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

**e-Meeting, August 16th – 27th, 2021**

**Source: Moderator (Intel Corporation)**

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

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| [106-e-NR-ePos-06] Email discussion/approval on issues in the Others section including the LSs in [R1-2106411](../../Docs/R1-2106411.zip) and [R1-2106412](../../Docs/R1-2106412.zip) from AI5 and any reply LSs necessary, with checkpoints for agreements on August 19, 24 and 27 – Alexey (Intel) |

Finally, in Section 6, we provide list of agreements made by RAN1 as an outcome of e-mail discussion [106-e-NR-ePos-06].

# Proposed Priority Order for Discussion

## Round #1

### NR Positioning in RRC\_INACTIVE State

It is proposed to prioritize discussion on this aspect

* Aspect #1: LS to RAN1 on positioning in RRC\_INACTIVE
* Aspect #2: Transmission of SRS for positioning
  + Aspect #3: Power Control for SRS for positioning
  + Aspect #4: TA for SRS for positioning
  + Aspect #5: Spatial Relation for SRS for positioning
  + Aspect #6: Configuration of SRS for positioning
* Aspect #7: Support of DL positioning in RRC\_INACTIVE state

### On demand DL PRS

* Aspect #1: LS to RAN1 on parameters for on-demand PRS
* Aspect #2: Types of UE / LMF initiated on-demand DL PRS request
* Aspect #3: Lists of parameters for UE / LMF initiated on-demand DL PRS request

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: Reply LS to RAN2 on positioning in RRC\_INACTIVE

RAN1 has received the LS from RAN2 on positioning in RRC\_INACTIVE with the following content:

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| **1. Overall Description:**  During RAN2#114-e meeting, RAN2 has discussed the support of positioning in RRC\_INACTIVE and made the following set of agreements regarding use of SDT framework for positioning in RRC\_INACTIVE:   * RAN2 agreed that the UE in RRC\_INACTIVE can send any uplink LCS or LPP message using Rel-17 SDT frame work as:   Agreements:  Any uplink LCS or LPP message can be transported in RRC\_INACTIVE from RAN2 perspective.   * RAN2 also agreed that the network may conditionally send DL messages for UE in RRC\_INACTIVE using Rel-17 SDT framework as:   Agreements:  Follow Rel-17 SDT framework for INACTIVE UL and DL positioning:   If the UE initiated data transmission using UL SDT, the network can send DL LCS, LPP message and RRC message (e.g. to configure SRS (TBD on what message is used), if UL positioning supported) to the UE.   Otherwise, if UE did not initiate UL SDT, rely on legacy operation, i.e. the network shall transition the UE to RRC\_CONNECTED, e.g. based on RAN paging.  Note that RAN2 discussed the 2nd priority objectives for UL/UL+DL positioning in RRC\_INACTIVE on the configuration in UL positioning and so far, has not reached any conclusion considering it is still open in RAN1 on how positioning SRS should be used for UE in RRC\_INACTIVE. RAN2 will continue the work as time permits.  **2. Actions:**  **To RAN1 group.**  **ACTION:** RAN2 respectfully requests RAN1 to take the above RAN2 agreements into account. |

### Round #1

Based on status of RAN2 work and its dependency on RAN1 progress, the following is proposed to facilitate further discussion:

**Proposal 3.1-1**

* + Send reply LS to RAN2 capturing the outcome of discussion at RAN1#106e including potential agreements on the following aspects (subject to the progress made):
    - Aspect #2: Transmission of SRS for positioning by RRC\_INACTIVE UEs
    - Aspect #3: Power control for SRS for positioning by RRC\_INACTIVE UEs
    - Aspect #4: TA for SRS for positioning by RRC\_INACTIVE UEs
    - Aspect #5: Spatial relation for SRS for positioning by RRC\_INACTIVE UEs
    - Aspect #6: Configuration of SRS for positioning by RRC\_INACTIVE UEs

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| Company Name | Comments |
| Qualcomm | Not sure if we really need to spend time to discuss/debate this proposal, but overall, yes, any agreements we make for RRC inactive SRS, will likely be useful to be sent to RAN2; we can decide after any/some progress is made. |
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## Aspect #2: Transmission of SRS for positioning

The support of SRS for positioning transmission by RRC\_INACTIVE UEs is discussed by majority of companies that have submitted contributions. The following views were expressed:

* [ZTE, [1]]
  + If RAN2 time budget allows, UL/DL+UL positioning can be specified for RRC INACTIVE positioning.
    - SRS based approach in RRC INACTIVE should be the only candidate if UL/DL+UL method is supported
  + Reply the RAN2 LS (R2-2106551) to clarify RAN1’s recommended solution of using SRS for UL related positioning in RRC INACTIVE.
    - RAN2 can further assess whether it is doable considering the time budget.
* [vivo, [2]]
  + Support SRS for positioning as UL positioning RS in inactive state.
* [Sony, [3]]
  + Support positioning request in paging message to enable SRS for positioning transmission in RRC\_INACTIVE state. The details are to be defined by RAN2.
* [CATT, [5]]
  + 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.
* [OPPO, [8]]
  + RAN1 focuses on the 1st priority objectives in the current stage
    - Postpone the 2nd priority objectives until the main issues of the 1st priority ones are well-addressed.
  + Once RAN1 agrees to start the work on the 2nd priority objectives, send a LS to RAN2 to clarify how it can work, e.g.,
    - How does UE get and maintain the TA for SRS transmission?
    - How to deal with frequent handover/cell-reselection while maintain the advantages of inactive state?
    - How to deal with the power control?
* [Qualcomm, [9]]
  + With regards to the RRC Inactive Positioning and enabling UL & DL+UL Positioning method, we make the following proposals from RAN1 perspective:
    - Enable transmitting SRS for Positioning during RRC Inactive State
* [CMCC, [10]]
  + RAN2 has not preclude any solutions for RRC\_inactive positioning, regarding the support of UL/DL+UL positioning in RRC\_inactive state, RAN2 cannot make more progress unless RAN1 provides some output and guidance.
  + Configuration and transmission of SRS for positioning is supported by UEs in RRC\_INACTIVE state for UL and DL+UL positioning.
* [Samsung, [4]]
  + Observation 2: Potential specification effort for UL/DL positioning in RRC inactive state can be acceptable.
  + Proposal 1: Positioning in RRC inactive state should be supported.
* [Intel, [11]]
  + For support of UL and DL+UL positioning by RRC\_INACTIVE UEs, RAN1 to discuss and conclude on
    - Support of SRS for positioning transmission by UEs in RRC\_INACTIVE state for RACH and CG based SDT
    - Support of UE Rx-Tx time difference measurements in RRC\_INACTIVE state and report
    - Further discuss details of power control, spatial relation, TA, and BW for SRS for positioning transmission by RRC\_INACTIVE UEs
* [InterDigital, [12]]
  + Support the use of pre-configured SRSp configuration received by UE during RRC CONNECTED for SRSp transmission when in INACTIVE
  + Support transmission of SRSp configuration (e.g. using SDT) or indication for initiating SRSp transmission to UE when in INACTIVE
* [Huawei, [13]]
  + LS reply from RAN1 to RAN2 is needed to facilitate RAN2 to complete the objective of UL/DL+UL positioning for RRC\_INACTIVE for this work item***.***
* [Mediatek, [14]]
  + Support SRS transmission for positioning in RRC inactive state
  + Support Rel-15 and Rel-16 SRS for transmission in RRC inactive state
* [Xiaomi, [17]]
  + SRS transmission for inactive UE can be triggered by gNB through paging.
* [Fraunhofer, [18]]
  + Support SRS transmission for positioning in RRC\_INACTIVE state.

### Round #1

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

**Proposal 3.2-1**

* + Transmission of SRS for positioning by UEs in RRC\_INACTIVE state is supported for UL and DL+UL positioning

Comments from companies:

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| Company Name | Comments |
| Qualcomm | support |
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## Aspect #3: Power Control for SRS for positioning

The following views were expressed by selected companies regarding OLPC for SRS for positioning transmission by RRC\_INACTIVE UEs:

* [vivo, [2]]
  + 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.
* [Qualcomm, [9]]:
  + SRS-SDT configuration may contain path loss references and spatial relation references for the purpose of open loop power control and Tx beam determination of the SRS-SDT during the RRC Inactive state
* [Huawei, [13]]
  + Support the power control mechanism for SRS transmission in RRC\_INACTIVE based on Rel-16 feature.
* [Fraunhofer, [18]]
  + RAN1 shall discuss how the power control shall be done during the RRC\_INACTIVE state. Possible candidates are:
    - The UE transmits the SRS-pos with a predefined power configuration.
    - Power control configuration signaled to the UE using the SDT mechanism.
    - FFS: Device efficient power control procedure related to the reference signals for pathloss and spatial relation.

### Round #1

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

**Proposal 3.3-1**

* Open loop power control defined in Rel.16 for transmission of SRS for positionng by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs

Comments from companies:

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| Company Name | Comments |
| Qualcomm | Support |
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## Aspect #4: TA for SRS for positioning

The following views were expressed by selected companies regarding TA for SRS for positioning transmission by RRC\_INACTIVE UEs:

* [vivo, [2]]
  + Regarding TA validation for SRS transmission in inactive state, support to use TA validation mechanism for CG-SDT as a reference, including:
    - TAT based TA validation
    - RSRP based TA validation
* [Qualcomm, [9]]:
  + TA validation procedures applicable to CG-SDT to also be applicable to SRS-SDT
* [Huawei, [13]]
  + Positioning SRS transmission in RRC\_INACTIVE state should be based on DL timing of the serving cell and a valid transmission TA.
    - The TA value can be either the one in RRC\_CONNECTED or provided in RRCRelease.
    - It is up to RAN2 to decide the TA validation/maintenance procedure for positioning SRS transmission in RRC\_INACTIVE.
  + Send an LS to RAN2 informing them of the decision.
* When the SRS resource is released, e.g. due to TA timer expiry, gNB should inform the LMF that the SRS resource is no longer available.
* [Mediatek, [14]]
  + The anchor gNB may report to LMF about the release of SRS due to TAT expiration of UE
* [Fraunhofer, [18]]
  + RAN1 shall discuss how TA shall be maintained during the RRC\_INACTIVE state, possible candidates are:
    - Maintaining the TA configuration provided in RRC\_CONNECTED state.
    - TA signaled to the UE using the SDT mechanism.
    - TA based on UE measurements or UE location.

### Round #1

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

**Proposal 3.4-1**

* TA procedures defined for CG-SDT support are reused for SRS for positioning transmission by RRC\_INACTIVE UEs

Comments from companies:

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| Company Name | Comments |
| Qualcomm | Support |
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## Aspect #5: Spatial Relation for SRS for positioning

The following views were expressed regarding spatial relation for SRS for positioning by RRC\_INACTIVE UEs:

* [Huawei, [13]]
  + Support the beam indication mechanism for SRS transmission in RRC\_INACTIVE based on Rel-16 feature.
* [vivo, [2]]
  + Regarding spatial relation RS validation for SRS transmission in inactive state, the following validity criteria 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.
  + Support to enable SRS beam sweeping in inactive state.
    - SRS repetition during beam sweeping can be considered.
* [Qualcomm, [9]]
  + Provide the SRS-SDT configuration in the RRC Release message
    - SRS-STD configuration may contain path loss references and spatial relation references for the purpose of open loop power control and Tx beam determination of the SRS-SDT during the RRC Inactive state.

### Round #1

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

**Proposal 3.5-1**

* Configuration of spatial relation reference signals for transmit beamforming by RRC\_INACTIVE UEs is supported

Comments from companies:

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| Company Name | Comments |
| Qualcomm | support |
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## Aspect #6: 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:

* [ZTE, [1]]
  + Proposal 2: Strive to reuse existing Rel-16 RRC structure/parameters for positioning SRS configuration in RRC\_INACTIVE
    - Only SSB can be configured as a source for path-loss RS and spatial relation if UE is in SDT INACTIVE period (still in RRC INACTIVE sate)
* [vivo, [2]]
  + Support to transmit configuration of SRS for positioning via RRC release when UE is in connected state for UL positioning in inactive state.
  + Transmission of the SRS configuration while retaining the UE in inactive state can be considered.
  + 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 is received
    - UE has valid TA
    - UE has valid spatial relation RS
    - UE has valid power control RS
  + 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
* [Sony, [3]]
  + When the UE is in RRC\_CONNECTED state, the UE receives the configuration of SRS positioning to be used in RRC\_INACTIVE state.
* [CATT, [5]] 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.
* [Qualcomm, [9]]
  + Provide the SRS-SDT configuration in the RRC Release message
    - SRS-STD configuration may contain path loss references and spatial relation references for the purpose of open loop power control and Tx beam determination of the SRS-SDT during the RRC Inactive state.
* [CMCC, [9]]
  + Configuration and transmission of SRS for positioning is supported by UEs in RRC\_INACTIVE state for UL and DL+UL positioning.
* [InterDigital, [12]]
  + Support the use of pre-configured SRSp configuration received by UE during RRC CONNECTED for SRSp transmission when in INACTIVE
  + Support transmission of SRSp configuration (e.g. using SDT) or indication for initiating SRSp transmission to UE when in INACTIVE
* [Huawei, [13]]
  + Support a separate positioning bandwidth configuration from that of BWP#0 configured by the system information for SRS transmission in RRC\_INACTIVE.
* [Mediatek, [14]]
  + Support the indication within RRC release with SuspendConfig message to indicate whether to continue using the existing SRS configuration, or to use new SRS configuration in RRC inactive state
  + Support SRS transmission bandwidth and uplink resource bandwidth to be decoupled in RRC inactive state.

### Round #1

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

**Proposal 3.6-1**

* Configuration parameters introduced for SRS for positioning in Rel.16 are reused for UEs in RRC\_INACTIVE state
  + FFS in RAN2 details of configuration signaling for SRS for positioning

Comments from companies:

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| Company Name | Comments |
| Qualcomm | Support |
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## Aspect #7: Support of DL positioning in RRC\_INACTIVE state

The following views were expressed by selected companies regarding support of NR DL Positioning by RRC\_INACTIVE UEs:

* [ZTE, [1]]
  + For NR DL positioning in RRC INACTIVE state, there is no remaining RAN1 specification impact.
* [vivo, [2]]
  + Validity criteria of PRS configuration in inactive state delivered by LPP message in connected state should be considered, e.g. validity criteria of UE/cell-specific PRS configuration such as priority indication, expected RSTD etc.
  + Support to reuse QCL configuration in connected state for PRS reception for inactive UEs.
  + The relationship between PRS measurement and initial DL BWP should be further studied, e.g. including
    - how to support UE to process PRS outside the initial DL BWP and/or PRS whose SCS is different with the initial DL BWP
  + In inactive state, when PRS and other DL signals (e.g. SSB, SIB1, COREST0, MSG2/MSGB, paging, etc.) are in the same symbol, how the UE processes PRS should be considered.
* [CATT, [5]]
  + For UE-assisted DL positioning for UEs in RRC\_INACTIVE state, support:
    - gNB to broadcast DL PRS assistance information in the system information;
    - UE to report DL measurement results to the serving gNB using RACH, and serving gNB to forward the DL measurement results to LMF.
* [Huawei, [13]]
  + The RAN1 work to support DL positioning methods in RRC\_INACTIVE state can be considered as completed.
* [LGE, [15]]
  + Study measurement time duration for supporting positioning measurement of UE in RRC\_INACTIVE. For examples, following options could be considered for PRS measurement.
    - Allowing UE to measure PRS within active time.
    - Allowing UE to measure PRS within inactive time
    - Allowing UE to measure PRS regardless of in/active time
* If network initiated positioning measurement is supported, RAN 1 can 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.
* [Xiaomi, [17]]
  + Suggest to associate a state ID with a PRS configuration, a measurement gap configuration and a PRS measurement report configuration, and MAC CE or DCI can activate/deactivate or trigger the PRS measurement report by indicating a state ID.
  + Consider to pre-configure the PRS for inactive UE when UE is in connected mode.
* [InterDigital, [12]]:
  + Support transmission of DL indication to UE for initiating measurement of preconfigured PRS when in INACTIVE using paging/RACH procedure

### Round #1

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

**Proposal 3.7-1**

* Select one of the following alternatives:
  + Alt.1 From RAN1 perspective, the work on NR DL positioning support by RRC\_INACTIVE UEs is completed (i.e. no additional enhancements are considered by RAN1 for support of NR DL Positioning by RRC\_INACTIVE UEs in Rel.17)
    - Details of DL PRS configuration signaling for RRC-INACTIVE UEs are up to RAN2
  + Alt.2 FFS in RAN1 the following aspects for DL positioning support by RRC\_INACTIVE UEs:
    - Validity criteria of DL PRS configuration
    - Relationship between DL PRS measurement BW and initial DL BWP
    - Reception of DL PRS and other DL signals/channel in the same symbol
    - UE DL PRS measurements within in-active / active time
    - Indication (e.g. activation/deactivation signaling) for UE DL PRS measurement and report

Comments from companies:

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| Company Name | Comments |
| Qualcomm | Alt. 2 together with “UE capabilities for this feature” |
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## Aspect #8: 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, [16]]
  + RACH preamble (i.e. TA based positioning) can be considered for NR positioning of UEs in RRC\_INACTIVE state
* [CMCC, [10]]
  + Support using RACH preamble as the UL reference signals for RRC\_inactive state positioning
  + Support enhancing NR E-CID using RACH preamble to obtain the UL measurements
* [Xiaomi, [17]]:
  + 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.

### Round #1

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

**Proposal 3.8-1**

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

Comments from companies:

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| Company Name | Comments |
| Qualcomm | No support. Even though we see some usecases, they are rather limited, and prefer to have a complete solution using SRS-based procedures. |
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## Aspect #9: Reporting by RRC\_INACTIVE UEs

The following views were expressed with respect to NR positioning reports by RRC\_INACTIVE UEs:

* [vivo, [2]]: UE report size optimization
  + 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 continuous report
* [InterDigital, [12]]:
  + Support UE reporting when the UE observes changes in its measurements during INACTIVE positioning
  + Support aperiodic measurement reporting during INACTIVE positioning
* [Xiaomi, [17]]:
  + Measurement report can be sent to gNB by PUSCH in Msg 3 or Msg A during random access procedure for inactive UE.

### Round #1

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

**Proposal 3.9-1**

* Details of NR positioning measurement reporting by RRC\_INACTIVE UEs are up to RAN2

Comments from companies:

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| Company Name | Comments |
| Qualcomm | Support |
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## Aspect #10: Triggering of SRS for positioning transmission by UEs in RRC\_INACTIVE state

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

* [Sony, [3]]
  + Support positioning request in paging message to enable SRS for positioning transmission in RRC\_INACTIVE state. The details are to be defined by RAN2.
* [CAICT, [7]]
  + For UL positioning in RRC\_IDLE state, a new paging message or a new random access process need to be specified.
* [InterDigital, [12]]
  + Support the use of pre-configured SRSp configuration received by UE during RRC CONNECTED for SRSp transmission when in INACTIVE
  + Support transmission of SRSp configuration (e.g. using SDT) or indication for initiating SRSp transmission to UE when in INACTIVE
* [Huawei, [13]]
  + Support at least periodic positioning SRS for RRC\_INACTIVE.
* [Mediatek, [14]]
  + Support periodic and semi-persistent SRS transmission in RRC inactive state
  + The activation command of semi-persistent SRS may be contained within the RRC release with SuspendConfig message
* [Xiaomi, [17]]
  + SRS transmission for inactive UE can be triggered by gNB through paging
* [Fraunhofer, [18]]
  + Consider mechanisms for SRS-Pos activation/deactivation based on DL-PRS measurements during RRC\_INACTIVE to lessen the necessity of additional SRS configurations.

### Round #1

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

**Proposal 3.10-1**

* Signaling details for activation and deactivation of SRS for positioning transmission by RRC-INACTIVE UEs are:
  + Alt.1: Defined by RAN1
  + Alt.2: Defined by RAN2

Comments from companies:

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| Company Name | Comments |
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## Aspect #11: PRS/SRS relationship with BWP0

The following views were expressed in terms of DL PRS and SRS relationship with initial BWP

* [vivo, [2]]:
  + The relationship between PRS measurement and initial DL BWP should be further studied, e.g. including
    - how to support UE to process PRS outside the initial DL BWP and/or PRS whose SCS is different with the initial DL BWP
* [Huawei, [13]]:
  + Support a separate positioning bandwidth configuration from that of BWP#0 configured by the system information for SRS transmission in RRC\_INACTIVE.

### Round #1

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

**Proposal 3.11-1**

* Companies are invited to comment on relationship of DL PRS and SRS for positioning bandwidth with initial DL and UL BWPs

Comments from companies:

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| Company Name | Comments |
| Qualcomm | 2nd order details; suggest to de-prioritize for now |
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## Aspect #12: UE capability for NR positioning in RRC\_INACTIVE state

One source has mentioned that UE capability for NR positioning in RRC\_INACTIVE state needs to be defined.

* [vivo, [2]]:
  + DL positioning capability should be defined in inactive state, e.g. including at least
    - * DL PRS processing capability in inactive state
      * DL PRS resource capability in inactive state

### Round #1

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

**Proposal 3.1-1**

* Continue discussion at later stages

Comments from companies:

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| Company Name | Comments |
| Qualcomm | We are supportive of having UE capability for Positioning in RRC inactive |
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## Aspect #13: Positioning Accuracy

Target accuracy for both UE-based and UE-assisted positioning of the UEs in the RRC\_Inactive state

* [Nokia, [6]]
  + RAN1 needs discussion on the target positioning accuracy for both UE-based and UE-assisted positioning of the UEs in the RRC\_Inactive state but the final answer may also involve RAN4. For UE-assisted based positioning, clarify the available reporting overhead by SDT and the required reporting overhead to achieve the target performance.

### Round #1

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

**Proposal 3.13-1**

* Companies are invited to provide views on target positioning accuracy for RRC\_INACTIVE UEs

Comments from companies:

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| Company Name | Comments |
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On-Demand DL PRS Support

## Aspect #1: Reply LS to RAN2 on parameters for on-demand PRS

RAN1 has received the LS from RAN2 on parameters for on-demand DL PRS with the following content:

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| **1. Overall Description:**  During RAN2#114-e meeting, RAN2 discussed the support of on-demand PRS and made the following set of agreements:   |  | | --- | | - The network can signal predefined PRS configurations to the UE and the UE can select one to request. FFS if the UE can request a configuration with different parameters and exactly which parameters are flexible.  - Define a new LPP assistance data IE which can contain a set of possible on-demand DL-PRS configurations, where each on-demand DL-PRS configuration has an associated identifier.  - This new LPP assistance data IE can be included in an LPP Provide Assistance Data message and/or a new posSIB.  - The procedure(s) for on-demand DL-PRS should support at least the following functionality (up to RAN3 what is in NRPPa vs. OAM, etc.):   * Providing the requested on-demand DL-PRS configuration information from an LMF to the gNB (e.g., explicit parameter or identifier of a predefined DL-PRS configuration), and confirmation of the request by the gNB * Provision of (possible/allowed) on-demand DL-PRS configurations that the gNB can support from a gNB to an LMF * TRP capability transfer (e.g., whether the RAN node supports the reconfiguration of DL-PRS, etc.) |   In addition, RAN2 expects that RAN1 shall define and specify parameters for support of on-demand DL-PRS request as needed.  RAN1 is requested to define and provide the list of parameters for on-demand DL-PRS and inform RAN2 accordingly.  **2. Actions:**  **To RAN1 group.**  **ACTION:** RAN2 respectfully requests RAN1 to provide the list of parameters for on-demand PRS request, taking the above into account. |

**Proposal 4.1-1**

* Send LS to RAN2 providing update on the list of parameters and work status based on agreements reached at RAN1#106

Comments from companies:

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| Company Name | Comments |
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## Aspect #2: Types of UE / LMF initiated on-demand DL PRS request

According to LS to RAN1 (R1-2106412) on parameters for on-demand DL PRS, RAN2 has agreed on on-demand DL PRS framework based on pre-configured set of on-demand DL PRS configurations:

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| --- | --- |
| |  | | --- | | - The network can signal predefined PRS configurations to the UE and the UE can select one to request. FFS if the UE can request a configuration with different parameters and exactly which parameters are flexible.  - Define a new LPP assistance data IE which can contain a set of possible on-demand DL-PRS configurations, where each on-demand DL-PRS configuration has an associated identifier.  - This new LPP assistance data IE can be included in an LPP Provide Assistance Data message and/or a new posSIB.  - The procedure(s) for on-demand DL-PRS should support at least the following functionality (up to RAN3 what is in NRPPa vs. OAM, etc.):   * Providing the requested on-demand DL-PRS configuration information from an LMF to the gNB (e.g., explicit parameter or identifier of a predefined DL-PRS configuration), and confirmation of the request by the gNB * Provision of (possible/allowed) on-demand DL-PRS configurations that the gNB can support from a gNB to an LMF * TRP capability transfer (e.g., whether the RAN node supports the reconfiguration of DL-PRS, etc.) |   In addition, RAN2 expects that RAN1 shall define and specify parameters for support of on-demand DL-PRS request as needed.  RAN1 is requested to define and provide the list of parameters for on-demand DL-PRS and inform RAN2 accordingly. |

Based on discussion at the last RAN1 meeting and in submitted to RAN1 contributions, companies discuss two approaches for UE/LMF initiated on-demnad DL PRS requests:

1. General request for on-demand DL PRS which is not associated with a specific set of DL PRS pre-configurations
2. Request related to pre-configured set of on-demand DL PRS configurations (e.g. set of on-demand DL PRS configurations provided in assistance data)

Before RAN1 starts discussion on details of parameters for on-demand DL PRS requests, it is important to align on types of on-demand DL PRS requests to be supported.

### Round #1

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

**Proposal 4.2-1**

* The following lists of on-demand DL-PRS parameters are defined by RAN1 and provided to RAN2:
  + List#1: List of parameters for UE-initiated on-demand DL PRS request
  + List#2: List of parameters for LMF-initiated on-demand DL PRS request
  + List #3: List of parameters for UE-initiated on-demand DL PRS request associated with pre-configured set of on-demand DL PRS configurations
  + List #4: List of parameters for LMF-initiated on-demand DL PRS request associated with pre-configured set of on-demand DL PRS configurations
* Notes:
  + Lists #1 and #2 contain DL PRS parameters and values recommended by UE / LMF respectively for on-demand DL PRS support
  + Lists #3 and #4 contain DL PRS parameters and values for pre-configured on-demand DL PRS configurations recommended by UE/LMF respectively for update

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | We support all 4 lists.  With regards to the case of pre-configured on-demand, there is an item that RAN1 can provide input on: If a UE gets 2 prec-configurations, each one with different PFLs/PRS-IDs/PRS-sets/etc, can a UE recommend/request some PFL/PRS-IDs/PRS-sets from the 1st pre-configuraiton and some from the other pre-configuraiton? OR the UE will only be allowed to pick a configuration ID? We do not see a harm from being able to recommend/request within/across the configurations. |
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## Aspect #3: Lists of parameters for UE / LMF initiated on-demand DL PRS request

The major topic of discussion for on-demand DL PRS support is the list of parameters indicated during the UE/LMF initiated on-demand DL PRS signalling. The following views were expressed:

* [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 periodicity, time offset, 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 BW, PRS comb size and CP type
    - Parameters for TRP configuration including dl-PRS-ID, nr-PhysCellID, nr-CellGlobalID, nr-ARFCN-r16 and nr-DL-PRS-Info-r16
  + Parameters for PRS resource and resource set configuration including beam/QCL configuration, transmit power, PRS resource repetition factor, the number of PRS symbols and PRS resource set periodicity
* [vivo, [2]]
  + The ON/OFF request should be supported for UE-initiated and LMF-initiated on-demand DL PRS request.
    - ON request of on-demand PRS means to start the transmission of on-demand PRS.
    - OFF request of on-demand PRS means to turn off the transmission of on-demand PRS and fallback to the transmission of PRS with basic configurations.
  + For UE-initiated and LMF-initiated on-demand DL PRS request, the following parameters should be supported:
    - ON/OFF indicator of the on-demand DL PRS
    - Start/end time of DL PRS transmission
    - DL PRS resource bandwidth
    - Number frequency layers or frequency layer indicator
    - DL PRS transmission periodicity and offset
    - PRS measurement window
    - DL PRS resource repetition factor
    - DL PRS muting patterns
    - Number of DL PRS symbols per DL PRS resource
    - Comb size, start PRB, Point A of DL PRS
    - Number of TRPs
    - DL PRS QCL information
    - Number of PRS resources per PRS resource set
    - Beam directions
    - Angle measurement window
    - Antenna configurations
  + For pre-configuration of on-demand DL PRS, the following parameters should be supported:
    - Start/end time of DL PRS transmission
    - DL PRS resource bandwidth
    - Number frequency layers or frequency layer indicator
    - DL PRS transmission periodicity and offset
    - PRS measurement window
    - DL PRS resource repetition factor
    - DL PRS muting patterns
    - Number of DL PRS symbols per DL PRS resource
    - Comb size, start PRB, Point A of DL PRS
    - Number of TRPs
    - DL PRS QCL information
    - Number of PRS resources per PRS resource set
    - Beam directions
    - Angle measurement window
    - Antenna configurations
    - Priority of PRS
* [Sony, [3]]
  + Proposal 3: For both UE- and LMF- initiated on-demand DL PRS request, the assistance information with at least the following parameters are supported:
    - Bandwidth of PRS transmission.
    - 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)
* [CATT, [5]]
  + 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;
    - The requested DL PRS resources in the time, frequency and spatial domain, and/or the QoS parameters related to target positioning performance (e.g., the start time, duration, periodicity, the repetition number of PRS resources, etc.) to help the gNBs to allocate DL PRS resources properly.
  + For LMF-initiated on-demand DL PRS, the LMF may provide the following information to the gNB when the LMF sends the request to the gNB:
    - The requested DL PRS resources in the time, frequency and spatial domain, and/or the QoS parameters related to target positioning performance (e.g., the start time, duration, periodicity, and repetition number of PRS resources, etc.) to help the gNB to allocate DL PRS resources properly.
  + 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 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.
* [Nokia, [6]]
  + Requested PRS parameters include preferable TRP information, beam directions, DL PRS QCL information, PRS resource ID, PRS resource set ID, PRS bandwidth, number of consecutive subframes within a positioning occasion and PRS periodicity (periodicity of positioning occasions) 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.
  + RAN1 to study partial updates of PRS AD for UEs in RRC\_ INACTIVE mode to reduce overhead and power consumption.
* [OPPO, [8]]
  + For Rel-17 on-demand PRS, support Alt.2: Non-pre-configuration based solution
    - UE requests an on-demand PRS by indicating its preferred value(s) of some DL PRS parameter(s)
    - LMF indicates gNB/TRP to apply a DL PRS configuration with some given value(s) for some DL PRS parameter(s)
  + For Rel-17 on-demand PRS, at least the following parameters can be used for the UE/LMF request signaling:
    - the start time and duration (validity window)
    - TRP information
    - Positioning Frequency layer (PFL) information
    - Periodicity
    - Repetition
    - Number of symbols
    - Bandwidth
    - Muting pattern
    - QCL information
* [Qualcomm, [9]]
  + For on-demand DL-PRS, the UE should be able to send an explicit parameter list for one or more desired DL-PRS configuration(s) without prior configuration of potential PRS configurations. The following parameters should be able to be signaled:
    - Start/end time of DL PRS transmission
    - DL PRS resource bandwidth
    - DL PRS resource set transmission periodicity and set/resource offsets
    - DL PRS resource repetition factor
    - Number of DL PRS symbols per DL PRS resource
    - DL PRS QCL information
    - Number of TRPs
    - Number of PRS resources per PRS resource set
    - Number frequency layers
    - Beam directions
    - Combsize
    - ON/OFF indicator of the DL PRS
  + For on-demand DL-PRS, the UE should be able to send an explicit parameter list for one or more desired DL-PRS configuration(s) which includes indeces to of the one or more PRS resources/sets/TRPs/PFLs from the prior-configured allowed PRS configuration(s):
    - DL-PRS configution ID from the set of allowed PRS configuration(s)
    - PRS ID(s)
    - Positioning frequency layer ID(s)
    - DL-PRS resource set ID(s)
    - DL PRS resource ID(s)
* Support a UE to include one or multiple desired DL-PRS configurations, in decreased ordering of priority.
* [CMCC, [10]]
  + 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 bandwidth
    - DL-PRS resource set IDs
    - DL PRS resource IDs
    - DL PRS transmission periodicity and offset
    - DL PRS resource repetition factor
    - DL PRS muting patterns
    - DL PRS QCL information
    - TRP information (e.g., TRP ID)
    - 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 bandwidth
    - DL-PRS resource set IDs
    - DL PRS resource IDs
    - DL PRS transmission periodicity and offset
    - DL PRS resource repetition factor
    - DL PRS QCL information
    - Number of TRPs
    - TRP information (e.g., TRP ID)
    - Number of PRS resources per PRS resource set
    - Number frequency layers or frequency layer indicator
    - Beam directions
    - ON/OFF indicator of the DL PRS
* [CAICT, [7]]
  + For on demand PRS, the multiple sets of configuration of DL PRS can be supported, and the potential signaling of parameters can include system information broadcasting or RRC signalling.
* [Intel, [11]]
  + Support on-demand DL PRS framework based on parameters provided in Table 1 for UE and LMF-initiated requests

|  |  |  |
| --- | --- | --- |
| **Parameter Name** | **UE initiated request** | **LMF initiated request** |
| Start/end time of DL PRS transmission | Yes  (accuracy + link budget +power consumption + latency considerations)  Note: we assume it refers to duration of total DL PRS transmission and its allocation in time | Yes |
| DL PRS resource bandwidth | Yes (accuracy considerations) | Yes  (accuracy considerations) |
| DL-PRS resource set IDs | Yes (recommended TRPs for measurements) | Yes  (dedicated positioning areas / set of TRPs) |
| DL PRS resource IDs | Yes (recommended beams for measurements) | Yes  (recommended beams for DL PRS transmission) |
| DL PRS transmission periodicity and offset | Yes (latency considerations) | Yes (latency considerations) |
| DL PRS resource repetition factor | Yes  (accuracy + link budget considerations) | Yes  (accuracy + link budget considerations) |
| Number of DL PRS symbols per DL PRS resource | Yes  (accuracy + link budget considerations) | Yes  (accuracy + link budget considerations) |
| DL PRS muting patterns | Yes  (Control of interference on PRS resource) | Yes  (Control of interference on PRS resource) |
| DL PRS QCL information | No | No |
| Number of TRPs | No | No |
| Number of PRS resources per PRS resource set | No | No |
| Number frequency layers or frequency layer indicator | No | No |
| Beam directions | Yes (Reduce measurement overhead) | Yes  (TX beam sweeping) |
| Combsize, start PRB, Point A of DL PRS | Yes (Combsize – orthogonalization of PRS transmissions in frequency)  No (Start PRB, Point A) | Yes (Combsize – orthogonalization of PRS transmissions in frequency)  No (Start PRB, Point A) |

* [InterDigital,[12]]
  + Support parameters shown in Table 1 for on-demand parameters

Table 1 PRS parameters for UE/LMF initiated on-demand PRS

|  |  |  |
| --- | --- | --- |
| **PRS parameters** | **UE initiated** | **LMF initiated** |
| Start/end time of DL PRS transmission | Yes | Yes |
| DL PRS resource bandwidth | Yes | Yes |
| DL-PRS resource set IDs | Yes | Yes |
| DL PRS resource IDs | Yes | Yes |
| DL PRS transmission periodicity and offset | Yes | Yes |
| DL PRS resource repetition factor | Yes | Yes |
| Number of DL PRS symbols per DL PRS resource | Yes | Yes |
| DL PRS muting patterns | Yes | Yes |
| DL PRS QCL information | Yes | Yes |
| Number of TRPs | Yes | No |
| Number of PRS resources per PRS resource set | Yes | No |
| Number frequency layers or frequency layer indicator | Yes | Yes |
| Beam directions | Yes | No |
| Combsize, start PRB, Point A of DL PRS | Yes | Yes |
| ON/OFF indicator of the DL PRS | No | Yes |
| Beam directions | Yes | No |
| Measurement gap | Yes | Yes |
| Number of samples | Yes | No |

* [Huawei,[13]]
  + The followings are supported for UE-initiated on-demand PRS.
    - Request based on “initial AD”
    - DL-PRS resource set ID
    - DL PRS QCL information
    - Priority order of TRPs and PRS resource sets
    - Periodicity scaling
    - Standalone request without “initial AD”
    - UE reporting SCell information in CommonIEsRequestAssistanceData
  + At least the following are supported for LMF-initiated on-demand PRS.
    - ON/OFF indicator
      * The granularity can be TRP level, PRS resource set level, or PRS resource level
    - Beam direction
      * This should be interpreted that multiple PRS resources close to the beam direction are requested.
    - QCL information
      * Initiated by UE
* [Lenovo,[19]]
  + RAN1 to agree the following on-demand PRS parameters:
    - Start/end time of DL PRS transmission,
    - DL PRS resource bandwidth,
    - DL-PRS resource set IDs,
    - DL PRS resource IDs,
    - DL PRS transmission periodicity and offset,
    - DL PRS resource repetition factor,
    - Number of DL PRS symbols per DL PRS resource,
    - DL PRS muting patterns,
    - DL PRS QCL information,
    - Number of TRPs,
    - Number of PRS resources per PRS resource set,
    - Number frequency layers or frequency layer indicator,
    - Combsize,
    - start PRB, Point A of DL PRS
    - ON/OFF indicator of the DL PRS for at least LMF-initiated on-demand PRS request.
    - FFS the details regarding Beam directions.
* [Ericsson, [20]]

No table of figures entries found.

### Round #1

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

**Proposal 4.3-1**

* Companies are invited to fill in uploaded Excel spreadsheet and indicate their views regarding support of specific on-demand DL PRS parameters for each supported type of UE/LMF-initiated on-demand DL PRS request.
* Notes:
  + List of parameters agreed last time is used as a starting point to collect companies views
  + If DL PRS parameter is missing in the template list, company is welcome to add it in a last row and provide relevant comments
  + Current discussion is limited only to configurable DL PRS parameters (i.e. measurements are out of scope of discussion on this aspect)

Comments from companies:

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| --- | --- |
| Company Name | Comments |
| Qualcomm | As a first order principle:   * If prior-configuraitons of possible/allowable PRS are provided, then a UE/LMF should be able to suggest PFL-ID/PRS-ID/PRS-resoruce-ID/PRS-resource-set-ID. This is for Lists 3, 4 in the spreadsheet * If no prior configuration is provided, then UE/LMF should be able to request/recommend time/frequency/spatial properties.   We filled in the spreadsheet using the above principles.  A question to the FL: If there is no prior-configuration, how would the UE recommending “IDs” work? Or did the FL added all the rows in all 4 lists, just for the purpose of completeness? |
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## Aspect #4: On-demand DL PRS & UE/gNB measurements

* [CATT, [5]]:
* 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;
* 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 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.
* [Nokia, [6]]
  + UE to LMF reported parameters include beam-specific measurement reports that assist the LMF determine and request certain PRS resources to the gNB.

### Round #1

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

**Proposal 4.4-1**

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

Comments from companies:

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| Company Name | Comments |
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## Aspect #5: Request for on-demand DL PRS support

The following views were expressed for signaling to request on-demand DL PRS

[LGE, [15]]

* + For supporting on-demand PRS, RAN1 can discuss how UE to request one among predefined PRS configurations. If requesting mechanism is needed, it can be considered to use uplink channel (e.g., PUCCH, RACH) as a candidate.
  + The parameters related to measurement reporting can be included additionally.
    - For example, if the CG-based PUSCH is supported for the measurement report, the information regarding triggering/activation also can be included.

### Round #1

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

**Proposal 4.6-1**

* Companies are invited to provided comments on signaling aspects for on-demand DL PRS request.

Comments from companies:

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| Company Name | Comments |
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## Aspect #6: Aperiodic/semi-persistent on-demand PRS

The following views were expressed with respect to support of on-demand PRS

* [Xiaomi, [17]]
  + On-demand PRS should support periodical transmission, semi-persistent transmission and aperiodic transmission.
* [Mediatek, [14]]
  + Support periodic and semi-persistent SRS transmission in RRC inactive state

### Round #1

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

**Proposal 4.6-1**

* Companies are invited to provided comments on support of periodical, semi-persistent and aperiodic on-demand DL PRS transmission.

Comments from companies:

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| Company Name | Comments |
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## Aspect #7: On-demand measurement gap

The following views were expressed with respect to measurement gap for on-demand DL PRS

* [vivo, [2]]
  + Support to introduce on-demand measurement gap for on-demand PRS in Rel-17.
    - LMF requests measurement gap should be supported.
  + The on-demand measurement gap can be configured along with the on-demand DL PRS.
    - The on-demand measurement gap is requested with the request of on-demand DL PRS.
    - The on-demand measurement gap is configured when gNB receives the request of on-demand DL PRS.
* [InterDigital, [12]]
  + Study details about measurement gap (e.g., necessity, configuration) for on-demand PRS.

### Round #1

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

**Proposal 4.7-1**

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

Comments from companies:

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| Company Name | Comments |
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## Aspect #8: Multiple DL PRS configurations

* [vivo, [2]]
  + NR supports pre-configuration of multiple DL PRS configurations to UE.
  + The request of specific parameters for on-demand DL PRS should be supported.
  + Two ways to pre-configure multiple DL PRS configurations can be considered:
    - Preconfigure several lists of PRS configurations each consists of associated DL-PRS parameters, and each list is associated with an identifier
    - Preconfigure several lists each associated with a single parameter with different values which are numbered with an identifier

### Round #1

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

**Proposal 4.8-1**

* Companies are invited to provided comments on support multiple DL PRS configurations

Comments from companies:

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| --- | --- |
| Company Name | Comments |
| Qualcomm | Isnt that close to the multiple (allowable/possible) PRS configurations |
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## Aspect #9: Other aspects

The following list of additional aspects was discussed by

* [vivo, [2]]
  + Prioritize the work on separate DL positioning and separate UL positioning in inactive state, and then work on the DL and UL positioning in inactive state.
  + Consider combining the measurement results (such as RSRP) and/or UE location estimate to initiate specific on-demand DL PRS.
  + Interference problems caused by on-demand PRS should be considered and solved by RAN1.
  + Support to introduce PRS muting pattern of frequency domain level.
  + Further discuss whether to introduce PRS muting pattern of resource level or periodicity level.
  + The priority of on-demand DL PRS and normal PRS should be considered.
* [InterDigital, [12]]
  + Support ACK/NACK messaging for on-demand PRS
  + The UE can request to change the number of samples in PRS processing
  + Form multiple sets of PRS parameters for on-demand PRS such that the UE can make a request by indicating the set ID
  + Study details about measurement reports for on-demand PRS.
  + For UE-based positioning, the UE indicates whether location information is derived based on on-demand PRS or non-on-demand PRS or both
  + Support both semi-static and dynamic request intended for LMF and gNB, respectively, for on-demand PRS
* [Xiaomi, [17]]
  + gNB initiated of on-demand PRS transmission can be supported by RRC, MAC CE and DCI.
  + Support PRS measurement report by PUSCH including configured grant PUSCH and dynamic grant PUSCH.
* [Lenovo, [19]]
  + RAN1 to discuss the need to capture at least the UE-initiated triggers for on-demand PRS that affect the existing DL-PRS physical layer configuration, and necessitate a DL-PRS configuration update, e.g., DL-PRS measurement quality, DL-PRS beam failure, etc. Send LS to RAN2, where applicable.
  + LMF-initiated on-demand PRS requests can be left up to UE implementation.
  + Support the collective on/off switching of adjacent beams/TRPs carrying DL-PRS via a grouping mechanism.
  + 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.
  + RAN1 to support separate capabilities of UEs performing RRC\_INACTIVE positioning.

The mentioned above aspects can be discussed based on progress made by RAN1 for preceeding aspects.

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#106e meeting.

The following agreements were made by RAN1 during the RAN1#106e meeting on the topics discussed in this document:

References

1. R1-2106554 Discussion on items led by RAN2 for NR positioning ZTE
2. R1-2106600 Discussion on inactive state positioning and on-demand PRS vivo
3. R1-2106814 Considerations on positioning in RRC Inactive and on-demand PRS Sony
4. R1-2106893 Discussion on on demand positioning and positioning in inactive state Samsung
5. R1-2106976 Discussion on on-demand DL PRS and positioning for UEs in RRC\_ INACTIVE state CATT
6. R1-2107062 Additional views on Inactive Mode Positioning and on-demand PRS Nokia, Nokia Shanghai Bell
7. R1-2107170 Discussion on other enhancements for on-demand PRS and INACTIVE mode positioning CAICT
8. R1-2107218 Discussion on positioning for UE in RRC\_INACTIVE and on-demand PRS OPPO
9. R1-2107350 Enhancements Related to On Demand PRS And Positioning in RRC Inactive State Qualcomm Incorporated
10. R1-2107407 Discussion on RAN2-led items for positioning CMCC
11. R1-2107595 On-demand DL PRS Signalling and NR Positioning for UEs in RRC-INACTIVE state Intel Corporation
12. R1-2107649 Discussion on on-demand PRS and INACTIVE mode positioning InterDigital, Inc.
13. R1-2107664 Discussion on RAN2 led objectives for NR positioning Huawei, HiSilicon
14. R1-2107830 Potential physical layer impact to the RAN2-led topics MediaTek Inc.
15. R1-2107831 Discussion on other enhancements for positioning LG Electronics
16. R1-2107863 Discussion on positioning for UEs in RRC\_INACTIVE state NTT DOCOMO, INC.
17. R1-2107925 On-demand PRS and positioning for in-active state UE Xiaomi
18. R1-2108105 Considerations on SRS transmission for positioning in RRC\_INACTIVE state Fraunhofer IIS, Fraunhofer HHI
19. R1-2108146 Discussion on On-Demand PRS and RRC\_INACTIVE Positioning Lenovo, Motorola Mobility
20. R1-2108169 On-demand transmission and reception of DL PRS for DL and DL+UL positioning Ericsson