**3GPP TSG RAN WG1 #106bis-e R1-210zzzz**

**e-Meeting, October 11th – 19th, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Feature Lead Summary#1 for E-mail Discussion [106bis-e-NR-ePos-06]**

**Agenda item:** **8.5.6**

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

# Introduction

In this contribution, we provide overview of contributions [1] - [20] on NR-Positioning in RRC\_INACTIVE state and on-demand DL PRS support. In each section, we formulate tentative proposals for RAN WG1 discussion and decision, and capture views provided by companies during RAN1 e-mail discussion [106bis-e-NR-ePos-06]:

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| [106bis-e-NR-ePos-06] Email discussion/approval on RAN2-led aspects in the Others section with checkpoints for agreements on October 14 and 19 – Alexey (Intel) |

# Proposed Priority Order for Discussion

## Round #1

### NR Positioning in RRC\_INACTIVE State

It is proposed to prioritize discussion on the following aspects

* Aspect #1: Types of SRS for positioning
* Aspect #2: DL PRS / SRS relationship with BWP#0
* Aspect #3: Validity criteria for SRS for positioning

### On demand DL PRS

It is proposed to prioritize discussion on the following aspects

* Aspect #1: On demand DL PRS parameters

NR Positioning in RRC\_INACTIVE State

The following list of design aspects / enhancements was identified based on submitted contributions for NR positioning support by RRC\_INACTIVE UEs

## Aspect #1: Types of SRS for Positioning

This section provides summary of views on types of SRS for positioning to be supported by RRC\_INACTIVE UEs.

* [ZTE, [1]]
  + From RAN1 perspective, support all of periodic, semi-persistent and aperiodic SRS transmission in RRC\_INACTIVE state
    - How to inform positioning SRS configuration should be up to RAN2
* [vivo, [2]]
  + At least support periodic SRS for positioning in inactive state from RAN1’s perspective
  + It is up to RAN2 to determine whether to support semi-persistent/aperiodic SRS for positioning in inactive state based on certain scenarios or procedures.
* [OPPO, [3]]
  + For transmission of SRS for positioning by UEs in RRC \_INACTIVE state for UL and DL+UL positioning, aperiodic SRS for positioning is not supported in Rel-17.
  + For transmission of SRS for positioning by UEs in RRC \_INACTIVE state for UL and DL+UL positioning, it is up to RAN2 to determine what types supported in Rel-17 in case it is difficult for RAN1 to achieve consensus on this topic.
* [CMCC, [5]]
  + Periodic SRS for positioning is supported for transmission by UEs in RRC\_inactive state.
* [CATT, [4][7]]
  + Both periodic SRS and semi-persistent SRS should be supported for RRC\_INACTIVE UEs
* [Nokia, [7]]
  + RAN1 to support only periodic SRS for positioning for UEs in RRC\_Inactive state.
* [Samsung, [9]]
  + Support aperiodic and/or semi-persistent SRS transmission for UL and DL+UL positioning in RRC \_INACTIVE state.
* [Intel, [10]]
  + For UL and DL+UL positioning by RRC\_INACTIVE UEs, support transmission of semi persistent UL SRS for positioning
    - The details of activation/deactivation can be directly considered in RAN2
* [NTT DOCOMO, [11]]
  + Support at least periodic SRS for positioning in RRC\_INACTIVE state
  + Rel-17 needs to study necessity of semi-persistent/aperiodic SRS for positioning in RRC\_INACTIVE state
* [Huawei, [12]]
  + Conclude in RAN1 that
    - Periodic SRS transmission in RRC\_INACTIVE can be directly supported
    - Support of semi-persistent SRS transmission depends on whether UE is able to receive DL MAC CE in RRC\_INACTIVE state
    - Support of aperiodic SRS transmission depends on whether UE is able to monitor DCI formats 0\_1, 0\_2, 1\_1, or 1\_2 in the UE specific search space in RRC\_INACTIVE state
    - It is RAN1 understanding that the support of transmission of semi-persistent SRS and aperiodic SRS in RRC\_INACTIVE state can be finally decided by RAN2
* [Sony, [13]]
  + Supporting various types of SRS for positioning can enable many positioning use-cases.
  + Support periodic, aperiodic, and semi-persistent SRS for positioning in RRC\_INACTIVE state
* [LGE, [15]]
  + If periodic SRS transmission by UEs in RRC\_INACTIVE state is supported, it causes more power consumption for UE since UE already consumes its power to monitor paging.
  + RAN1 should support periodic SRS transmission for UEs in RRC\_INACTIVE state as lower priority than other types (i.e., semi-persistent, aperiodic).
* [InterDigital, [16]]
  + Support at least periodic SRS for positioning for UL and DL + UL positioning during RRC\_INACTIVE
* [Qualcomm, [17]]
  + Introduce both Periodic and Semi-persistent SRS for UEs in RRC Inactive.
* [Ericsson, [20]]
  + SRS for positioning aperiodic transmission is not supported in RRC\_INACTIVE state
  + SRS for positioning semi-persistent transmission is not supported in RRC\_INACTIVE state

**Summary:**

Based on provided inputs it seems there is no common view on types of SRS for positioning to be supported by RRC\_INACTIVE UEs. Views are almost equally divided between the following options:

1. Periodic SRS for positioning: Ericsson, InterDigital (at least), NTT DOCOMO (study necessity for other types), CMCC, OPPO
2. Periodic and semi-persistent SRS for positioning: Intel, Qualcomm, CATT
3. Periodic, semi-persistent and aperiodic SRS for positioning: LGE, Sony, Samsung, ZTE
4. Up to RAN2 to decide: Huawei, vivo

Note that support of periodic SRS for positioning is already agreed by RAN2.

### Round #1

It is suggested to discuss the following proposal as a middle ground:

**Proposal 3.1-1**

* Send LS to RAN2 with the outcome of RAN1 discussion on types of SRS for positioning to be supported by UEs in RRC\_INACTIVE state
* From RAN1 perspective, at least support of semi-persistent SRS for positioning by RRC\_INACTIVE UEs is recommended in addition to support of periodic SRS for positioning
* It is up to RAN2 to confirm support of semi-persistent SRS for positioning by RRC\_INACTIVE UEs and determine necessary signaling details

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | OK. |
| vivo | Periodic SRS can be supported firstly, and whether to support semi-persistent SRS and aperiodic SRS can be determined by RAN2.  For semi-persistent SRS, it is activated/deactivated by MAC CE, which is more like a RAN2 issue. Whether the corresponding MAC CE can be piggybacked with RRC release or transmitted via on-going SDT is better for RAN2 discussion.  For aperiodic SRS, we think it can only be triggered during the period of SDT subsequent transmissions, which is scenario/procedure dependent, it is also RAN2 related. |
| Intel | Support at least semi-persistent |
| OPPO | Support |
| CATT | Support |
| Nokia/NSB | Not support. In our view, whether to support SP and AP of SRS for positioning is up to RAN2. |
| Qualcomm | Support |
| ZTE | We suggest treat SP-SRS and AP-SRS as the same level because both of them can be activated/triggered in SDT active period. The final decision can be up to RAN2. Here is our suggestion   * Send LS to RAN2 with the outcome of RAN1 discussion on types of SRS for positioning to be supported by UEs in RRC\_INACTIVE state * From RAN1 perspective, ~~at least~~ support of semi-persistent and aperiodic SRS for positioning by RRC\_INACTIVE UEs is feasible~~recommended~~ in addition to support of periodic SRS for positioning * It is up to RAN2 to confirm support of semi-persistent and aperiodic SRS for positioning by RRC\_INACTIVE UEs and determine necessary signaling details |
| NTT DOCOMO | Support |
| China Telecom | Support |
| CMCC | We share similar views with vivo that, whether to support semi-persistent and/or aperiodic SRS pos by inactive UE can be up to RAN2. |

## Aspect #2: DL PRS / SRS relationship with BWP0

The following views were expressed by companies in terms of DL PRS and SRS for positioning relationship with initial DL/UL BWPs for RRC\_INACTIVE UEs.

* [vivo, [2]]:
  + In inactive state, the relationship between PRS measurement and initial DL BWP should be considered, that is, UE is not expected to process PRS outside the initial DL BWP and/or PRS whose SCS is different with the initial DL BWP
* [Huawei, [12]]:
  + Support a separate positioning bandwidth configuration from that of BWP#0 configured by the system information for SRS transmission in RRC\_INACTIVE.

### Round #1

Given that this aspect has not been discussed/agreed yet and may have potential impact on specification, the following is proposed:

**Proposal 3.2-1**

* Select one of the following alternatives for DL PRS measurement by UEs in RRC\_INACTIVE state:
  + Alt.1: UE in RRC\_INACTIVE state is not expected to process DL PRS outside the initial DL BWP and/or DL PRS whose SCS is different with the initial DL BWP
  + Alt. 2: UE in RRC\_INACTIVE state supports DL PRS processing outside and inside the initial DL BWP and/or DL PRS whose SCS is different with the initial DL BWP
* Select one of the following alternatives for transmission of SRS for positioning by UEs in RRC\_INACTIVE state:
  + Alt.1: For RRC\_INACTIVE UEs, SRS for positioning bandwidth is configured by RRC and does not exceed bandwidth of initial UL BWP configured by the system information. The SCS and CP type of initial UL BWP are used
  + Alt.2: For RRC\_INACTIVE UEs, SRS for positioning bandwidth, SCS and CP type are configured by RRC and can be different from that of initial UL BWP configured by the system information

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Alt. 2 for both. |
| vivo | For the first main bullet, support Alt.1 for the consideration of power consumption.  For the second main bullet, we think SRS may be configured on either initial BWP or separate BWP. However, it is better to determine it in next meeting based on further output from SDT.  CG-SDT resource can be configured on either initial BWP or separate SDT BWP. Ask RAN1 to confirm |
| Intel | Alt 2 for both |
| OPPO | Alt.2 for both. If only narrow bandwidth is allowed for the positioning in RRC\_INACTIVE state, the accuracy will be limited and it may make this feature less valuable. |
| CATT | Alt 2 for both |
| Nokia/NSB | Support Alt 2 for both main bullets. In consideration of the high accuracy, it seems necessary. |
| Qualcomm | Alt. 2 for both. However, there should be an understanding that a UE would need some gap between the initial BWP and the PRS in order to do both processing. It is known that a UE requires some retuning gap (e.g. 0.5 msec in FR1) to retune between the initial BWP and the PRS.   * + *Alt. 2: UE in RRC\_INACTIVE state supports DL PRS processing outside and inside the initial DL BWP and/or DL PRS whose SCS is different with the initial DL BWP*     - *Note: It is RAN1 understanding that further discussions maybe needed in RAN4 with regards to potential gaps between the initial DL BWP and the DL PRS when the BW or the SCS is different.*     - *Send an LS to RAN4 with this agreement* |
| ZTE | Because RAN2 has agreed a separate BWP for SDT, there is no reason to restrict PRS or SRS processing into the initial BWP at least in SDT active period.  Hence, it is better to clarify or separately discuss whether the proposal is applicable inside SDT or outside SDT active period (still in RRC inactive state)   * For PRS   + In the case outside SDT period, we think it is better to support PRS measurement regardless of initial BWP since PRS configuration may not be known from the serving gNB.   + In the case inside SDT period, since there is no measurement gap in RRC inactive state based on RAN4’s agreement, PRS can only be proceed inside DL SDT BWP like the measurement window we agreed in another addenda. In such case, we can further discuss whether a separate measurement window is needed in DL SDT BWP. * For SRS,   + In the case outside SDT period, we think it is better to support at least P-SRS transmission regardless of initial UL BWP since there is no other UL signalling in this case.     - The SRS configuration can be from RRC connection or RRC Release signaling.   + In the case inside SDT period, SRS should be only allowed to transmit in UL SDT BWP.     - The previous P-SRS may be suspended if it is not inside the UL SDT BWP. Otherwise, it will be continued.     - SP or AP-SRS can be activated or triggered |
| NTT DOCOMO | Alt.2 for both. |
| China Telecom | Alt.2 for both. |
| CMCC | We believe that a unified design can be applied for DL and UL. As per the SDT discussion in RAN2, support Alt. 2 for both. |
| Lenovo, Motorola Mobility | Support Alt.2 for both DL PRS measurement and SRS transmissions. |

## Aspect #3: Validity criteria for SRS for positioning

This section provides summary of views on validity criteria of SRS for positioning transmission by RRC\_INACTIVE UEs:

* [ZTE, [1]]
  + Validity criteria of DL PRS configuration is under discussion in RAN2 post-meeting email, no RAN1 discussion is needed.
* [vivo, [2]]
  + The validity criteria for SRS configuration in inactive state should be considered, at least following validity criteria can be considered:
    - UE is in the valid predefined area, e.g. the cell where RRC release containing SRS configuration is received
    - UE has valid TA
    - UE has valid spatial relation RS
    - UE has valid power control RS
  + Spatial relation
    - If spatial relation RS is configured for SRS transmission in inactive state, the following validity criteria for spatial relation RS validation can be considered.
    - Reuse criteria of RSRP based TA validation.
    - Reuse criteria of accurately pathloss RS measurement: if the UE determines that the UE is not able to accurately measure the pre-configured spatial relation RS, the spatial relation RS will not be valid.
  + Power control
    - For SRS power control in inactive state, support to reuse open loop power control mechanism in connected state in Rel-16 positioning, including:
    - Configure power control related parameters towards multiple cells via RRC release.
    - Reuse validity criteria of accurately measurement and related fallback behavior for pathloss RS measurement in connected state
    - If the UE determines that the UE is not able to accurately measure the pre-configured pathloss RS, the UE calculates pathloss using a RS resource obtained from the SS/PBCH block of the cell that the UE uses to obtain MIB, e.g. MIB of the camping cell.
  + SRS Configuraiton
    - The fallback behavior should be considered when the validity criteria for SRS configuration in inactive state is not met, including:
    - Entering connected state to perform UL positioning or request/update the SRS configuration; or remaining in inactive state to perform UL positioning and request/update SRS configuration
    - Both UE and gNBs release previous SRS configuration applied in inactive state
* [OPPO, [3]]
  + Regarding the validation criteria, consider the following factors:
    - Timing advance
    - Path loss measurement
* [CMCC, [5]]
  + For transmission of UL SRS for positioning by UEs in RRC\_inactive state, support to reuse the validation criteria of SDT.
  + Support defining a validation rule including a validation area.
* [Nokia, [7]]
  + RAN1 to discuss, for RRC\_Inactive UEs, validity criterion for the parameters for SRS resources which were configured in RRC\_Connected state
* [Samsung, [9]]
  + For UL positioning in RRC inactive state, if the camping cell is changed, whether the SRS configuration is assumed valid can be further discussed.
* [Sony, [13]]
  + Support to introduce validation scheme when the UE can transmit SRS for positioning in RRC\_INACTIVE state. As part of the validation scheme, the UE can transmit SRS for positioning when the UE is still camp to the same cell or a pre-configured group of cells.
* [InterDigital, [16]]
  + One of the validity conditions for SRSp is TA timer.
* [Ericsson, [20]]
  + Do not discuss further the SRS parameters validation aspects in RAN1.

**Summary**

Companies have expressed diverse views on validity criteria for SRS for positioning transmission by RRC\_INACTIVE UEs, including the leading working group to define those. Given that RAN1 has agreed to reuse OLPC and spatial relation frameworks from RRC\_CONNECTED UEs, it seems fair to discuss validity criteria for at least these functionalities.

Based on FL understanding, the validity criteria for OLPC of SRS for positioning was a part of the following agreement.

|  |
| --- |
| Agreement:   * Open loop power control defined in Rel.16 for transmission of SRS for positioning by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs. |

If there is no common understanding across companies on this aspect, it is proposed to clarify.

### Round #1

Based on review of contributions, the following is proposed to facilitate further discussion in RAN1:

**Proposal 3.3-1**

* For OLPC of SRS for positioning transmission by RRC\_INACTIVE UEs,
  + Reuse validity criteria for pathloss measurement defined for RRC\_CONNECTED UES in Rel.16 including fallback behavior
* For spatial relation of SRS for positioning transmission by RRC\_INACTIVE UEs,
  + FFS whether to define validity criteria or reuse validity criteria for OLPC pathloss measurement to determine whether spatial relation with configured RS is valid

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | OK |
| vivo | Support |
| Intel | Support with FFS in the second bullet |
| OPPO | Support |
| CATT | Okay |
| Nokia/NSB | For both OLPC of SRS and spatial relation of SRS, we are okay to reuse validity criteria for pathloss measurement. However, we need to reconsider the reuse of fallback behavior. If we reuse the current fallback behavior, the UE still transmits SRS resources based on serving cell SSB. That is, even if it is not valid, the UE still transmits SRS and it leads to potential interferences. In our understanding, after the validity check of the UE, the UE behavior needs separate discussion.  In the current proposal, we are fine with the following modification. However, if the configured SRS is not valid anymore, it may be reasonable not to transmit SRS.   * For OLPC of SRS for positioning transmission by RRC\_INACTIVE UEs,   + Reuse validity criteria for pathloss measurement defined for RRC\_CONNECTED UES in Rel.16 ~~including~~excluding fallback behavior * For spatial relation of SRS for positioning transmission by RRC\_INACTIVE UEs,   + FFS whether to define validity criteria or reuse validity criteria for OLPC pathloss measurement to determine whether spatial relation with configured RS is valid |
| ZTE | We think it is better to wait RAN2’s outcome for this issue. The validity criteria may not only be for OLPC but also for others including TA, spatial relation, etc. which may use the unified solution. |
| China Telecom | Support. |
| CMCC | We share similar views with Nokia that fallback behaviour of OLPC and spatial relation info should be separately discussed. |

## Aspect #4 QCL Information for DL PRS reception

This section provides summary of views on QCL information for DL PRS reception by RRC\_INACTIVE UEs:

* [vivo, [2]]
  + Support to reuse QCL configuration in connected state for PRS reception for inactive UEs.

**Summary**

It seems support of QCL configuration by RRC\_INACTIVE UEs may need to be clarified since companies may have different interpretations based on previous agreement for DL PRS measurements by RRC\_INACTIVE UEs

|  |
| --- |
| Agreement:  NR positioning supports DL PRS-RSRP (section 5.1.28 in the TS 38.215) and DL RSTD (section 5.1.29 in the TS 38.215) measurements by UEs in RRC\_INACTIVE state   * FFS additional potential impact on RAN1 |

### Round #1

Based on review of contributions, the following is proposed to facilitate further discussion:

**Proposal 3.4-1**

* QCL configuration is supported for DL PRS reception by RRC\_INACTIVE UEs
  + Note: QCL framework defined for RRC\_CONNECTED UEs in Rel.16 is reused

Comments from companies:

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| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | We do not think there is any spec impact, since LMF does not sense the UE RRC state. |
| vivo | Support |
| OPPO | We share the same view as Huawei. Would the proponent(s) like to elaborate a bit more on what spec impact is expected by this proposal? |
| CATT | We assume RRC\_INACTIVE UEs will follow the same way as connected UEs to use the QCL information provided in *NR-DL-PRS-Info.* But, we share the similar views with Huawei and OPPO that it may not have specification impact. |
| Nokia/NSB | The LMF may not be able to consider separately the RRC\_Inactive UEs for PRS configuration since the RRC state is transparent to the LMF. In our view, we do not need an agreement on this proposal. |
| ZTE | We share the similar view as Huawei, OPPO, CATT and Nokia. |
|  |  |
|  |  |

## Aspect #5: Priority of DL PRS processing

The following views were expressed on priority of DL PRS processing vs other DL channels/signals by RRC\_INACTIVE UEs

* [ZTE, [1]]
  + Collision issue between DL-PRS and other signals/channels in SDT active period should be solved
    - Serving gNB can indicate to prioritize or deprioritize DL-PRS over other signals/channels in SDL BWP
* [vivo, [2]]
  + In inactive state, when PRS and other DL signals (e.g., SSB, SIB1, COREST0, MSG2/MSGB, paging, etc.) collide, UE is not expected to process PRS.

**Summary**

This aspect was not discussed so far and feedback from companies is invited.

### Round #1

**Proposal 3.5-1**

* Companies are invited to provide comments on priority of DL PRS reception by RRC\_INACTIVE UEs vs other DL signals (e.g., SSB, SIB1, COREST0, MSG2/MSGB, paging, etc.)

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Since INACTIVE state positioning does not target latency, we think that high priority for other DL signals should at least supported. |
| vivo | From our point of view, other DL signals are important signals (e.g., SSB, SIB1, COREST0, MSG2/MSGB, paging, etc.) for initial access which should be treated as high priority, so that when collision between PRS and these signals occurs, UE is not expected to process PRS. |
| OPPO | For the signals listed in the proposal, we think they should have higher priority |
| CATT | Share the similar view that DL PRS has lower priority for RRC\_INACTIVE UEs. |
| Qualcomm | We are generally support of the intention that PRS should be lower priority than the broadcast channels, but there needs to be a clarification on what we mean by “collision” between PRS and these channels:   * When PRS symbols and the broadcast channels are in different BW or different SCS, even if they are in different symbols (i.e, no collision in the strictly speaking sense), the UE may still need to do a retune if it wants to measure both of them. * So, if the gap in between the PRS + expectedRSTDwindow and the broadcast channel is not large enough, the PRS should be deprioritized. * Similarly, even if the PRS is in the initial BWP and the same SCS, the collision should be based on the configured PRS symbols together with the expectedRSTDwindow.   Last thing to consider:   * If indeed PRS is depriorized when there is collision with other channels, it may be needed to send an LS to RAN4 to consider how/whether the measurement period should be adjusted. |
| ZTE | We are open the solutions. However, it should clarify what is UE behaviour when PRS and **other DL SDT signals** collide. One straightforward way is to reuse what we agreed for measurement window for PRS outside measurement gap, e.g. indicate PRS is higher priority or lower priority than DL SDT signals. |
| China Telecom | We share the similar view as HW that the DL PRS should have a lower priority compared with the listed DL signals. |
| CMCC | We agree that for the listed DL signals, the priority of DL PRS should be deprioritized. |
|  |  |

## Aspect #6: Relationship with DRX

* [vivo, [2]]
  + In inactive state, the impact of PRS measurement on inactive DRX configuration should be minimized
    - e.g., UE is expected to measure PRS once in an inactive DRX cycle.
* [LGE, [15]] On DL PRS reception
  + Regarding DL positioning for UEs in RRC\_INACTIVE state, RAN1 should support PRS reception considering DRX cycle, and the following options can be studied.
    - Option 1: UE always measures PRS within preconfigured duration periodically after every paging occasion
    - Option 2: UE obtains some information related with time window for DL PRS reception through paging and then UE measure PRSs within the configured window dynamically
  + If paging is used for NRPP message (such as measurement request) and UE monitors every PRS resources that are in adjacent PO, it causes larger power consumption for UE.
* [LGE, [15]] On SRS for positioning transmission
  + RAN1 should support a time window (or occasion) of SRS transmission for UE power saving when periodic SRS is supported for UE in RRC\_INACTITVE
  + If UE can transmit SRS without going to deep sleep after Paging Occasion (PO), UE saves its power to go to sleep and wake up again
  + RAN1 should support SRS transmission considering DRX cycle (including related procedure and signaling)
* [Lenovo, Motorola Mobility, [19]]
  + RAN1 to consider the DL-PRS configuration impact on measurement accuracy in RRC\_INACTIVE state. FFS solutions to address this gap, e.g., separate DL-PRS configurations for RRC\_INACTIVE UEs, sharing of the UE DRX configuration with the LMF for optimal RRC\_INACTIVE measurements, etc.

**Summary**

From FL perspective, the DRX impact on specification, if any, for DL PRS reception or SRS for positioning transmission by RRC\_INACTIVE UEs, can be directly discussed in RAN2. Feedback from companies is invited.

### Round #1

**Proposal 3.6-1**

* Companies are invited to provide comments on potential specification impact of DRX on DL PRS reception or SRS for positioning transmission by RRC\_INACTIVE UEs

Comments from companies:

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| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Suggest to postpone to future releases. |
| vivo | In inactive state, in order to ensure UE at the power saving state, we recommend to minimize the number of times the UE wakes up, especially from deep sleep mode. Therefore, the impact of PRS measurement on inactive DRX configuration should be minimized. For example, UE is expected to measure PRS once in an inactive DRX cycle. |
| Nokia/NSB | It may be okay to deprioritize this issue. |
| ZTE | Low priority issue can be discussed in next release. |
| CMCC | Low priority |
| Lenovo, Motorola Mobility | Prefer this be handled in this release to ensure optimal DL PRS measurement handling between active and inactive UE DRX cycles. |
|  |  |
|  |  |

## Aspect #7: Configuration of SRS for positioning

Companies supporting SRS for positioning transmission by RRC\_INACTIVE UEs have also discussed potential options for configuration of SRS for positioning. The following views were expressed:

* [vivo, [2]]
  + Transmission of the SRS configuration while retaining the UE in inactive state can be considered.
* [CATT, [4]]
  + Support the following three SRS-Pos configuration methods for UL positioning in RRC\_INACTIVE state:
    - UE keeps the SRS-Pos configuration information obtained in RRC\_CONNECTED state
    - UE obtains the SRS-Pos configuration information through the paging message
    - Introducing a new RACH procedure for UE to obtain the SRS-Pos configuration information
* [Xiaomi, [8]]
  + Consider to pre-configure the PRS for inactive UE when UE in connected mode.
* [Sony, [13]]
  + When the UE is in RRC\_CONNECTED state, the UE receives the configuration of SRS positioning to be used in RRC\_INACTIVE state
  + The configuration of SRS positioning can contain the activation for a UE to transmit periodic SRS positioning when the UE is in RRC\_INACTIVE state
* [Ericsson, [20]]
  + The UE can be configured with SRS in RRC\_INACTIVE by listing in the RRC release message the applicable SRS resource sets / resource IDs currently configured SRS in RRC\_CONNECTED to be kept in RRC\_INACTIVE
  + When the UE SRS has been originally configured in connected mode, the bandwith parameters can be configured to fallback to a predetermined value if the configured bandwidth when the UE moves to RRC\_INACTIVE.
    - The predetermined value could be indicated via capability signalling
    - FFS: additional parameters beside bandwidth

**Summary**

Companies have diverse views on configuration of SRS for positioning by RRC\_INACTIVE UEs. From FL perspective, signaling mechanisms for SRS for positioning transmission can be directly discussed by RAN2. From RAN1 perspective, it may need to be confirmed that RRC IEs for SRS for positioning configuration can be reused.

### Round #1

Based on review of contributions the following is proposed to facilitate further discussion:

**Proposal 3.7-1**

* Configuration parameters introduced for SRS for positioning in Rel.16 are reused for UEs in RRC\_INACTIVE state (i.e., *SRS-PosResource* and *SRS-PosResourceSet* IEs)
  + Details of configuration signaling are up to RAN2

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Support. |
| vivo | OK |
| OPPO | Support |
| CATT | Okay |
| Nokia/NSB | From our side, we are not clear with the current proposal. Can we just say that “RAN1 assumes that SRS for positioning for UEs in RRC\_inactive state is configured using the IE SRS-PosResourceSet” |
| Qualcomm | OK |
| ZTE | We think this belongs to RAN2 design for ASN.1 |
| China Telecom | Support |
| Lenovo, Motorola Mobility | Generally fine with FL’s proposal |
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|  |  |

## Aspect #8: Triggering of SRS for positioning transmission

The following views were expressed for triggering of SRS for positioning transmission by UEs in RRC\_INACTIVE state:

* [Xiaomi, [8]]
  + SRS transmission for Inactive UE can be triggered by gNB through paging.
* [Samsung, [9]]
  + Support Paging DCI or MAC CE in paging MAC PDU to activate/deactivate SRS.
* [Sony, [13]]
  + The UE can be triggered to transmit aperiodic SRS / semi-persistent SRS in RRC\_INACTIVE state by the reception of downlink transmission in RRC\_INACTIVE state (e.g. paging message, RACH procedure, SDT). The details are to be defined by RAN2.

**Summary**

The triggering mechanisms for SRS for positioning transmission by RRC\_INACTIVE UEs (including the need for triggering) can be discussed once it is clear which SRS for positioning types are supported in RRC\_INACTIVE state.

### Round #1

To facilitate further discussion, it is proposed to express views on triggering mechanisms for transmission of SRS for positioning by RRC\_INACTIVE UEs

**Proposal 3.8-1**

* Companies are invited to provide views on triggering mechanisms for SRS for positioning transmissions by RRC\_INACTIVE UEs for proposed types of SRS for positioning

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Although we think it should be OK to support aperiodic SRS transmission during SDT, support of AP-SRS transmission should be lower priority for this release.  SP-SRS is up to RAN2 to decide, but feasible from RAN1 perspective. |
| OPPO | It is preferred to postpone the discussion on detailed triggering mechanism until aperiodic SRS is agreed to be supported |
| CATT | May be discussed after the decision to support aperiodic SRS transmission. |
| QC | SP-SRS and P-SRS can be supported using similar frameworks as discussed in RAN2 already. OK to deprioritize AP-SRS. |
| ZTE | Discuss later |
| CMCC | Whether to support semi-persistent and/or aperiodic SRS pos by inactive UE and if supported, how to (de)activate/trigger, should be up to RAN2. |

## Aspect #9: RACH for NR positioning in RRC\_INACTIVE state

The following views were expressed by selected companies regarding the use of RACH for NR positioning by RRC\_INACTIVE UEs:

* [NTT DOCOMO, [11]]
  + RACH preamble (i.e. TA based positioning) can be considered for NR positioning of UEs in RRC\_INACTIVE state
* [CAICT, [6]]
  + The UL positioning reference signal can be SRS-pos signal or RACH preambles.
* [Xiaomi, [8]]
  + Random access procedure can be reused for UL and DL&UL positioning of Inactive UE.
  + Random access preamble can be reused as UL reference signal for Inactive UE.

**Summary**

This aspect has been discussed at the previous meetings. Last time it was mentioned that if the UL E-CID is enhanced as a part of the TEI-17 work, then use of RACH preamble for gNB measurements can be applicable to UE in RRC\_INACTIVE state without specification impact. From FL perspective, the discussion on this aspect can be skipped at this meeting.

### Round #1

Based on review of contributions, the following is proposed to facilitate further discussion:

**Proposal 3.9-1**

* Companies are invited to provide their views on support of RACH preamble for NR UL positioning and DL+UL positioning measurements

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | This can be done via paging-triggered RRC resumption procedure for UL E-CID with type 2 TA. |
| OPPO | One question for clarification: Is it transparent for UE that RACH signal is used for positioning or is there any spec impact for UE behaviour proposed by the proponent(s)? |
| Qualcomm | Prefer to keep the discussion in the TEI agenda (and only within UE-transparent solutions) |
| ZTE | Not support. The positioning accuracy should be evaluated first. |
| NTT DOCOMO | We are OK to keep the discussion in the TEI agenda.  To OPPO: In our view, using RACH preamble for positioning is transparent to UE and does not impact on the current UE behaviour. |
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|  |  |

## Aspect #10: UE capability for NR positioning in RRC\_INACTIVE state

The following views were expressed on UE capability for NR positioning in RRC\_INACTIVE state

* [ZTE, [1]]
  + Do NOT support an additional UE capability for NR DL positioning in RRC\_INACTIVE
* [Huawei, [12]]
  + There is no need to report UE capability of receiving PRS in RRC\_INACTIVE to LMF, since RRC state is not exposed to LMF.
  + UE capability of receiving PRS in RRC\_INACTIVE should be reported to the gNB.
* [Qualcomm]
  + Proposal 3: Introduce a UE capability for UEs transmitting SRS in RRC inactive state.
  + Proposal 4: DL positioning capability should be defined in inactive state, e.g. including at least
    - DL PRS processing capability in inactive state
  + Observation 1: No UE capability for PRS reception or SRS transmission in RRC inactive, will render the feature practically non-existent, non-deployable and non-testable.

**Summary**

From FL perspective, UE capabilities for NR positioning support by UEs in RRC\_INACTIVE state can be directly discussed in AI 8.17.5 UE features for NR positioning enhancements

### Round #1

Based on review of contributions the following is proposed to facilitate further discussion:

**Proposal 3.10-1**

* Continue discussion on UE capabilities for NR positioning support by UEs in RRC\_INACTIVE state in AI 8.17.5 UE features for NR positioning enhancements

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | OK |
| OPPO | Support |
| CATT | Okay |
| Nokia/NSB | Discussion is okay, but we are not sure if it is really necessary since the LMF does not know the RRC state of the UE. |
| Qualcomm | OK, but it is clear to us that there needs to be multiple capabilities for the feature. |
| ZTE | The same view as Nokia |
| Lenovo, Motorola Mobility | Ok to discuss under UE features. |
|  |  |
|  |  |

## Aspect #11: Other aspects of NR positioning in RRC\_INACTIVE

* [vivo, [2]]
  + The data size optimization of positioning report especially for positioning measurements in inactive state should be considered, e.g. including the following options
    - priority indication for TRPs/PRSs to be measured and reported
    - differential report between multiple reports
  + Support to enable SRS beam sweeping in inactive state
  + Additional indicator in SRS configuration to enable SRS beam sweeping in inactive state is needed
    - SRS repetition during beam sweeping can be considered
* [CATT,[4] ]
  + From RAN1 perspective, the work on NR DL positioning support by RRC\_INACTIVE UEs is completed
* [Lenovo, Motorola Mobility, ]
  + RAN1 to consider the DL-PRS configuration impact on measurement accuracy in RRC\_INACTIVE state. FFS solutions to address this gap, e.g., separate DL-PRS configurations for RRC\_INACTIVE UEs, sharing of the UE DRX configuration with the LMF for optimal RRC\_INACTIVE measurements, etc.
* [LGE, [15]]
  + RAN1 should support a time window (or occasion) of SRS transmission for UE power saving when periodic SRS is supported for UE in RRC\_INACTITVE
  + If UE can transmit SRS without going to deep sleep after Paging Occasion (PO), UE saves its power to go to sleep and wake up again
* [LGE, ]
  + If network initiated positioning measurement is supported for UEs in RRC\_INACTIVE state, RAN 1 needs to firstly discuss which DL channel is used for the transmission of information from LMF to UE
    - Paging PDCCH (esp., message in DCI for paging) can be considered as one of options for indicating whether the positioning related message is delivered.
* [Nokia, [7]]
  + RAN1 to study partial updates of PRS AD for UEs in RRC\_INACTIVE mode to reduce overhead and power consumption
  + For the UE-assisted positioning for RRC\_Inactive state, the UEs report an indicator along with the positioning measurements, where the indicator informs LMF of whether to jointly utilize the currently reported positioning measurements with the previously reported positioning measurements

### Round #1

**Proposal 3.11-1**

* Companies are invited to provide comments on other aspects

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Nokia/NSB | The current discussion is focusing on how to transmit reference signals and perform measurement for RRC\_Inactive UEs. However, UE's reporting in the RRC\_Inactive state needs to be discussed. From our side, we are expecting that the configured resource for reporting might not be enough to report all measurements at a single reporting instance like RRC\_Connected state. |
| Huawei, HiSilicon | To Nokia  RAN2 is discussing LPP segmentation and use of subsequence UL to transmit the remaining segmentation in RRC\_INACITVE. Would that be sufficient? |
| Nokia/NSB | To Huawei,HiSilicon,  Thanks for the comment. Sorry for only mentioning the reporting overhead problem, and we are considering a further detailed problem. In consideration of the mobility, we actually think that the segmentation of reporting messages may or may not be enough functionality in consideration of the mobility.  From the segmentation in LPP, we are expecting the following example behavior: If the UE needs to report positioning measurements for nine TRPs, the UE may report positioning measurements for two or three TRPs at each reporting instance, and the LMF may estimate the location of the UE using a part of positioning measurements and/or all of them. However, even if the UE has been moved between different reporting instances, if the UE keeps reporting the measurements that were originally going to report, it might not be meaningful information to the LMF. Thus, the UE may report new measurements which are not correlated to the previous one even before completing the report whole measurements that were originally going to be sent. However, while the UE reports segment message containing a part of measurements, the LMF may not know if the currently reported measurements can be jointly used with the previously reported measurements to run location estimation algorithm, unless additional information is not provided. For this reason, we are seeing a value in discussing UE's reporting behavior considering the limited reporting overhead at each instance and UE mobility. |
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On-Demand DL PRS Support

## Aspect #1: On-demand DL PRS parameters

The following views were expressed by companies for on-demand DL PRS parameters:

* [ZTE, [1]]
  + On-demand DL-PRS request should include the preferred transmission time window within which DL PRS is transmitted
    - The time window parameters include window length and the number of window occasions
  + The following PRS parameters can also be included in the on-demand PRS request by LMF/UE.
    - Parameters for frequency layer configuration including PRS comb size and CP type
    - A list of preferred TRP ID
    - Parameters for PRS transmit power, PRS resource repetition factor, the number of PRS symbols
* [vivo, [2]]
  + Support UE/LMF-initiated parameters for on-demand PRS based on the summary of Table1 .
    - Table 1: Summary of UE/LMF-initiated On-demand DL PRS parameters

|  |  |  |
| --- | --- | --- |
| **Parameter Name** | **UE initiated request** | **LMF initiated request** |
| ON/OFF indicator of the on-demand PRS | Yes | Yes |
| Start/end time of DL PRS transmission | Yes | Yes |
| DL-PRS Start PRB, Subcarrier Spacing,  DL PRS PointA,  DL PRS RE Offset | No | Yes |
| DL PRS ResourceSetSlotOffset, DL-PRS Resource Slot Offset,  DL-PRS Resource Symbol Offset | No | Yes |
| DL PRS Resource Repetition Factor, DL PRS Resource Time Gap | Repetition factor: Yes  Time gap: No | Yes |
| Number of DL PRS Resource Symbols per DL PRS resource, DL PRS CombSizeN | Yes | Yes |
| DL PRS Muting Option 1/2 | No | Yes |
| Number of TRPs | Yes | No |
| Number of frequency layers | Yes | No |
| Number of DL PRS resources per DL PRS resource set | Yes | No |
| Beam related information (including beam directions, beamwidth, beam granularity, etc.) | Yes | Yes |
| Expected PRS measurement /distribution window | Yes | Yes |

* [OPPO, [3]]
  + RAN1 identifies one list of parameters for both UE-initiated and LMF-initiated on-demand LD PRS.
  + For Rel-17 on-demand PRS, the following additional parameters can be used for the UE/LMF request signaling:
    - The start time and duration (validity window)
    - Repetition factor
    - Number of symbols
    - Comb size
    - Muting pattern
    - TRP information including number of TRPs
    - Positioning Frequency layer (PFL) information
* [CATT, [4]]
  + Include the parameters shown in Table 1 for both UE-initiated and LMF-initiated on-demand DL PRS requests.
    - Table 1: Remaining parameters of on-demand DL PRS request

|  |  |
| --- | --- |
| Parameter Name | Parameter Definition |
| Start/end time of DL PRS transmission | Time interval / time window in slots recommended for DL PRS transmissions within SFN cycle. Note: It may contain one or more DL PRS occasions/periods which perodicity and length are indicated separately |
| Number of DL PRS frequency layers | Recommended number of DL PRS frequency layers |
| DL PRS frequency layer indicator | Recommended DL PRS frequency layers |
| DL-PRS Subcarrier Spacing | Subcarrier spacing of the DL-PRS Resource |
| DL-PRS Start PRB | Start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer |
| DL-PRS CombSizeN | Resource element spacing in each symbol of the DL-PRS Resource |
| DL PRS ResourceSetSlotOffset | The slot offset with respect to SFN #0 slot #0 |
| DL PRS Resource Repetition Factor | Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set |
| DL PRS Resource Time Gap | Recommended offset in units of slots between two repeated instances of a DL-PRS Resource corresponding to the same DL-PRS Resource ID within a single instance of the DL-PRS Resource Set |
| Number of DL PRS Resource Symbols per DL PRS resource | Recommended number of symbols per DL-PRS Resource within a slot |
| Number of DL PRS resources per DL PRS resource set | Recommended number of DL PRS resources per DL PRS resource set [per frequency layer] |

* [CMCC, [5]]
  + For potential signaling of one or more parameters for UE-initiated on-demand DL PRS request, at least the following should be supported:
    - Start/end time of DL PRS transmission
    - DL-PRS resource set IDs
    - DL PRS resource IDs
    - DL PRS resource repetition factor
    - Number of PRS resources per PRS resource set
    - Number frequency layers or frequency layer indicator
    - Beam directions
    - ON/OFF indicator of the DL PRS
  + For potential signaling of one or more parameters for LMF-initiated on-demand DL PRS request, at least the following should be supported:
    - Start/end time of DL PRS transmission
    - DL-PRS resource set IDs
    - DL PRS resource IDs
    - DL PRS resource repetition factor
    - Number of PRS resources per PRS resource set
    - DL PRS muting patterns
    - Number frequency layers or frequency layer indicator
    - Beam directions
    - ON/OFF indicator of the DL PRS
  + NR positioning should support the ON/OFF request/activates/trigger of one or more pre-configured on-demand DL PRS configurations via lower layer signalling.
* [CAICT, [6]]
  + DL PRS parameters and values for pre-configured on-demand DL PRS configurations can be recommended by UE/LMF.
  + Lists of parameters for UE / LMF initiated on-demand DL PRS request can be PRS frequency bands, PRS time-frequency resources, participating positioning base station information and beam direction information configurations.
* [Intel, [10]]
  + In addition to the DL PRS Periodicity, DL PRS Resource Bandwidth, and DL PRS QCL-Info, at least the following parameters are supported for UE-initiated and LMF-initiated on-demand DL PRS requests:
    - Start/end time of DL PRS transmission
      * Time interval in slots recommended for DL PRS transmission within the SFN cycle
    - DL-PRS CombSizeN
      * Resource element spacing in each symbol of the DL-PRS Resource
    - DL PRS Resource Repetition Factor
      * Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set
    - DL PRS Resource Time Gap
      * Recommended offset in units of slots between two repeated instances of a DL-PRS Resource corresponding to the same DL-PRS Resource ID within a single instance of the DL-PRS Resource Set
    - Number of DL PRS Resource Symbols per DL PRS Resource
      * Recommended number of symbols per DL-PRS Resource within a slot
* [Nokia, [7]]
  + The on-demand PRS parameter for DL PRS QCL information implies both of the followings.
    - The UE may send a DL RS resource ID, a QCL source, to the LMF to inform its preferrable beam direction so that the PRS can be sent with the direction
    - Reconfiguration request of DL PRS QCL information in order to be configured with a more appropriate RS resource for QCL type-D
    - Proposal 7: Requested PRS parameters include a list of preferable TRPs, beam directions, PRS resource ID, PRS resource set ID, repetition factor for both UE-initiated and LMF-initiated.
  + Support of indication of expected AoD/ZoD value and uncertainty (of the expected AoD/ZoD value) range(s) is signaled by the LMF to gNBs/TRPs at least for LMF-initiated on-demand PRS.
* [Huawei, [12]]
  + The followings are supported for UE-initiated on-demand PRS.
    - DL-PRS resource set ID
      * For each TRP that has more than one PRS resource sets (on a positioning frequency layer), UE may indicate a specific DL-PRS resource set ID to be only included the updated assistance data
    - Priority order of TRPs and PRS resource sets
      * For each positioning frequency layer, UE may suggest a new TRP sequence in the updated assistance data
      * For each TRP that has more than one PRS resource sets, UE may suggest a new DL-PRS resource set sequence in the updated assistance data
    - SCell information
      * UE reports the SCell information, similar to the PCell information with or without reception of any initial assistance data
    - Parameters that are optional without a default value, including Rel-17 new parameters
      * This means that UE would request the parameter to be provided if not in the initial assistance data or without any initial assistance data, instead of being a specific value
  + At least the ON/OFF indicator is supported for LMF-initiated on-demand PRS.
    - The granularity can be TRP level, PRS resource set level, or PRS resource level
* [Sony, [13]]
  + For both UE- and LMF- initiated on-demand DL PRS request, the assistance information with at least the following parameters is supported:
    - Beam direction(s) that can be in a form of PRS resource ID(s)
    - List of TRP(s)
    - Timing information for on-demand PRS
    - Selected frequency layer(s) and PRS resource-set(s)
* [Fraunhofer, ]
  + Support in the parameters lists for on-demand DL-PRS the following:
    - Number of DL PRS resource symbols per DL PRS resource, and
    - Beam directions
* [InterDigital, [16]]
  + In addition to the on-demand PRS parameters agreed in RAN1#106e, Support both number of DL PRS resource symbols per DL PRS resource and start/end time of DL PRS transmission for UE-initiated and LMF-initiated on-demand PRS requests
  + For UE-initiated on-demand DL-PRS, pre-configured sets of PRS parameters consist of at least a combination of values for bandwidth and periodicities for PRS, excluding DL PRS QCL information.
* [Qualcomm, [17]]
  + Include at least the following on-demand DL PRS parameters:
    - Start/end time of DL PRS transmission
    - PRS resource and PRS resource set slot offsets
    - DL PRS resource repetition factor
    - Number of DL PRS Resource Symbols per DL PRS resource
    - Number of DL PRS resources per DL PRS resource set
    - Number of TRPs
    - Beam Directions
* [Mediatek, [18]]
  + The PRS resource(s) in each resource set could be selected for transmission and measurement. Support PRS resource indexes, and resource set indexes as the parameters of on-demand PRS
  + Support symbol number as the parameter of on-demand PRS
* [Lenovo, [19]]
  + Support the indicated UE-initiated and LMF-initiated parameters as shown in Table 1.
  + Support TRP Priority order indication as part of UE-initiated On-demand PRS.
  + Support ON/OFF indicator of the DL PRS per TRP and associated TRP indication/Group TRP indication for signalling which TRPs to switch on/off.
* [Ericsson, [20]]
  + DL PRS QCL information is removed from the list of on-demand PRS parameters.
  + The PRS request message to gNB should include:
    - The list of PRS resources set that can be configured by the TRPs hosted in the NG-RAN node.
    - The resource ID for each resource set
    - For each PRS resource ID:
      * The number of UEs that have detected RSRP values with good quality
      * Their average RSRP/RSRQ

**Summary**

RAN1 has received response LS from RAN2 (please refer to R1-2108711):

|  |
| --- |
| RAN2 does not expect RAN1 to send the list of parameters for on-demand DL PRS request associated with pre-configured set of on-demand DL PRS since how to handle DL PRS pre-configuration will be discussed in RAN2.  RAN2 respectfully request RAN1 to provide the list of parameters that can be dynamically adjusted for UE-initiated/LMF-initiated on-demand DL PRS request, taking the above into account. |

Based on reply LS from RAN2, the RAN1 is not expected to discuss parameters associated with pre-configured set of on-demand DL PRS configurations, which will be directly handled by RAN2.

The on-demand DL PRS parameters were discussed at RAN1 #106. The list of parameters with majority support (except agreed ones) is proposed for further discussion.

### Round #1

The following is proposed to facilitate further discussion for on-demand DL PRS parameters:

**Proposal 4.1-1**

* The following on-demand DL PRS parameters are supported for UE and LMF-initiated on-demand DL PRS requests

1. Start/end time of DL PRS transmission
2. DL PRS resource repetition factor
3. Number of DL PRS resource symbols per DL PRS resource
4. Beam directions
5. DL-PRS CombSizeN
6. DL PRS resource time gap
7. Number of DL PRS resources per DL PRS resource set
8. Number of DL PRS frequency layers
9. DL-PRS start PRB
10. Number of TRPs
11. FFS other parameters

* FFS if on-demand DL PRS parameter values are requested per frequency layer, per TRP, resource set, etc

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Although we do not think most of the parameters are useful, but thanks to the discussion from Qualcomm R1-2110192 to address our concerns, we can accept the following updated list if ON/OFF indicator for LMF initiated case is included.   1. Start/end time of DL PRS transmission 2. DL PRS resource repetition factor 3. Number of DL PRS resource symbols per DL PRS resource 4. DL-PRS CombSizeN 5. Number of DL PRS resources per DL PRS resource set 6. Number of DL PRS frequency layers 7. DL-PRS start PRB 8. Number of TRPs 9. ON/OFF indicator (for LMF-initiated) 10. FFS other parameters   For beam direction, we are OK if this is requesting to provide DL-AoD beam information instead of requesting a specific beam direction value.  For DL PRS resource gap, it is not clear why UE/LMF would recommend a reasonable value, and we suggest to let gNB figure out how the gap is determined according to the repetition configuration.  Also some clarification question from our side:  Q1: Should the request based on some configuration in advance to provide the allowed value or based on LCS request?  Q2: Should the parameter “value” be PFL specific, TRP specific, or resource set/resource specific?  Q3: What is the UE behaviour if UE receives the configuration differently from what it has previously “demanded”. |
| vivo | Generally, we can support these parameters.  However, we wonder whether these parameters are both supported for UE and LMF initiated on demand request. For example, for ‘Number of TRPs’, it is more suitable for UE initiated request rather than LMF initiated request, since the request from LMF to gNB may be specific parameters for configuration instead of a rough number limitation.  In addition, for the beam direction, we think it can be expected beam direction except signal ID in the QCL information. For example, UE is expect the narrow beams between PRS resource 1 and PRS resoure 2, so that UE/LMF is expected to configure the PRS within the expected direction . |
| Intel | At least support the following parameters:   1. Start/end time of DL PRS transmission 2. DL PRS resource repetition factor 3. Number of DL PRS resource symbols per DL PRS resource 4. DL-PRS CombSizeN 5. DL PRS resource time gap |
| OPPO | * Beam directions: We have agreed the parameter of QCL. It is better to clarify what other information the beam directions refer to? * Number of DL PRS resources per DL PRS resource set: Not sure what the intention of this parameter is. * If the intention is to suggest more or less beams for transmission, it seems not work since how many beams can be used depends on the TRP capability * If the intention is to suggest more repetition of the same beam(s), it can be achieved by the parameters of Periodicity (which was agreed) and/or repetition factor * DL PRS resource time gap: we don’t think this parameter is useful * DL-PRS start PRB: It seems not impacting the accuracy or latency. |
| CATT | We are fine with most of the proposed parameters, except following:  “3. Beam directions”: Similar with OPPO, it is unclear to us what the parameter refer to.  “10. Number of TRPs”: the intentio of the parameter is unclear to us. For example, for LMF-initiated on-demand DL PRS requests, we assume the LMF will make request of the information for each TRP. It is unclear why LMF to request a TRP with the number of TRPs. |
| Nokia/NSB | From our side, in the current list, at least the following parameter should be included:   1. DL PRS resource repetition factor 2. Beam directions   In addition to the list, we suggest adding “MG-less possible PRS.”  To reduce the latency, the target on-demand PRS transmission needs to consider the UE's preference on MG-less mode or MG-based mode. If the UE needs to keep receiving the data but the LMF requests the positioning, the target PRS transmission needs to be received in MG-less mode. For this purpose, we needs to support that UE requests on-demand PRS and indicates if the PRS can be received in MG-less mode.  Regarding FFS point, we need separate discussions for each parameter to determine resource-specific, TRP-specific, or PFL-specific after making a list of parameters since each parameter is a different level of the request. For example, even if we are not supportive of the start/end time, but if it is agreed, it should not be the resource level. |
| Qualcomm | To OPPO/CATT:   * Beam directions: AoD in GCS requested by the UE. * QCL Information: A reference signal ID to be used as QCL source for PRS.   The above are 2 different things.   * In QCL-information request, the assumption is that the UE has measured some SSB already, or some other PRS, and asks the LMF to transmit PRS in a QCLed fashion with those reference signals. * In Beam information request, a UE has a first estimate of where it is (e.g. based any other location method), and since it receives the locations of the TRPs, it makes a suggestion of what should be the DL-AoD of the TRP beams. It is not the same as QCL, since QCL is just a Reference Signal ID. If the UE doesn’t have any previous PRS configured, how would the UE be able to ask the network for specific directions? Or, if the UE doesn’t know the beam direction of the other reference signals (e.g. SSBs, DL PRS), it will have to first measure these, determine whether they are good signals to be used for positioning and ask additional PRS using the same beams. However, the UE would not be able to request of different/alternative beams than those that are already configured/measured. Having a generic beam direction request (i.e., DL-AoD in azimuth and zenith) would be a separate solution than the “QCL Information on demand request”. |
| ZTE | We are general fine with the proposal except for the following parameters   * Beam directions, which is redundant as we have QCL already * DL PRS resource time gap, we don’t know how it is helpful * DL-PRS start PRB, it does not impact positioning accuracy.   Furthermore, we think the current hierarchical structure of PRS assistance data IE can be reused for the new LPP assistance data IE which contains a set of possible on-demand DL-PRS configurations. Hence, only limited specification effort is needed |
| OPPO2 | Reply to QC: Thanks for the explanation.   * Just to confirm my understanding. I noticed your comment “since it receives the locations of the TRPs”. Thus, is this parameter only intended for UE-based positioning method? * If UE know the DL-AoD, it can get its location information. Why does it need to request on-demand PRS? Please correct me if I missed something. |
| CMCC | To us, the necessity of supporting the following parameters needs to be further clarified:  6. DL PRS resource time gap  9. DL-PRS start PRB  10. Number of TRP  Regarding the “3. Beam direction”, thanks QC for further clarification. To us, the cases elaborated by QC seems marginal, and we believe that for most cases, having QCL is enough. But we have strong objections on supporting the beam direction.  On top of the above parameters, we should also have “ON/OFF indicator of the DL PRS”. |
| Lenovo, Motorola Mobility | Generally supportive of the FL’s initial proposed parameters. FFS can address the 2nd order details. |

## Aspect #2: On-demand DL PRS & UE/gNB measurements

One company expressed the view that UE/gNB measurements are beneficial for on-demand DL PRS framework:

* [CATT, [4]]:
  + For UE-initiated on-demand DL PRS, the UE may provide the following information to the gNB and/or LMF when the UE sends an on-demand PRS request to the LMF:
    - DL measurements available in UE, which may include SS-RSRP, CSI-RSRP, etc., measured from the serving gNB and neighboring gNBs.
  + For LMF-initiated on-demand DL PRS, the LMF may request UE to provide the following information to the LMF before LMF sends an on-demand PRS request to the gNBs:
    - DL measurements available in UE, which may include SS-RSRP, CSI-RSRP, etc., measured from the serving gNB and neighboring gNBs.
  + When a serving gNB sends the response to LMF-initiated on-demand DL PRS for a UE, the serving gNB may provide the following information to the LMF in addition to the allocated DL PRS resources for supporting the on-demand DL PRS:
    - DL measurements reported by the UE if available at the serving gNB, which may include SS-RSRP, CSI-RSRP, etc., measured from the DL RS of serving gNB and neighboring gNBs;
    - UL measurements related to the UE if available at the gNB, which may include SRS-RSRP, etc., measured by the serving gNB.

### Round #1

Considering lack of feedback/discussion on this aspect, comments from companies are invited:

**Proposal 4.2-1**

* Companies are invited to provided comments on reporting of UE/gNB measurements to support on-demand DL PRS framework

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Not needed. |
| vivo | We are okay with reporting some initial measurement results to help the on-demand PRS configuration |
|  |  |
| OPPO | The benefits are not clear why the reporting contents should be different for on-demand PRS and normal PRS. |
| Qualcomm | Not needed |
| ZTE | Not needed |

## Aspect #3: Request for on-demand DL PRS support

The following views were expressed for request of on-demand DL PRS transmission

* [CAICT, [6]]
  + For supporting on-demand PRS, requesting mechanism can be considered to use uplink RACH channel as a candidate
* [Xiaomi, [8]]
  + UE initiated on-demand PRS transmission can be indicated by PRACH or PUCCH

### Round #1

Based on review of contributions the following is proposed to facilitate further discussion:

**Proposal 4.3-1**

* Companies are invited to provide comments on request for on-demand DL PRS.

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Not needed. |
| OPPO | The benefits are not clear |
| ZTE | Can discuss in next release |
|  |  |
|  |  |
|  |  |

## Aspect #4: On-demand DL PRS and measurement gap

The following views were expressed on measurement gap for on-demand DL PRS measurements

* [Mediatek, [18]]
  + Support on-demand PRS measurement with gaps and outside the gaps
  + RAN1 may identify the transmission duration and inspect whether there is suitable MG to match with. Longer MG duration than the transmission duration may reduce the system efficiency. If there is no suitable MG duration, RAN1 may notify RAN4 for further support
* [vivo, [2]]
  + Support to introduce on-demand measurement gap for on-demand PRS in Rel-17
  + LMF requests on-demand measurement gap should be supported
  + The on-demand measurement gap can be requested and configured along with the on-demand DL PRS
  + The on-demand measurement gap can be requested along with the request of on-demand DL PRS
  + The on-demand measurement gap can be configured after gNB receives the request of on-demand DL PRS
* [Nokia, [7]]
  + Rel-17 NR positioning supports that a UE separately requests a DL PRS resource to be received in an MG-less mode and a DL PRS resource to be received in an MG-based mode.

### Round #1

Based on review of contributions the following is proposed to facilitate further discussion:

**Proposal 4.4-1**

* Companies are invited to provide comments on support of on-demand DL PRS measurement gap and LMF request of measurement gaps

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | Out of scope. |
| OPPO | No dedicated enhancement is needed and we can reuse the existing mechanism or any new introduced mechanism of Rel-17. |
| ZTE | We are OK to discuss this issue, e.g. LMF or UE can recommend a preferred measurement gap for on-demand PRS which would be helpful or gNB to decide a good gap for PRS measurement. |
|  |  |
|  |  |
|  |  |

## Aspect #5: Other aspects for on-demand DL PRS support

The following list of additional aspects was discussed by

* [vivo, [2]]
  + The priority of on-demand DL PRS and normal PRS should be considered
  + Support the request of explicit parameters at least for UE-initiated on-demand DL-PRS
  + Interference caused by on-demand PRS to regular UEs should be considered and solved by RAN1
  + To solve the interference caused by on-demand PRS to regular UEs, support switching off certain PRS resources for regular UEs
  + PRS resource level muting can be considered
    - Note: It is not to completely switch off the PRS resources, but to allow the transmission of these PRS resources based on regular PRS configuration
  + To solve the interference caused by on-demand PRS to regular UEs, support indicating on-demand PRS configuration to regular UEs and corresponding serving gNB
* [CAICT, [6]]
  + For UL positioning in RRC\_IDLE state, a new paging message or a new random access process need to be specified.
  + For on demand PRS, the potential signaling can be system information broadcasting or RRC signaling.
* [Xiaomi, [8]]
  + gNB initiated of on-demand PRS transmission can be supported by RRC, MAC CE and DCI.
  + Suggest to determine the validity of pre-configured PRS by RSRP or time of arrival.
  + After determining no valid of the pre-configured PRS, UE can request the new configured PRS by LPP in RRC\_INACTIVE state or by transferring to RRC\_CONNETTED state.
* [Sony, [13]]
  + Support LMF to assist gNBs to facilitate the two-stage beam sweeping operation. It can be performed such as LMF configures sweeping beam directly by on-demand PRS, or LMF sent assistance information to gNB (e.g., the expected AoD range, beam width).
  + Support two-stage beam sweeping for DL-AOD and DL-TDOA positioning
* [Fraunhofer, [14]]
  + Support the LMF and UE to request an update of one or more parmeters to the list of preconfigured PRS resources.
  + Support the device to activate or deactivate measurements on DL-PRS resources in the second stage depending on the received associated DL PRS resources in the first stage.
* [Lenovo, [19]]
  + Association between resources belonging to two DL PRS resource sets of the same TRP can be enabled by a grouping ID and can be signalled in the assistance data.
  + Two-stage PRS beam sweeping can be enabled by the on-demand PRS mechanism.

### Round #1

Based on review of contributions the following is proposed to facilitate further discussion:

**Proposal 4.5-1**

* Companies are invited to express views on any other aspects for on-demand DL PRS support

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | UE capability for the on demand feature is needed |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

Other Aspects

One company proposed to continue discussion on DL PRS optimizations.

* [LGE, [15]]
  + NR should consider cyclic shift based SFN transmission of PRS.
    - Study on benefit of the simultaneous transmission of a common PRS sequence with different intentional cyclic time-domain delays.
  + Support 1-symbol PRS resource for Rel-17 NR positioning.

Conclusion

In this contribution, we provided review of the submitted contributions for RRC\_INACTIVE UEs, on-demand DL PRS and prepared set of proposals to facilitate further discussion/decision by RAN WG1 during the RAN1#106bis-e meeting.

References

1. R1-2108883 Discussion on items led by RAN2 for NR positioning ZTE
2. R1-2108980 Discussion on inactive state positioning and on-demand PRS vivo
3. R1-2109056 Discussion on positioning for UE in RRC\_INACTIVE and on-demand PRS OPPO
4. R1-2109229 Further discussion on on-demand DL PRS and positioning for UEs in RRC\_ INACTIVE state CATT
5. R1-2109286 Discussion on RAN2-led items for positioning CMCC
6. R1-2109347 Discussion on enhancements of  INACTIVE mode positioning and on-demand PRS CAICT
7. R1-2109368 Additional views on Inactive Mode Positioning and on-demand PRS Nokia, Nokia Shanghai Bell
8. R1-2109416 On-demand PRS and positioning for UE in RRC\_INACTIVE state Xiaomi
9. R1-2109495 Discussion on on demand positioning and positioning in inactive state Samsung
10. R1-2109616 Support of On-demand DL PRS and NR Positioning in RRC\_INACTIVE State Intel Corporation
11. R1-2109684 Discussion on positioning for UEs in RRC\_INACTIVE state NTT DOCOMO, INC.
12. R1-2109744 Discussion on INACTIVE state positioning and on-demand PRS Huawei, HiSilicon
13. R1-2109795 Considerations on on-demand PRS and positioning in RRC Inactive Mode Sony
14. R1-2109867 Considerations for on-Demand PRS and positioning in RRC\_INACTIVE state Fraunhofer IIS, Fraunhofer HHI
15. R1-2110093 Discussion on other enhancements for positioning LG Electronics
16. R1-2110151 On-demand PRS and positioning during INACTIVE mode InterDigital, Inc.
17. R1-2110192 Remaining issues on enhancements Related to On Demand PRS And Positioning in RRC Inactive State Qualcomm Incorporated
18. R1-2110261 Potential physical layer impact to the RAN2-led topics MediaTek Inc.
19. R1-2110302 Discussion on On-Demand PRS and RRC\_INACTIVE Positioning Lenovo, Motorola Mobility
20. R1-2110354 Further details for on-demand PRS reception and SRS in RRC\_INACTIVE Ericsson

Tdocs

## \_ZTE

* Observation 1: Validity criteria of DL PRS configuration is under discussion in RAN2 post-meeting email, no RAN1 discussion is needed.
* Proposal 1: From RAN1 perspective, support all of periodic, semi-persistent and aperiodic SRS transmission in RRC\_INACTIVE state
  + How to inform positioning SRS configuration should be up to RAN2
* Proposal 2: Collision issue between DL-PRS and other signals/channels in SDT active period should be solved
  + Serving gNB can indicate to prioritize or deprioritize DL-PRS over other signals/channels in SDL BWP
* Proposal 3: Do NOT support an additional UE capability for NR DL positioning in RRC\_INACTIVE
* Proposal 4: On-demand DL-PRS request should include the preferred transmission time window within which DL PRS is transmitted
  + The time window parameters include window length and the number of window occasions
* Proposal 5: The following PRS parameters can also be included in the on-demand PRS request by LMF/UE.
  + Parameters for frequency layer configuration including PRS comb size and CP type
  + A list of preferred TRP ID
  + Parameters for PRS transmit power, PRS resource repetition factor, the number of PRS symbols

## \_vivo

In this contribution, we discuss issues for inactive positioning and on-demand PRS with the following proposals.

* P1
  + Support to reuse QCL configuration in connected state for PRS reception for inactive UEs.
* P2
  + In inactive state, the relationship between PRS measurement and initial DL BWP should be considered, that is, UE is not expected to process PRS outside the initial DL BWP and/or PRS whose SCS is different with the initial DL BWP
* P3
  + In inactive state, when PRS and other DL signals (e.g. SSB, SIB1, COREST0, MSG2/MSGB, paging, etc.) collide, UE is not expected to process PRS.
* P4
  + In inactive state, the impact of PRS measurement on inactive DRX configuration should be minimized.
    - E.g. UE is expected to measure PRS once in an inactive DRX cycle.
* P5
  + The data size optimization of positioning report especially for positioning measurements in inactive state should be considered, e.g. including the following options
    - priority indication for TRPs/PRSs to be measured and reported
    - differential report between multiple reports
* P6
  + At least support periodic SRS for positioning in inactive state from RAN1’s perspective
  + It is up to RAN2 to determine whether to support semi-persistent/aperiodic SRS for positioning in inactive state based on certain scenarios or procedures.
* P7
  + The validity criteria for SRS configuration in inactive state should be considered, at least following validity criteria can be considered:
    - UE is in the valid predefined area, e.g. the cell where RRC release containing SRS configuration is received
    - UE has valid TA
    - UE has valid spatial relation RS
    - UE has valid power control RS
* P8
  + Support to enable SRS beam sweeping in inactive state.
  + Additional indicator in SRS configuration to enable SRS beam sweeping in inactive state is needed.
    - SRS repetition during beam sweeping can be considered.
* P9
  + If spatial relation RS is configured for SRS transmission in inactive state, the following validity criteria for spatial relation RS validation can be considered.
  + Reuse criteria of RSRP based TA validation.
  + Reuse criteria of accurately pathloss RS measurement: if the UE determines that the UE is not able to accurately measure the pre-configured spatial relation RS, the spatial relation RS will not be valid.
* P10
  + For SRS power control in inactive state, support to reuse open loop power control mechanism in connected state in Rel-16 positioning, including:
  + Configure power control related parameters towards multiple cells via RRC release.
  + Reuse validity criteria of accurately measurement and related fallback behavior for pathloss RS measurement in connected state
  + If the UE determines that the UE is not able to accurately measure the pre-configured pathloss RS, the UE calculates pathloss using a RS resource obtained from the SS/PBCH block of the cell that the UE uses to obtain MIB, e.g. MIB of the camping cell.
* P11
  + The fallback behavior should be considered when the validity criteria for SRS configuration in inactive state is not met, including:
  + Entering connected state to perform UL positioning or request/update the SRS configuration; or remaining in inactive state to perform UL positioning and request/update SRS configuration
  + Both UE and gNBs release previous SRS configuration applied in inactive state
* P12
  + Transmission of the SRS configuration while retaining the UE in inactive state can be considered.
* P13
  + Support UE/LMF-initiated parameters for on-demand PRS based on the summary of Table1 .
* Table 2: Summary of UE/LMF-initiated On-demand DL PRS parameters

|  |  |  |
| --- | --- | --- |
| **Parameter Name** | **UE initiated request** | **LMF initiated request** |
| ON/OFF indicator of the on-demand PRS | Yes | Yes |
| Start/end time of DL PRS transmission | Yes | Yes |
| DL-PRS Start PRB, Subcarrier Spacing,  DL PRS PointA,  DL PRS RE Offset | No | Yes |
| DL PRS ResourceSetSlotOffset, DL-PRS Resource Slot Offset,  DL-PRS Resource Symbol Offset | No | Yes |
| DL PRS Resource Repetition Factor, DL PRS Resource Time Gap | Repetition factor: Yes  Time gap: No | Yes |
| Number of DL PRS Resource Symbols per DL PRS resource, DL PRS CombSizeN | Yes | Yes |
| DL PRS Muting Option 1/2 | No | Yes |
| Number of TRPs | Yes | No |
| Number of frequency layers | Yes | No |
| Number of DL PRS resources per DL PRS resource set | Yes | No |
| Beam related information (including beam directions, beamwidth, beam granularity, etc.) | Yes | Yes |
| Expected PRS measurement /distribution window | Yes | Yes |

* P14
  + Support the request of explicit parameters at least for UE-initiated on-demand DL-PRS
* P15
  + Interference caused by on-demand PRS to regular UEs should be considered and solved by RAN1
* P16
  + To solve the interference caused by on-demand PRS to regular UEs, support switching off certain PRS resources for regular UEs
  + PRS resource level muting can be considered
    - Note: It is not to completely switch off the PRS resources, but to allow the transmission of these PRS resources based on regular PRS configuration
* P17
  + To solve the interference caused by on-demand PRS to regular UEs, support indicating on-demand PRS configuration to regular UEs and corresponding serving gNB
* P18
  + Support to introduce on-demand measurement gap for on-demand PRS in Rel-17
  + LMF requests on-demand measurement gap should be supported
* P19
  + The on-demand measurement gap can be requested and configured along with the on-demand DL PRS
  + The on-demand measurement gap can be requested along with the request of on-demand DL PRS
  + The on-demand measurement gap can be configured after gNB receives the request of on-demand DL PRS
* P20
  + The priority of on-demand DL PRS and normal PRS should be considered

## \_OPPO

* Proposal 1: For transmission of SRS for positioning by UEs in RRC \_INACTIVE state for UL and DL+UL positioning, aperiodic SRS for positioning is not supported in Rel-17.
* Proposal 2: For transmission of SRS for positioning by UEs in RRC \_INACTIVE state for UL and DL+UL positioning, it is up to RAN2 to determine what types supported in Rel-17 in case it is difficult for RAN1 to achieve consensus on this topic.
* Proposal 3: Regarding the validation criteria, consider the following factors:
  + Timing advance
  + Path loss measurement
* Proposal 4: RAN1 identifies one list of parameters for both UE-initiated and LMF-initiated on-demand LD PRS.
* Proposal 5: For Rel-17 on-demand PRS, the following additional parameters can be used for the UE/LMF request signaling:
  + The start time and duration (validity window)
  + Repetition factor
  + Number of symbols
  + Comb size
  + Muting pattern
  + TRP information including number of TRPs
  + Positioning Frequency layer (PFL) information

## \_CATT

* Proposal 1: Include the parameters shown in Table 1 for both UE-initiated and LMF-initiated on-demand DL PRS requests.

**Table 1: Remaining parameters of on-demand DL PRS request**

|  |  |
| --- | --- |
| Parameter Name | Parameter Definition |
| Start/end time of DL PRS transmission | Time interval / time window in slots recommended for DL PRS transmissions within SFN cycle. Note: It may contain one or more DL PRS occasions/periods which perodicity and length are indicated separately |
| Number of DL PRS frequency layers | Recommended number of DL PRS frequency layers |
| DL PRS frequency layer indicator | Recommended DL PRS frequency layers |
| DL-PRS Subcarrier Spacing | Subcarrier spacing of the DL-PRS Resource |
| DL-PRS Start PRB | Start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer |
| DL-PRS CombSizeN | Resource element spacing in each symbol of the DL-PRS Resource |
| DL PRS ResourceSetSlotOffset | The slot offset with respect to SFN #0 slot #0 |
| DL PRS Resource Repetition Factor | Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set |
| DL PRS Resource Time Gap | Recommended offset in units of slots between two repeated instances of a DL-PRS Resource corresponding to the same DL-PRS Resource ID within a single instance of the DL-PRS Resource Set |
| Number of DL PRS Resource Symbols per DL PRS resource | Recommended number of symbols per DL-PRS Resource within a slot |
| Number of DL PRS resources per DL PRS resource set | Recommended number of DL PRS resources per DL PRS resource set [per frequency layer] |

* Proposal 2: For UE-initiated on-demand DL PRS, the UE may provide the following information to the gNB and/or LMF when the UE sends an on-demand PRS request to the LMF:
  + DL measurements available in UE, which may include SS-RSRP, CSI-RSRP, etc., measured from the serving gNB and neighboring gNBs.
* Proposal 3: For LMF-initiated on-demand DL PRS, the LMF may request UE to provide the following information to the LMF before LMF sends an on-demand PRS request to the gNBs:
  + DL measurements available in UE, which may include SS-RSRP, CSI-RSRP, etc., measured from the serving gNB and neighboring gNBs.
* Proposal 4: When a serving gNB sends the response to LMF-initiated on-demand DL PRS for a UE, the serving gNB may provide the following information to the LMF in addition to the allocated DL PRS resources for supporting the on-demand DL PRS:
  + DL measurements reported by the UE if available at the serving gNB, which may include SS-RSRP, CSI-RSRP, etc., measured from the DL RS of serving gNB and neighboring gNBs;
  + UL measurements related to the UE if available at the gNB, which may include SRS-RSRP, etc., measured by the serving gNB.
* Proposal 5: From RAN1 perspective, the work on NR DL positioning support by RRC\_INACTIVE UEs is completed
* Proposal 6: Both periodic SRS and semi-persistent SRS should be supported for RRC\_INACTIVE UEs
* Proposal 7: Support the following three SRS-Pos configuration methods for UL positioning in RRC\_INACTIVE state:
  + UE keeps the SRS-Pos configuration information obtained in RRC\_CONNECTED state.
  + UE obtains the SRS-Pos configuration information through the paging message.
  + Introducing a new RACH procedure for UE to obtain the SRS-Pos configuration information.

## \_CMCC

In this contribution, we discuss the RAN2-led enhancements for positioning, and the following observations and proposals are provided:

* Proposal 1: Periodic SRS for positioning is supported for transmission by UEs in RRC\_inactive state.
* Proposal 2: For transmission of UL SRS for positioning by UEs in RRC\_inactive state, support to reuse the validation criteria of SDT.
* Proposal 3: Support defining a validation rule including a validation area.
* Proposal 4: For potential signaling of one or more parameters for UE-initiated on-demand DL PRS request, at least the following should be supported:
  + Start/end time of DL PRS transmission
  + DL-PRS resource set IDs
  + DL PRS resource IDs
  + DL PRS resource repetition factor
  + Number of PRS resources per PRS resource set
  + Number frequency layers or frequency layer indicator
  + Beam directions
  + ON/OFF indicator of the DL PRS
* Proposal 5: For potential signaling of one or more parameters for LMF-initiated on-demand DL PRS request, at least the following should be supported:
  + Start/end time of DL PRS transmission
  + DL-PRS resource set IDs
  + DL PRS resource IDs
  + DL PRS resource repetition factor
  + Number of PRS resources per PRS resource set
  + DL PRS muting patterns
  + Number frequency layers or frequency layer indicator
  + Beam directions
  + ON/OFF indicator of the DL PRS
* Proposal 6: NR positioning should support the ON/OFF request/activates/trigger of one or more pre-configured on-demand DL PRS configurations via lower layer signalling.

## \_CAICT

In this contribution, we give following proposals of enhancements for on-demand PRS and INACTIVE mode positioning:

* Proposal 1: For UL positioning in RRC\_IDLE state, a new paging message or a new random access process need to be specified.
* Proposal 2: The UL positioning reference signal can be SRS-pos signal or RACH preambles.
* Proposal 3: DL PRS parameters and values for pre-configured on-demand DL PRS configurations can be recommended by UE/LMF.
* Proposal 4: Lists of parameters for UE / LMF initiated on-demand DL PRS request can be PRS frequency bands, PRS time-frequency resources, participating positioning base station information and beam direction information configurations.
* Proposal 5: For supporting on-demand PRS, requesting mechanism can be considered to use uplink RACH channel as a candidate.
* Proposal 6: For on demand PRS, the potential signaling can be system information broadcasting or RRC signaling.

## \_Nokia

**Observation 1**: UEs in RRC\_INACTIVE state relying on assistance data obtained while in RRC\_CONNECTED state without updates to the assistance data and/or mobility conditions can result in the aging of assistance data provided to UEs.

**Observation 2:** Current mechanisms to update AD for positioning are mainly designed for static scenarios and RRC\_CONNECTED UEs in mind, thus can fail in scenarios involving RRC\_INACTIVE UEs and dynamic condition changes due to on-demand PRS and mobility.

**Proposal 1:** RAN1 to study partial updates of PRS AD for UEs in RRC\_INACTIVE mode to reduce overhead and power consumption.

**Proposal 2:** RAN1 to discuss, for RRC\_Inactive UEs, validity criterion for the parameters for SRS resources which were configured in RRC\_Connected state.

**Proposal 3:** RAN1 to support only periodic SRS for positioning for UEs in RRC\_Inactive state.

**Proposal 4:** For the UE-assisted positioning for RRC\_Inactive state, the UEs report an indicator along with the positioning measurements, where the indicator informs LMF of whether to jointly utilize the currently reported positioning measurements with the previously reported positioning measurements.

**Proposal 5:** RAN1 to support that as part of UE request of on-demand PRS, the UE indicates if the PRS can be received in MG-less mode or requires a MG.

**Proposal 6**: The on-demand PRS parameter for DL PRS QCL information implies both of the followings.

* The UE may send a DL RS resource ID, a QCL source, to the LMF to inform its preferrable beam direction so that the PRS can be sent with the direction
* Reconfiguration request of DL PRS QCL information in order to be configured with a more appropriate RS resource for QCL type-D

**Proposal 7**: Requested PRS parameters include a list of preferable TRPs, beam directions, PRS resource ID, PRS resource set ID, repetition factor for both UE-initiated and LMF-initiated.

**Proposal 8:** Rel-17 NR positioning supports that a UE separately requests a DL PRS resource to be received in an MG-less mode and a DL PRS resource to be received in an MG-based mode.

**Proposal 9**: Support of indication of expected AoD/ZoD value and uncertainty (of the expected AoD/ZoD value) range(s) is signaled by the LMF to gNBs/TRPs at least for LMF-initiated on-demand PRS.

## \_Xiaomi

* Proposal 1: UE initiated on-demand PRS transmission can be indicated by PRACH or PUCCH.
* Proposal 2: Consider to pre-configure the PRS for inactive UE when UE in connected mode.
* Proposal 2: gNB initiated of on-demand PRS transmission can be supported by RRC, MAC CE and DCI.
* Proposal 3: Suggest to determine the validity of pre-configured PRS by RSRP or time of arrival.
* Proposal 4: After determining no valid of the pre-configured PRS, UE can request the new configured PRS by LPP in RRC\_INACTIVE state or by transferring to RRC\_CONNETTED state.
* Proposal 5: Random access procedure can be reused for UL and DL&UL positioning of Inactive UE.
* Proposal 6: Random access preamble can be reused as UL reference signal for Inactive UE.
* Proposal 7: SRS transmission for Inactive UE can be triggered by gNB through paging.

## \_Samsung

* Proposal 1: Support aperiodic and/or semi-persistent SRS transmission for UL and DL+UL positioning in RRC \_INACTIVE state.
* Proposal 2: Support Paging DCI or MAC CE in paging MAC PDU to activate/deactivate SRS.
* Proposal 3: For UL positioning in RRC inactive state, if the camping cell is changed, whether the SRS configuration is assumed valid can be further discussed.

## \_Intel

* Proposal 1:
  + In addition to the DL PRS Periodicity, DL PRS Resource Bandwidth, and DL PRS QCL-Info, at least the following parameters are supported for UE-initiated and LMF-initiated on-demand DL PRS requests:
    - Start/end time of DL PRS transmission
      * Time interval in slots recommended for DL PRS transmission within the SFN cycle
    - DL-PRS CombSizeN
      * Resource element spacing in each symbol of the DL-PRS Resource
    - DL PRS Resource Repetition Factor
      * Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set
    - DL PRS Resource Time Gap
      * Recommended offset in units of slots between two repeated instances of a DL-PRS Resource corresponding to the same DL-PRS Resource ID within a single instance of the DL-PRS Resource Set
    - Number of DL PRS Resource Symbols per DL PRS Resource
      * Recommended number of symbols per DL-PRS Resource within a slot
* Proposal 2:
  + For UL and DL+UL positioning by RRC\_INACTIVE UEs, support transmission of semi persistent UL SRS for positioning
    - The details of activation/deactivation can be directly considered in RAN2
  + Define UE Rx-Tx time difference measurement for UEs in RRC\_INACTIVE state

## \_DOCOMO

* Proposal 1:
  + RACH preamble (i.e. TA based positioning) can be considered for NR positioning of UEs in RRC\_INACTIVE state
* Proposal 2:
  + Support at least periodic SRS for positioning in RRC\_INACTIVE state
  + Rel-17 needs to study necessity of semi-persistent/aperiodic SRS for positioning in RRC\_INACTIVE state

## \_Huawei

* Observation 1: With regards to SRS resource types
  + RAN2 is already working on periodic SRS.
  + Support of semi-persistent SRS relies on whether UE is able to receive DL MAC CE in RRC\_INACTIVE state.
  + Support of aperiodic SRS relies on whether UE is able to monitor DCI formats 0\_1, 0\_2, 1\_1, or 1\_2 in the UE specific search space in RRC\_INACTIVE state.
* Observation 2: Rel-17 targets the same requirement of accuracy for positioning in RRC\_IDLE/INACTIVE as in RRC\_CONNECTED.
* Observation 3: There is no need to report UE capability of receiving PRS in RRC\_INACTIVE to LMF, since RRC state is not exposed to LMF.
* Observation 4: Rel-16 LocationMeasurementIndication and other ongoing discussion for MG-based and MG-less PRS measurement (e.g. LMF based UE PRS measurement indication) can be used for the gNB to determine RRC state for PRS measurement.
* Proposal 1: Conclude in RAN1 that
  + Periodic SRS transmission in RRC\_INACTIVE can be directly supported.
  + Support of semi-persistent SRS transmission depends on whether UE is able to receive DL MAC CE in RRC\_INACTIVE state.
  + Support of aperiodic SRS transmission depends on whether UE is able to monitor DCI formats 0\_1, 0\_2, 1\_1, or 1\_2 in the UE specific search space in RRC\_INACTIVE state.
  + It is RAN1 understanding that the support of transmission of semi-persistent SRS and aperiodic SRS in RRC\_INACTIVE state can be finally decided by RAN2.
* Proposal 2: Support for SRS transmission in RRC\_INACTIVE a separate positioning bandwidth configuration from that of BWP#0 configured by the system information.
* Proposal 3: UE capability of receiving PRS in RRC\_INACTIVE should be reported to the gNB.
* Proposal 4: The followings are supported for UE-initiated on-demand PRS.
  + DL-PRS resource set ID
    - For each TRP that has more than one PRS resource sets (on a positioning frequency layer), UE may indicate a specific DL-PRS resource set ID to be only included the updated assistance data
  + Priority order of TRPs and PRS resource sets
    - For each positioning frequency layer, UE may suggest a new TRP sequence in the updated assistance data
    - For each TRP that has more than one PRS resource sets, UE may suggest a new DL-PRS resource set sequence in the updated assistance data
  + SCell information
    - UE reports the SCell information, similar to the PCell information with or without reception of any initial assistance data
  + Parameters that are optional without a default value, including Rel-17 new parameters
    - This means that UE would request the parameter to be provided if not in the initial assistance data or without any initial assistance data, instead of being a specific value
* Proposal 5: At least the ON/OFF indicator is supported for LMF-initiated on-demand PRS.
  + The granularity can be TRP level, PRS resource set level, or PRS resource level

## \_Sony

* Observation 1: Supporting various types of SRS for positioning can enable many positioning use-cases.
* Observation 2: The SRS transmission in RRC\_INCATIVE state should not interfere or at least minimize the interference with other UE uplink transmission and also the SRS can be received by the intended TRPs with certain quality.
* Observation 3: DL-AoD positioning accuracy can be improved by increasing beam density (number of beam / sweeping range). Simulation also shows that the improvement becomes insignificant when the beam density reaches a certain value (e.g., 16beams/120º in InF-SH, FR2).
* Proposal 1: Support periodic, aperiodic, and semi-persistent SRS for positioning in RRC\_INACTIVE state
* Proposal 2: When the UE is in RRC\_CONNECTED state, the UE receives the configuration of SRS positioning to be used in RRC\_INACTIVE state.
* Proposal 3: The configuration of SRS positioning can contain the activation for a UE to transmit periodic SRS positioning when the UE is in RRC\_INACTIVE state.
* Proposal 4: The UE can be triggered to transmit aperiodic SRS / semi-persistent SRS in RRC\_INACTIVE state by the reception of downlink transmission in RRC\_INACTIVE state (e.g. paging message, RACH procedure, SDT). The details are to be defined by RAN2.
* Proposal 5: Support to introduce validation scheme when the UE can transmit SRS for positioning in RRC\_INACTIVE state. As part of the validation scheme, the UE can transmit SRS for positioning when the UE is still camp to the same cell or a pre-configured group of cells.
* Proposal 6: For both UE- and LMF- initiated on-demand DL PRS request, the assistance information with at least the following parameters is supported:
  + Beam direction(s) that can be in a form of PRS resource ID(s)
  + List of TRP(s)
  + Timing information for on-demand PRS
  + Selected frequency layer(s) and PRS resource-set(s)
* Proposal 7: Support LMF to assist gNBs to facilitate the two-stage beam sweeping operation. It can be performed such as LMF configures sweeping beam directly by on-demand PRS, or LMF sent assistance information to gNB (e.g., the expected AoD range, beam width).
* Proposal 8: Support two-stage beam sweeping for DL-AOD and DL-TDOA positioning

## \_Fraunhofer

* Proposal 1: Support in the parameters lists for on-demand DL-PRS the following:
  + Number of DL PRS resource symbols per DL PRS resource, and
  + Beam directions
* Proposal 2: Support the LMF and UE to request an update of one or more parmeters to the list of preconfigured PRS resources.
* Proposal 3: Support the device to activate or deactivate measurements on DL-PRS resources in the second stage depending on the received associated DL PRS resources in the first stage.

## \_LGE

**Transmission of SRS for positioning**

* Observation #1:
  + If periodic SRS transmission by UEs in RRC\_INACTIVE state is supported, it causes more power consumption for UE since UE already consumes its power to monitor paging.
* Proposal #1:
  + RAN1 should support periodic SRS transmission for UEs in RRC\_INACTIVE state as lower priority than other types (i.e., semi-persistent, aperiodic).
* Proposal #2:
  + RAN1 should support a time window (or occasion) of SRS transmission for UE power saving when periodic SRS is supported for UE in RRC\_INACTITVE.
* Observation #2:
  + If UE can transmit SRS without going to deep sleep after Paging Occasion (PO), UE saves its power to go to sleep and wake up again.
* Proposal #3:
  + RAN1 should support SRS transmission considering DRX cycle (including related procedure and signaling).

**Reception of PRS for positioning**

* Proposal #4:
  + If network initiated positioning measurement is supported for UEs in RRC\_INACTIVE state, RAN 1 needs to firstly discuss which DL channel is used for the transmission of information from LMF to UE.
  + Paging PDCCH (esp., message in DCI for paging) can be considered as one of options for indicating whether the positioning related message is delivered.
* Observation #3:
  + If paging is used for NRPP message (such as measurement request) and UE monitors every PRS resources that are in adjacent PO, it causes larger power consumption for UE.
* Proposal #5:
  + Regarding DL positioning for UEs in RRC\_INACTIVE state, RAN1 should support PRS reception considering DRX cycle, and the following options can be studied.
    - Option 1: UE always measures PRS within preconfigured duration periodically after every paging occasion
    - Option 2: UE obtains some information related with time window for DL PRS reception through paging and then UE measure PRSs within the configured window dynamically

**SFN PRS with Cyclic shift**

* Proposal #6:
  + NR should consider cyclic shift based SFN transmission of PRS.
    - Study on benefit of the simultaneous transmission of a common PRS sequence with different intentional cyclic time-domain delays.
* Proposal #7:
  + Support 1-symbol PRS resource for Rel-17 NR positioning.

## \_InterDigital

* Observation 1: One of the validity conditions for SRSp is TA timer.
* Proposal 1: Support at least periodic SRS for positioning for UL and DL + UL positioning during RRC\_INACTIVE
* Proposal 2: In addition to the on-demand PRS parameters agreed in RAN1#106e, Support both number of DL PRS resource symbols per DL PRS resource and start/end time of DL PRS transmission for UE-initiated and LMF-initiated on-demand PRS requests
* Proposal 3: For UE-initiated on-demand DL-PRS, pre-configured sets of PRS parameters consist of at least a combination of values for bandwidth and periodicities for PRS, excluding DL PRS QCL information.

## \_Qualcomm

Overall, we make the following proposals:

* Proposal 1: Include at least the following on-demand DL PRS parameters:
  + Start/end time of DL PRS transmission
  + PRS resource and PRS resource set slot offsets
  + DL PRS resource repetition factor
  + Number of DL PRS Resource Symbols per DL PRS resource
  + Number of DL PRS resources per DL PRS resource set
  + Number of TRPs
  + Beam Directions
* Proposal 2: Introduce both Periodic and Semi-persistent SRS for UEs in RRC Inactive.
* Proposal 3: Introduce a UE capability for UEs transmitting SRS in RRC inactive state.
* Proposal 4: DL positioning capability should be defined in inactive state, e.g. including at least
  + DL PRS processing capability in inactive state
* Observation 1: No UE capability for PRS reception or SRS transmission in RRC inactive, will render the feature practically non-existent, non-deployable and non-testable.

## \_Mediatek

* Proposal 2-1: The PRS resource(s) in each resource set could be selected for transmission and measurement. Support PRS resource indexes, and resource set indexes as the parameters of on-demand PRS
* Proposal 2-2: Support on-demand PRS measurement with gaps and outside the gaps
* Proposal 2-3: RAN1 may identify the transmission duration and inspect whether there is suitable MG to match with. Longer MG duration than the transmission duration may reduce the system efficiency. If there is no suitable MG duration, RAN1 may notify RAN4 for further support
* Proposal 2-4: Support symbol number as the parameter of on-demand PRS

## \_Lenovo

* Observation 1: “Number of TRPs” only indicates the recommended total number of TRPs transmitting DL-PRS and does not indicate which of those TRPs are best suited for UE measurement.
* Observation 2: DL-only measurement durations and periods may be different between RRC\_CONNECTED and RRC\_INACTIVE states due to e.g., UE DRX configuration, which may affect the overall location accuracy and power consumption.

Based on the discussion, the following proposals are summarized as follows:

* Proposal 1: Send a reply LS to RAN2 containing List#1 (UE-initiated) and List#2 (LMF-initiated) DL-PRS, after the on-demand parameters have been agreed upon.
* Proposal 2: Support the indicated UE-initiated and LMF-initiated parameters as shown in Table 1.
* Proposal 3: Support TRP Priority order indication as part of UE-initiated On-demand PRS.
* Proposal 4: Support ON/OFF indicator of the DL PRS per TRP and associated TRP indication/Group TRP indication for signalling which TRPs to switch on/off.
* Proposal 5: Association between resources belonging to two DL PRS resource sets of the same TRP can be enabled by a grouping ID and can be signalled in the assistance data.
* Proposal 6: Two-stage PRS beam sweeping can be enabled by the on-demand PRS mechanism.
* Proposal 7: RAN1 to consider the DL-PRS configuration impact on measurement accuracy in RRC\_INACTIVE state. FFS solutions to address this gap, e.g., separate DL-PRS configurations for RRC\_INACTIVE UEs, sharing of the UE DRX configuration with the LMF for optimal RRC\_INACTIVE measurements, etc.
* Proposal 8: RAN1 to support separate capabilities of UEs performing RRC\_INACTIVE positioning.

## \_Ericsson

* Observation 1
  + Procedure with validation of the SRS configuration parameters are part of RAN2 responsibility
* Observation 2
  + SRS Beam sweeping is supported by the SRS configuration framework in RRC\_INACTIVE.
* Observation 3
  + DL PRS QCL information can be derived by the gNB without assistance from the UE
* Observation 4
  + As DL PRS is shared between multiple UEs, on-demand PRS with UE-specific PRS signal for each served UE is not scalable when the number of UEs is large.
* Observation 5
  + The DL PRS on-demand signalling defined by RAN3 is cell specific
* Observation 6
  + The network and the UE both benefit from knowing which of the configured PRSs are producing meaningful UE measurements.
* Proposal 1
  + SRS for positioning aperiodic transmission is not supported in RRC\_INACTIVE state
* Proposal 2
  + SRS for positioning semi-persistent transmission is not supported in RRC\_INACTIVE state
* Proposal 3
  + The UE can be configured with SRS in RRC\_INACTIVE by listing in the RRC release message the applicable SRS resource sets / resource IDs currently configured SRS in RRC\_CONNECTED to be kept in RRC\_INACTIVE
* Proposal 4
  + When the UE SRS has been originally configured in connected mode, the bandwith parameters can be configured to fallback to a predetermined value if the configured bandwidth when the UE moves to RRC\_INACTIVE.
    - The predetermined value could be indicated via capability signalling
    - FFS: additional parameters beside bandwidth
* Proposal 5
  + Do not discuss further the SRS parameters validation aspects in RAN1.
* Proposal 6
  + DL PRS QCL information is removed from the list of on-demand PRS parameters.
* Proposal 7
  + - The PRS request message to gNB should include:
      * The list of PRS resources set that can be configured by the TRPs hosted in the NG-RAN node.
      * The resource ID for each resource set
      * For each PRS resource ID:
        + The number of UEs that have detected RSRP values with good quality
        + Their average RSRP/RSRQ
* Proposal 8
  + Send an LS to RAN3 to provide a PRS activity Report via NRPPa to optimize DL-PRS transmission.