3GPP TSG-RAN WG2 Meeting #109-e R2-2001935

Online, 24 February – 6 March 2020

**Agenda item: 6.8.2.1**

**Source: Huawei, HiSilicon**

**Title: [Offline-611][POS] Summary on support of non-periodic SRS cases**

**Document for: Discussion and Decision**

# 1 Introduction

This document provide the collection of summary for the following offline discussion.

* [AT109e][611][POS] Support of non-periodic SRS cases (Huawei)

Intended outcome: Summary of agreements on support of aperiodic SRS including triggering by gNB or LMF, and progress towards design of a MAC CE for SP activation/deactivation. Summary in R2-2001935.

Deadline: Wednesday 2020-03-04 1300 CET

# 2 Discussion

## 2.1 Support of aperiodic SRS

In the LS from RAN1 [1], the following information has been provided.

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| --- |
| RAN1 would like to inform other RAN WGs on the following agreement:  Agreement:   * SRS for positioning supports semi persistent configuration with MAC CE activation/deactivation, with SRS for positioning to be received at the serving cell and neighbor cell * The aperiodic SRS for positioning is triggered by a DCI * There is no impact to Rel-15 DCI (reuse the triggers in place in rel-15) * The support of the reception of aperiodic SRS for positioning by the neighbor cell, is up to decision by RAN2 and RAN3 working groups * RAN1 assumes that the SRS for positioning configuration will be included in the RRC configuration of a UE and that it is up to RAN2 and RAN3 WG’s scope to analyze further the system level aspects along with any further work on the design of higher layer signaling. |

As summarized in the stage2 summary, the following options have been provided by different companies during the meeting:

* *Option1: Define a new NRPPa procedure that enables an LMF to request activation/deactivation of semi-persistent and aperiodic SRS-for-positioning resource sets from a gNB. [R2-2001214]*
* *Option2: At the time when non-periodic SRS resource is activated (for LTE, it is the time when SRS configuration in eNB is changed or UE performs handover), gNB sends UPLINK POSITIONING INFORMATION UPDATE message to the LMF. Then, the LMF sends MEASUREMENT REQUEST to the neighbouring cells with the configuration of non-periodic SRS resources. This procedure is similar to the SRS configuration update procedure in UTDOA in LTE. R2-2000513*
* *Option3: After the selection of TRP, LMF sends all the SRS configurations to the neighbouring cells, including periodic, semi-persistent and aperiodic SRS configuration. Then, the neighbouring cells blindly detects periodic, semi-persistent, and aperiodic SRS sent by the UE. If any of the SRS signal is detected, the neighbouring cells would sent MEASUREMENT RESULTS back to the LMF. R2-2000513*
* *Option4: configuration is provided to the neighbouring cells with the configuration of periodic SRS configuration. Then, it is up to the gNB implementation (with the proper DCI timing) to ensure the non-periodic SRS is transmitted according to the time/frequency configuration of the periodic SRS configuration. The main consideration is that the interaction of gNB and LMF may take too long time for the neighbouring cells to receive/measure the non-periodic SRS. R2-2000967*

For the above 4 options, we can make a summary with the following table with regard to different aspects of the design

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Activation/deactivation decided by | Activation/deactivation triggered by | Configuration transferred in the NRPPa MEASUREMENT REQUEST | Additional activation/deactivation signalling required in NRPPa |
| Option1 | Serving gNB | LMF | all non-periodic SRS configurations | signalled by NRPPa from LMF to serving gNB and LMF to neighbouring cells |
| Option2 | Serving gNB | serving gNB | all non-periodic SRS configurations | signalled by NRPPa from serving gNB to LMF and LMF to neighbouring cells |
| Option3 | Serving gNB | serving gNB | all non-periodic SRS configuration | No need |
| Option4 | Serving gNB | serving gNB | only periodic SRS configuration | No need |

Based on the above LS, the support of the reception of aperiodic SRS for positioning by the neighbor cell is contingent on discussion in RAN2/3. We suggest to discuss the following two issues for SP and AP SRS.

* Feasibility for the neighbor gNB to receive the aperiodic SRS
* Triggering SRS transmission by gNB or LMF

### Discussion#1: Feasibility for the neighbor gNB to receive the aperiodic SRS

Companies are invited to provide inputs on the following issue:

***Q1: Do company think it is feasible for the neighboring gNB to receive the aperiodic SRS with the potential NRPPa signaling delay?***

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Ericsson | No | Besides the delay, there are certain SRS dropping rules, thus UE may skip aperiodic SRS transmission. |
| Qualcomm | Yes | The TX request message sent by an LMF to the serving gNB of the target device can include a start time when the AP SRS is requested.  In response to Ericsson comment, we understand that AP-SRS has higher priority than SP or periodic SRS, and already the periodic SRS-for-positioning could be dropped compared to an AP-SRS or SP-SRS for other purposes. So, the fact that AP-SRS can be dropped is not a “new” problem and seems irrelevant in this context. |
| Nokia | Yes | We think it is technically feasible to receive aperiodic SRS in neighbor cells/gNB given relevant signaling support are in place. What will be the signaling delay in doing so and whether it will be useful for commercial use cases is difficult to say without detailed evaluations. |
| Huawei | No in general cases | It is not possible to neighbouring gNB to know the slot level timing of the SRS, since neighbouring gNB is not receiving the DCI from the serving gNB.  In one particular case, the AP SRS configuration is provided to the neighbouring gNB in a form of “periodic SRS configuration”, and serving gNB ensures the transmission timing of triggered SRS to match the “periodic SRS configuration”, and it can be feasible. |
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***Summary:***

***Proposal :***

### Discussion#2: Triggering SRS transmission by gNB or LMF

For the triggering of non-periodic SRS, generally, there are two options:

1. The activation/deactivation is triggered by LMF
2. The activation/deactivation is triggered by gNB

Companies are encouraged to provide their views on the following question:

***Q2: Whether the activation/deactivation should be triggered by gNB or LMF?***

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| --- | --- | --- |
| Company | Triggering entity gNB/ LMF | Comments |
| Ericsson | Depends upon use case | If the trigger is based upon the measurement report from UE and if LMF further wants do change; then LMF should trigger. This should be however decided by RAN3 as it has NRPPa impacts  If the use case is based upon SSB configuration updates etc; then this is informed as part of Xn update procedure in legacy and thus gNB may trigger.  Further, if gNB has any updates from the UE regarding RRM related measurements (beam sweep), then gNB may trigger. |
| Qualcomm | LMF | Given the LCS architecture, the trigger can only come from an LMF. As specified in TS 23.273, the LMF manages the overall coordination and scheduling of resources required for the location of a target UE. The gNB has no "location context" for the target UE; only an LMF (which manages the location measurement requests for the TRPs) can decide when the UL transmission from a target UE is needed. We also cannot see the difference to periodic SRS transmission for positioning. Also for periodic SRS, the LMF initiates the procedure and requests the periodic SRS from the serving gNB of a target device. |
| Nokia | LMF | I assume “non-periodic SRS” terminology is a generic reference to both aperiodic and semi-persistent SRS for positioning. Since RAN1 had already agreed that the actual activation/deactivation is done by serving gNB (MAC CE in the case of SP-SRS and DCI in the case of AP-SRS), the terminology “triggering SRS transmission” refers to what causes the serving gNB to activate or deactivate the SRS for positioning? SRS for positioning is needed to do UL measurements for positioning a target UE and since the positioning method is decided by LMF, the LMF (and the need to position a target UE) is the trigger for the activation/deactivation of SRS by serving gNB. |
| Huawei | Final decision by gNB, while LMF may recommend. | It should be noted that the final decision should still be gNB.  For example   * LMF sends the request in POSITIONING INFORMATION REQUEST (as normal SRS configuration request) to indicate   + The number of transmission to be 1 as implicit recommendation of using AP SRS, and may also recommend a rough time [ms] for the gNB to activate the SRS, or   + The spatial relation/pathloss subject to “dynamically changing” as an implicit recommendation of using SP SRS, and may also recommend a rough time [ms] for the gNB to activate the SRS * gNB provides the configuration of SRS in POSITIONING INFORMATION RESPONSE to LMF * LMF forwards the SRS configuration, or even include a measurement start time to the neighbouring gNB and the serving gNB, in case serving gNB is also tasked to perform the measurement   gNB configures the SRS and activates the SRS. |
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***Summary:***

***Proposal :***

## 2.2 MAC CE design for SP-SRS

RAN2 agree that SP-SRS is supported. According to the RAN1 spec, the following functionality of the MAC CE can be summarized:

1. Indication of SP SRS resource (R15 or R16 for positioning) to be activated/deactivated
2. Indication of spatial relation for the activated SP SRS resource to facilitate the UL beam transmission

[1] is straightforward that the MAC CE needs to indicate the SRS resource of a configured SRS resource set under the current active BWP. [2]

* Indication of activation/deactivation of R15 SP-SRS resource, with reference to
  + SSB and NZP CSI-RS resource
    - Configured in the serving cell with *ResourceServingCellID*
    - If *ResourceServingCellID* is absent, same serving cell as the SRS resource set is configured
  + SRS resource
    - Configured in the serving cell and BWP with *ResourceServingCellID*  and *resourceBWPID*
    - If not configured, same serving cell and active BWP
* Indication of activation/deactivation of R16 SP SRS for positioning resource, with reference to
  + Same indication for R15 SP SRS resource
  + SSB of a non-serving cell
  + DL PRS of a serving or non-serving cell

We first focus on the choice of whether to design a new MAC CE or reusing legacy/existing MAC CE (e.g. Rel-15 SP SRS activation/deactivation MAC CE, or Rel-16 new MAC CE introduced in MIMO)

### Discussion#3: New MAC CE or reusing existing MAC CE

Based on the discussion in the submitted contributions, there are two approaches for realizing the functionality of activation/deactivation for SP SRS:

1. Reuse the R15 SP SRS activation/deactivation MAC CE or R16 MAC CE in eMIMO
2. Design a new MAC CE

For the SP-SRS activation/deactivation in R15, the details are as follows as in TS 38.321

|  |
| --- |
| - A/D: This field indicates whether to activate or deactivate indicated SP SRS resource set. The field is set to 1 to indicate activation, otherwise it indicates deactivation;  - SRS Resource Set's Cell ID: This field indicates the identity of the Serving Cell, which contains activated/deactivated SP 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 Resource IDi fields. The length of the field is 5 bits;  - 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 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 Resource IDi fields. 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) are present. If this field is set to 1, the octets containing Resource Serving Cell ID field(s) and Resource BWP ID field(s) are present, otherwise 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;  - SP SRS Resource Set ID: This field indicates the SP SRS Resource Set ID identified by *SRS-ResourceSetId* as specified in TS 38.331 [5], which is to be activated or deactivated. The length of the field is 4 bits;  - Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource within SP SRS Resource Set indicated with SP SRS Resource Set ID field. F0 refers to the first SRS resource within the resource set, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index is used. The length of the field is 1 bit. This field is only present if MAC CE is used for activation, i.e. the A/D field is set to 1;  - Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource within the resource set, Resource ID1 to the second one and so on. If Fi is set to 0, and the first bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, and the first bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 7 bits. This field is only present if MAC CE is used for activation, i.e. the A/D field is set to 1;  - Resource Serving Cell IDi: This field indicates the identity of the Serving Cell on which the resource used for spatial relationship derivation for SRS resource i 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 SRS resource i is located. The length of the field is 2 bits;  - R: Reserved bit, set to 0. |

While for the MAC CE in R16 designed under the work item eMIMO, they have not been finalized yet

Based on the observation on the need for functionality for positioning SRS and the design of legacy R15 MAC CE, rapporteur found it might be hard to reuse the legacy MAC CE. One obvious reason is that: Legacy MAC CE cannot indicate the DL PRS as the spatial relation. With the combination of Fi and the first bit of resource ID, it is able to indicate the spatial relation with NZP CSI-RS/SRS/SSB, but not for DL PRS. Another is the legacy MAC CE can only trigger the activation/deactivation of SRS under a single SRS resource set.

Nevertheless, [2] has proposed an approach to utilize the reserved bit in the second octet of the legacy MAC CE, and then redesign the rest of the MAC CE based on this switch bit.

Companies are invited to provide inputs on the following issue:

***Q: Whether to (a) reuse the R15 legacy SP SRS activation/deactivation MAC CE or (b) design a new MAC CE?***

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| --- | --- | --- |
| Company | Option (a)/(b) | Comments |
| Ericsson | B | The current MAC CE is mainly for MIMO purpose where each of the resources in a resource set needs to be indicated even when there is no change. This may result in a MAC CE to be of several octets. Further, there is no provision to support new reference signal DL PRS, distinction between Rel-15 SRS Resource set or Rel-16 SRS Resource set. Further neighbor SSB related information are also not indicated. If the current MAC CE design is used, it will be complex specification and several octets which should eb avoided. |
| Qualcomm | A or B | Given that an extended LCID space will be introduced, we are fine with both options. The decision should be made based on the design requirements. I.e., design the MAC CE first and then decide whether a new MAC CE would be more appropriate. |
| Nokia |  | While we acknowledge that RAN1 had agreed to use MAC CE for activation/deactivation of semi-persistent SRS for positioning, the efforts required to design a MAC CE seem to be high given the number of additional issues for discussion listed in this document. MAC CE design requires further discussions involving user plane experts and so I am not sure if this group can converge in this email discussion in RAN2#109-e meeting. We need to revisit the decision to support semi-persistent SRS for positioning in Rel-16 or see if the MAC CE design work can be done after this meeting. |
| Huawei/HiSilicon | B | Seems a new MAC CE is future proof. |
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***Summary:***

***Proposal :***

Regardless of the choice of designing a new MAC CE or reusing the legacy MAC CE, we think the following aspects are common for both approaches:

* Partial Activation and deactivation with a single MAC CE
* Activation/deactivation granularity
* Support of spatial relation
* Support of pathloss reference
* Indication of spatial relation RS or pathloss reference RS

### Discussion#4: Activation/deactivation granularity

As can be seen above for the R15 MAC CE, the activation/deactivation is for the SRS resources within a single SRS resource set. For the new MAC CE, we should decide whether the MAC CE can activate

* Option 1: Single positioning SRS resource set on a BWP of a CC, or
* Option 2: Multiple positioning SRS resource sets on a BWP of a CCs, or
* Option 3: Multiple positioning SRS resource sets across BWPs/CCs

Companies are encouraged to provide their views on the following issue

***Q: Companies are encouraged to provide their views on what is the granularity for the activation/deactivation***

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| --- | --- | --- |
| Company | Option (a)/(b)/(c) | Comments |
| Ericsson | Option 1 | To keep it simple and efficient. We do not expect multiple changes simultaneously. |
| Qualcomm | Option 1/2/3 | The basic principle of the Rel-15 MAC CE for SRS activation/deactivation seems also appropriate for SRS-for-positioning.  However, we noticed that there are similar discussions ongoing in eMIMO WI. It may make sense to align with eMIMO. In general, we would also support Options 2/3. Option 1 is not mutually exclusive with Options 2/3. |
| Huawei/HiSilicon | Option 1 |  |
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***Summary:***

***Proposal :***

### Discussion#5: Partial activation and deactivation with a single MAC CE

As can be observed for the legacy MAC CE, it can only active or deactivate SRS resources (as indicated with the field “A/D” within the MAC CE), but cannot activate some SP SRSs while deactivate some other SP SRSs at the same time. RAN2 needs to discuss this for SP SRS for positioning, especially from the perspective that R16 support both R15 SRS and R16 SRS for positioning.

Note that this may be correlated with the above question on the granularity of activation/deactivation indication. When the granularity of indication is multiple SRS resource sets, the MAC CE might be able to activate some resource set while deactivate other resource set.

Companies are encouraged to provide their views on the following issue

***Q: Whether it is necessary to activate some SRS resources while deactivate other SRS resources with a single MAC CE?***

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Ericsson | No | Let’s keep it simple and not complicate it. |
| Qualcomm | Depends on #4 conclusion | The basic principle of the Rel-15 MAC CE for SRS activation/deactivation seems also appropriate for SRS-for-positioning.  However, we noticed that this depends on Discussion#4.  Within a single SRS resource set, we can follow the Rel-15 approach where all resources are activated/deactivated together. If multiple resource sets are supported (option 2,3 of discussion 4), we should have separate activation/deactivation for each resource set. |
| Huawei/HiSilicon | No | Not necessary. |
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***Summary:***

***Proposal :***

### Discussion#6: Support of activation/deactivation of R15 SRS

According to the RAN1 agreement and the current CR agreed to 38.214, as summarized above, the following reference signals can serve as the source for the spatial relation information for the SP SRS in R15 and SP SRS in R16 in R16 positioning:

* R16 SRS
  + SSB from serving cell and non-serving cell;
  + NZP CSI-RS resource from serving cell;
  + SRS resource;
  + SRS-for-positioning resource;
  + DL-PRS from serving and non-serving cell.
* R15 SRS
  + SSB from serving cell ~~and non-serving cell~~;
  + NZP CSI-RS resource from serving cell;
  + SRS resource;

While for the R15 MAC CE, the spatial relationship indication can only support the following:

* SSB from serving cell;
* NZP CSI-RS resource from serving cell;
* SRS resource;

Companies are encouraged to provide their views on the following issue

***Q: Whether it is necessary that the new MAC CE can activate/deactivate R15 SRS resource***

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Ericsson | Yes | Yes, since RAN1 agreement allows Rel-16 SRS to be spatially configured with Rel-15 SRS. Thus, this should be indicated. |
| Qualcomm | No | The benefit of Rel-15 SRS is that there are no new UE impacts; i.e., UL-only positioning may (to some extend) work with legacy UEs. We cannot see why a new MAC-CE is needed for Rel-15 SRS activation/deactivation. |
| Huawei/HiSilicon | No | We already have the MAC CE(s) for Rel-15 SRS. Since the resource set IDs for positioning SRS and resource set IDs for legacy SRS may overlap, it is complicated and thus unnecessary to design a MAC CE that can simultaneously activate positioning SRS and legacy SRS. |
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***Summary:***

***Proposal :***

### Discussion#7: Granularity of spatial relationship indication

Next, for R15 SRS resource activation/deactivation, the indication of spatial relation is per SRS resource. We assume that the spatial relation is also resource-specific for the new MAC CE for SP SRS activation/deactivation for R16 positioning.

***Q: Whether the activation/deactivation indicate per-SRS resource spatial relation?***

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Ericsson | Yes | It can be per resource |
| Qualcomm | Yes |  |
| Huawei/HiSilicon | Yes | Reuse existing mechanism and align with RRC.  One question for clarification, should this MAC CE also be used to update the spatial relation of AP-SRS? |
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***Summary:***

***Proposal :***

### Discussion#8: Support of pathloss reference

In R15, the MAC CE does not indicate the pathloss reference for SRS. This part addresses whether the MAC CE can initialize/update the pathloss reference of each SRS resource set. We assume that the pathloss reference is resource-set specific.

***Q: Companies are encouraged to provide their views whether pathloss reference for SRS should be supported for the activation/deactivation MAC CE?***

|  |  |  |
| --- | --- | --- |
| Company | Y/N | Comments |
| Ericsson | N | It is not needed to explicitly configure only for the pathloss. UE may use it when spatial configuration has been configured for pathloss too. But, as far as we understand MAC CE resource is not to indicate pathloss. |
| Qualcomm | Y | The maximum number of supported SRS resource sets for positioning is a UE capability, with configurability of 1-16 resource sets per BWP. If a UE supports only one SRS resource set for positioning, the MAC CE would then selectively activate the resource set across time with different beams (i.e., spatial relations). Along with changing the spatial relation there is typically also a need to change the pathloss reference to enable the UE transmitting towards all desired TRPs. |
| Huawei/HiSilicon | Y | Reuse what we have in eMIMO.  One question for clarification, should this MAC CE also be used to update the pathloss reference of AP-SRS? |
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***Summary:***

***Proposal :***

### Discussion#9: Indication of spatial relation RS or pathloss reference RS

Last but not the least, we need to discuss how to indicate the spatial relation/pathloss reference RS. Since the spatial relation RS or pathloss reference RS can be either from the serving cell or a neighbouring cell, and the RS can be SSB, PRS, CSI-RS (for the serving cell), or another SRS, how to indicate those RS in the MAC CE should be discussed.

In R16, the difference from R15 is that the spatial relation with the source as the neighbouring cell RS can also be supported for SSB and DL-PRS. In [R2-2001237], a spatial relation ID has been proposed to compress the information for this spatial relation indication, but for this, special configuration for this “spatial relation ID” is needed.

This issue needs to be specially handled if we support SP SRS and companies are invited to provide their solutions in the following open question:

***Q: Companies are encouraged to provide their views on how the spatial relation is indicated.***

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| --- | --- |
| Company | Comments |
| Ericsson | We may need 3 bits to represent the various RS/TCI states in MAC CE.  Example:  000-> SSB  001->PRS  010->SRS Rel-15  011->SRS Rel-16  100->CSI-RS |
| Qualcomm | This can be done analogous to the Rel-15 MAC-CE for SRS activation/deactivation. The spatial relation indication must in addition contain the appropriate IDs such that the target TRP can be identified. The MAC-CE for SRS-for-positioning should support the following cases as summarized in R2-2001214:   |  |  |  | | --- | --- | --- | | Case | Information Required | # Bits | | (a) SSB | - PCI  - SSB ID | - 10 bits  - 6 bits | | (b) NZP CSI-RS   (serving cell only) | - NZP CSI-RS Resource ID | - 8 bits | | (c) SRS | - SRS Resource ID | - 6 bits | | (d)SRS-for-positioning | - SRS-for-positioning Resource ID | - 6 bits | | (e) DL-PRS | - ID  - DL-PRS Resource Set ID  - DL-PRS Resource ID | - 8 bits  - 3 bits  - 6 bits |   The MAC-CE should convey the above information to the target UE. |
| Huawei/HiSilicon | A pool of spatial relations configured in RRC and using MAC CE code point to point to the ID of the spatial relations, similar to TCI framework in downlink, can be considered as a starting point. |
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***Summary:***

***Proposal :***

# 3 Conclusions

TBD

# 4 References

1. R2-1914310 LS on SRS for NR Positioning (R1-1911634; contact: Intel) RAN1 LS in Rel-16 NR\_pos To:RAN2, RAN3 Cc:RAN4

[2]. R2-2001214 Semi-persistent and aperiodic SRS-for-positioning Qualcomm Incorporated discussion Rel-16 NR\_pos-Core