured by RRC. Then, the UE can identify the 2 or 3 *SRS-PosResourceSet* linked for that combination. Then, we can indicate activation/deactivation status of each linked *SRS-PosResourceSet* by using 3bits in the MAC CE (e.g., ‘1’ of SETi bit indicates activation of the *SRS-PosResourceSet*, ‘0’ of SETi bit indicates deactivation).  |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.3 How to include spatial relation info

RAN1’s agreement indicates the aggregated SRS resources have the same spatial relation info:

|  |  |
| --- | --- |
| RAN1#114-bis AgreementConfirm the following WA:

|  |
| --- |
| **Working assumption**For semi-persistent positioning SRS for bandwidth aggregation, a single MAC CE can activate or deactivate:* SRS resource set(s) in one or two or three of three aggregated carriers
* SRS resource set(s) in one or two of two aggregated carriers.

Note: the single spatial relation is indicated by the MAC CE for each of two or three aggregated SRS resources. |

 |

Within each combination, there can be up to 16 aggregated SRS resource pair (since one SRS resource set can have up to 16 SRS resources). Since the MAC CE’s activation is per aggregated combination, so each MAC CE should contain up to 16 Spatial Relation for Resource IDi field, wherein each Spatial Relation for Resource IDi field is for an aggregated SRS resource pair.



Figure 3. Up to 16 spatial relation info for one aggregated combination

Based on above analysis, rapporteur thinks spatial relation info design should be same as the legacy SP-SRS activation/deactivation MAC CE, i.e., containing S/C field, and up to 16 Spatial Relation for Resource IDi.fields.

**Q5: Do companies agree that the spatial relation info in the new MAC CE is same as that in legacy SP-SRS activation/deactivation MAC CE, i.e., containing S/C field, and up to 16 Spatial Relation for Resource IDi.fields?**

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, HiSilicon | Disagree | First, it should be clarified that all the resource sets have the same number of resources and the linkage between the resource sets on the resource level is by the order of the resource, for example, for the case of 2 CC with 2 resource sets, resouce#1 in resource set#1 is linked to resource#1 in resource set#2; resouce#2 in resource set#1 is linked to resource#2 in resource set#2, and so on.Then, the total number of spatial relation is equal to the number of resources within each resource set. |
| Qualcomm | Agree | The comment from Huawei above seems to be a NW configuration issue? |
| Samsung | See comments. | Agree with HW. From our understanding, it is not true that all the linked SRS resource sets have the same number of resources and those resources are linked in order of their IDs. Please, refer to the case in the following figure.Note that the set of aggregated resources are not explicitly configured by NW and the UE just assume that the SRS resources across the linked SRS resource sets are linked if the conditions are satisfied based on the RAN1 agreement. However, it seems very complicated for the MAC CE to indicate the spatial information for each set of aggregated resources. Thus, in our view, the MAC CE can just indicate up to 16 Spatial Relation for Resource Idi for ‘one reference SRS resource set’. Here, the reference SRS resource set can be one of the linked SRS resource sets (e.g., *SRS-PosResourceSet* with lowest ID among the linked *SRS-PosResourceSet*s for that combination). Then, the UE can use the Spatial Relation of Resource Idi in the reference resource set for the set of aggregated resources including the Resource Idi. In the example above, the MAC CE can include 4 Spatial Relations for the 4 resources in the reference set X and then the UE can use the Spatial Relation corresponding to SRS-PosResource 3 in the set X for the set of aggregated resources 2. |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.4 Whether the new MAC CE can be used directly in RRC\_INACTIVE

Legacy SP-SRS activation/deactivation MAC CE is used in both RRC\_CNNECTED and RRC\_INACTIVE, so the new MAC CE should also be used in both RRC\_CNNECTED and RRC\_INACTIVE, since the BW aggregation feature applies to both RRC states, and SP-SRS feature is supported to both RRC states.

An issue is whether there should be different design of the MAC CE for different RRC status. A LS is sent to ask which RRC state the 32 SRS linage combinations can be applied to. From Rapporteur perspective, at least the MAC CE can be applied to the RRC\_CONNECTED. For RRC INACTIVE, RAN2 should wait for RAN1’s response on whether the 32 combination can be appliled to RRC\_INACTIVE.

**Q6: Do companies agree that the current MAC CE design can be used for RRC\_CONNECTED, and wait for RAN1’s reply LS to decide whether there should be a change for RRC\_INACTIVE?**

|  |  |  |
| --- | --- | --- |
| Companies  | Agree/disagree | comments |
| Huawei, HiSilicon |  | We can use 5 bits for 32 combinations for now and take the maximum number of combinations between CONNECTED and INACTIVE.  |
| Qualcomm | Agree | It will not be more than 32 combinations. |
| Samsung | Agree |  |
|  |  |  |
|  |  |  |
|  |  |  |

## 2.4 Other issue

According to the above analysis, an example of the new MAC CE design is given as follow (note: Spatial Relation for Resource IDi field is same with legacy SP-SRS activation/deactivation MAC CE, section 6.1.3.36):

|  |
| --- |
| Figure 4. An example of the new MAC CE design |

**Q7: Do companies have any other comments on the new MAC CE design?**

|  |  |
| --- | --- |
| Companies  | comments |
| Qualcomm | As mentioned under Q3/Q4, it is not clear how a UE can interpret the "Aggregation Indication" and "Aggregated Combination". RRC only configures up to 32 *SRS-PosResourceSetLinkedForAggBW-r18.* If we use the above design, a change in RRC seems needed so that the UE explicitly knows the CCs and "component groups". |
| Samsung | As mentioned under Q4, we can just have 3 bits indication to indicate the activation/deactivation status of each linked resource set instead of having A/D(1bit) + Aggregation Indication (2bits). |
|  |  |
|  |  |
|  |  |
|  |  |

# 3 Conclusion

The following is proposed:

# 4 References

[1]R1-2401708, LS on bandwidth aggregation for positioning, LS in, 2024-03

[2] RP-240778, Revised WID on Expanded and Improved NR Positioning, 2024-03

# 4 Annex

TS38.321

#### 6.1.3.36 SP Positioning SRS Activation/Deactivation MAC CE

The SP Positioning SRS Activation/Deactivation MAC CE is identified by a MAC subheader with eLCID as specified in Table 6.2.1-1b. It has a variable size with following fields:

- A/D: This field indicates whether to activate or deactivate indicated SP Positioning SRS resource set. The field is set to 1 to indicate activation, otherwise it indicates deactivation;

- Positioning SRS Resource Set's Cell ID: This field indicates the identity of the Serving Cell, which contains activated/deactivated SP Positioning SRS Resource Set. If the C field is set to 0, this field also indicates the identity of the Serving Cell which contains all resources indicated by the Spatial Relation for Resource IDi fields, if present. The length of the field is 5 bits;

- Positioning SRS Resource Set's BWP ID: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], which contains activated/deactivated SP Positioning SRS Resource Set. If the C field is set to 0, this field also indicates the identity of the BWP which contains all resources indicated by the Spatial Relation for Resource IDi fields, if present. The length of the field is 2 bits;

- C: This field indicates whether the octets containing Resource Serving Cell ID field(s) and Resource BWP ID field(s) within the field Spatial Relation for Resource ID i are present, except for Spatial Relation Resource IDi with DL-PRS or SSB. When A/D is set to 1, if this field is set to 1, the octets containing Resource Serving Cell ID field(s) and Resource BWP ID field(s) in the field Spatial Relation for Resource IDi are present, otherwise if this field is set to 0, they are not present. When A/D is set to 0, this field is always set to 0 that they are not present;

- SUL: This field indicates whether the MAC CE applies to the NUL carrier or SUL carrier configuration. This field is set to 1 to indicate that it applies to the SUL carrier configuration, and it is set to 0 to indicate that it applies to the NUL carrier configuration;

- Positoining SRS Resource Set ID: This field indicates the SP Positioning SRS Resource Set identified by *SRS-PosResourceSetId* as specified in TS 38.331 [5], which is to be activated or deactivated. The length of the field is 4 bits;

- Spatial Relation for Resource IDi: The field Spatial Relation for Resource IDi is only present if MAC CE is used for activation, i.e. the A/D field is set to 1. M is the total number of Positioning SRS resource(s) configured under the SP Positioning SRS resource set indicated by the field Positioning SRS Resource Set ID. There are 4 types of Spatial Relation for Resource IDi, which is indicated by the F (F0 and F1) field within. The fields within Spatial Relation for Resource IDi are shown in Figures 6.1.3.36-2 to 6.1.3.36-5 for the 4 types of Spatial Relations for Resource IDi;

- S: This field indicates whether the fields Spatial Relation for Resource IDi for the positioning SRS resource i within the positioning SRS resource set are present. If the field is set to 1, the fields Spatial Relation for Resource IDi are present; otherwise, they are absent;

- R: Reserved bit, set to 0.



Figure 6.1.3.36-1: SP Positioning SRS Activation/Deactivation MAC CE



Figure 6.1.3.36-2: Spatial Relation for Resource IDi with NZP CSI-RS



Figure 6.1.3.36-3: Spatial Relation for Resource IDi with SSB



Figure 6.1.3.36-4: Spatial Relation for Resource IDi with SRS



Figure 6.1.3.36-5: Spatial Relation for Resource IDi with DL-PRS

The field Spatial Relation for Resource IDi consists of the following fields:

- F0: This field indicates the type of a resource used as a spatial relation for the ith Positioning SRS resource within the Positioning SRS Resource Set indicated with the field Positioning SRS Resource Set ID. The field is set to 00 to indicate NZP CSI-RS resource index is used; it is set to 01 to indicate SSB index is used; it is set to 10 to indicate SRS resource index is used; it is set to 11 to indicate DL-PRS index is used. The length of the field is 2 bits;

- F1: This field indicates the type of SRS resource used as spatial relation for the ith Positioning SRS resource within the SP Positioning SRS Resource Set indicated with the field Positioning SRS Resource Set ID when F0 is set to 10. The field is set to 0 to indicate SRS resource index *SRS-ResourceId* as defined in TS 38.331 [5] is used; the field is set to 1 to indicate Positioning SRS resource index *SRS-PosResourceId* as defined in TS 38.331 [5] is used;

- NZP CSI-RS Resource ID: This field contains an index of *NZP-CSI-RS-ResourceID*, as specified in TS 38.331 [5], indicating the NZP CSI-RS resource, which is used to derive the spatial relation for the positioning SRS. The length of the field is 8 bits;

- SSB index: This field contains an index of SSB *SSB-Index* as specified in TS 38.331 [5] and/or TS 37.355 [23]. The length of the field is 6 bits;

- PCI: This field contains physical cell identity *PhysCellId* as specified in TS 38.331 [5] and/or TS 37.355 [23]. The length of the field is 10 bits;

- SRS resource ID: When F1 is set to 0, the field indicates an index for SRS resource *SRS-ResourceId* as defined in TS 38.331 [5]; When F1 is set to 1, the field indicates an index for Positioning SRS resource *SRS-PosResourceId* as defined in TS 38.331 [5]. The length of the field is 5 bits representing the index from 0 to 31;

- E: This field indicates the extension of SRS resource ID as the MSB of SRS resource ID. The total length of the extended SRS resource ID is 6 bits. If E bit is set to 1, the SRS resource ID value is 5-bit SRS resource ID field + 32;

- DL-PRS Resource Set ID: This field contains an index for DL-PRS Resource Set *nr-DL-PRS-ResourceSetId* as defined in TS 37.355 [23]. The length of the field is 3 bits;

- DL-PRS Resource ID: This field contains an index for DL-PRS resource *nr-DL-PRS-Resource-Id* as defined in TS 37.355 [23]. The length of the field is 6 bits;

- DL-PRS ID: This field contains an identity for DL-PRS resource *dl-PRS-ID* as defined in TS 37.355 [23]. The length of the field is 8 bits;

- PI: This field indicates whether the field DL-PRS resource ID is present within the Spatial Relation for Resource IDi with DL-PRS. If the field is set to 1, the octet containing the field DL-PRS resource ID is present; otherwise, the octet is omitted;

- SI: This field indicates whether the field SSB index is present within the Spatial Relation for Resource IDi with SSB. If the field is set to 1, the octet containing the field SSB index is present; otherwise, the octet is omitted;

- Resource Serving Cell IDi: This field indicates the identity of the Serving Cell on which the resource used for spatial relationship derivation for the ith Positioning SRS resource is located. The length of the field is 5 bits;

- Resource BWP IDi: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], on which the resource used for spatial relationship derivation for the ith Positioning SRS resource is located. The length of the field is 2 bits.