**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]:

|  |
| --- |
| [106-e-NR-ePos-06] Email discussion/approval on issues in the Others section including the LSs in [R1-2106411](file:///C:\\Users\\Docs\\R1-2106411.zip) and [R1-2106412](file:///C:\\Users\\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 & 2 & 3

### 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. |
| ZTE | We are OK to send reply LS unless some progress can be made in RAN1. However, the final decision on whether to specify UL/DL+UL positioning in RRC\_INACTIVE still depends on RAN2’s time budget/progress. |
| Huawei, HiSilicon | We support the intention to provde the reply to RAN2 if RAN1 is able to make progress. |
| CATT | We may decide whether to send LS to RAN2 based on the outcome of discussion during the meeting. |
| Futurewei | This can be decided later pending agreements made. |
| OPPO | It depends on RAN1 progress. Thus, the proposal can be discussed later |
| vivo | Support to send reply LS to RAN2 if RAN1 progress is made. |
| LG | We are fine to send reply LS. But, we’re wondering how much time we can spend to disucss on this proposal. |
| Intel | Support |
| SONY | This can be used as our reference points for discussion (e.g: ends up in Conclusion/Note). LS to RAN2 is subject to our progress. |
| InterDigital | Support |
| Nokia/NSB | It is early to decide now if RAN1 sends LS. If RAN1 makes progress in this meeting, we are okay to send an LS to RAN2 but we can decide later. |

### Round #2

This section is reserved to discuss draft LS reply to RAN2 once more progress is made by RAN1.

**Proposal 3.1-2**

* TBD

Comments from companies:

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| Company Name | Comments |
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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 |
| ZTE | We think the following two questions should be discussed in RAN1 to make proposal clearer.  **1. Does the SRS include all time domain types, i.e. aperiodic, semi-persistent and periodic SRS?**  **2. Can the SRS transmission only be supported in SDT active period (still in RRC\_INACTIVE) or can be supported outside SDT active period?**  We suggest to only support periodic SRS for simplicity especially if SRS transmission is supported outside SDT active period as there is no DL DCI/MACCE to trigger/active SRS.  Last, we think the final descision still should be RAN2. So our suggestion is   * + Transmission of SRS for positioning by UEs in RRC\_INACTIVE state is supported for UL and DL+UL positioning from RAN1 perspective     - RAN2 can further assess whether it is doable considering the time budget |
| Huawei, HiSilicon | Support.  To ZTE, we do not think there is pressing need to explicitly worry about RAN2 TU in a RAN1 proposal. |
| CATT | Support in general, assuming we will work on it more details on the transmission of SRS for positioning. |
| Futurewei | Support |
| OPPO | Whether this feature is supported or not is up to RAN2. Thus, RAN1 don’t need to discuss this proposal. What RAN1 can do is to design some scheme(s) to support it if RAN2 agrees to support it in Rel-17. For example ,we need to addree some key issues, e.g.,   * How does UE get and maintain the TA for SRS transmission? * How to do power control?   Similar to ZTE, we also support to clarify/discuss what type of SRS is used for this feature |
| vivo | Support. |
| CMCC | Support |
| LG | We are fine with the proposal. |
| Intel | Support |
| SONY | Support |
| InterDigital | Support |
| Xiaomi | Support. Further discussion is needed for the details. |

### Round #2

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

**Proposal 3.2-2**

* + From RAN1 perspective, transmission of SRS for positioning by UEs in RRC\_INACTIVE state is supported for UL and DL+UL positioning
  + RAN1 to select one of the following alternatives
    - Alt.1 Periodic and semi-persistent SRS for positioning are supported
    - Alt.2 Periodic SRS for positioning is supported

Comments from companies:

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| --- | --- |
| Company Name | Comments |
| CATT | Alt.1 is preferred. |
| Xiaomi | Alt. 1is preferred |
| Apple | We prefer Alt1, but there are still some questions left to us. Let’s first start with PosSRS Configuration for UE in RRC\_INACTIVE, aspect 5/4, etc then we can come back to this proposal. Question (may not be directly related to this proposal), How UE indicates capability to support PosSRS transmission in RRC\_Inactive? E.g. if UE is capable for PosSRS in RRC connected but not inactive …Please add subject to UE capability |
| vivo | Support the 1st bullet.  For the 2nd bullet, Alt. 2 is preferred. We think periodic SRS should be supported first, and whether to support semi-persistent/aperiodic SRS may be FFS. |
| Nokia/NSB | We have already suggested a modified proposal in the email thread. We just copy and paste our proposal in here to help of the review from other companies.  Proposal:   1. From RAN1 perspective, at least transmission of periodic SRS for positioning by UEs in RRC \_INACTIVE state is supported for UL and DL +UL positioning under certain validation criteria    1. FFS : whether/how semi-persistent and/or aperiodic SRS for positioning by UEs in RRC \_INACTIVE state is supported.    2. FFS: Details of validation criteria 2. ~~RAN1 to select one of the following alternatives~~    1. ~~Alt.1: Periodic and semi-persistent SRS for positioning are supported~~    2. ~~Alt.2: Periodic SRS for positioning is supported~~ |
| LG | As we all know, the original motivation of RRC inactive state is reducing the power. Why do we consider the periodic SRS defaultly? In fact, we think aperidic or semi-persistent SRS is more proper for inactive state. |
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### Round #3

Based on discussion over e-mail reflector it is recommended to further check the latest proposal suggested for agreement at the 1st check point and express view on modifications that can make it agreeable:

**Proposal 3.2-3**

* + From RAN1 perspective, transmission of SRS for positioning by UEs in RRC \_INACTIVE state is supported for UL and DL+UL positioning under certain validation criteria
    - FFS : Type(s) of SRS for positioning (i.e., periodic, semi-persistent, aperiodic)
    - FFS : Details of validation criteria which may also be discussed in RAN2

**Companies are invited to provide comments if above proposal is not acceptable and suggest modification that can make it agreeable**

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | We support the proposal, though we think at least periodic SRS should be supported. |
| Qualcomm | support |
| Nokia/NSB | Support. From our perspective, validation criteria is important. If the UE transmits SRS resources without consideration of any validation criteria, it could lead to interference to one or multiple TRPs, which may hurt the overall network performance. |
| InterDigital | We support the proposal. |
| CATT | Support |
| ZTE | Support |
| Xiaomi | We are fine with the proposal. But we have some concern on periodic pos-SRS for inactivate UE because of power consumption. Maybe it can be solved by a large periodicity. |
| OPPO | It is an RAN2-led topic. Thus, whether is supported or not should be decided by RAN2. Moreover, in RAN2 LS, it says:  *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.*  Baed on the highlighted part, RAN2 cares about “how positioning SRS should be used”, rather than whether RAN1 will support it nor not.  Based on the above discussion, we propose to revise the proposal as below,which is also more aligned with the condidtion “under certain validation criteria”:   * + From RAN1 perspective, it is feasible to support transmission of SRS for positioning by UEs in RRC \_INACTIVE state ~~is supported~~ for UL and DL+UL positioning under certain validation criteria     - FFS : Type(s) of SRS for positioning (i.e., periodic, semi-persistent, aperiodic)     - FFS : Details of validation criteria which may also be discussed in RAN2   Regarding the types of SRS, we think at leasty periodic SRS should be supported. |
| Vivo | Support, and oppo’s version also is acceptable |
| Intel | Support FL’s proposal |
| CMCC | Support |
| Apple | Support OPPO’s version (given we cannot converge on SRS type). |
| Ericsson | Ok with oppo’s rewording. We think that we could be more precise and limit SRS to periodic and SP SRS. |
| ZTE | OK with OPPO’s revision. We noticed RAN2 is also discussing time domain type of SRS transmission, so whether P/SP/AP SRS is supported should be up to RAN2 first. |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Support |
| ZTE | OK |
| Huawei, HiSilicon | Support. |
| CATT | Support |
| Futurewei | Support |
| OPPO | One question for the Pathloss RS. If UE in the active state, gNB can set a proper DL RS for pathloss measurement. However, if a UE with inactive state is moving to other cells, how to address the mismatch issue of the pathloss RS? Does the proposal mean that the UE will be enter into active state to update the pathloss RS when it moves to another cell? |
| vivo | Support  Reply to OPPO, this problem still exists in the connected state. We can reuse the fallback mechanism for inactive state to address potential mismatch. For example, 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. |
| CMCC | Support |
| LG | We support the proposal 3.3-1. |
| Intel | Support |
| SONY | Support |
| InterDigital | Support |
| Nokia/NSB | Support if SRS transmission is agreed for RRC\_INACTIVE UEs. |
| Xiaomi | Support |

### Round #2

Based on review of responses so far, majority of companies supported proposal in round #1 and thus it is proposed for endorsement at upcoming GTW

**Proposal 3.3-2**

* 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support |
| Xiaomi | Support |
| NTT DOCOMO | Support |
| vivo | Support, and please change “positionng” to “positioning” |
| Nokia/NSB | Support |
| OPPO | Support |
| ZTE | Support |
| LG | Agree. |
| Huawei, HiSilicon | Support. The typo can be corrected. |
| Qualcomm | Support |
| Intel | Support |
| ericsson | OK |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Support |
| ZTE | We think RAN2 will handle this issue. If majority is OK, we suggest   * From RAN1 perspective, TA procedures defined for CG-SDT support can be reused for SRS for positioning transmission by RRC\_INACTIVE UEs |
| Huawei, HiSilicon | Support. |
| CATT | Support |
| Futurewei | Support |
| OPPO | There are different characteristics between SRS transmission and data transmission. The transmission occasion of small data is random. However, the periodic SRS transmission will have pre-determined transmission occasions. In this case, gNB can exploit the periodic SRS for determine whether TA is needed to be updated. Thus, some new procedure should be considered for SRS for positioning in order to avoid the larger overhead and high power comsumption of RACH transmission |
| vivo | Support |
| CMCC | Support |
| LG | We think if UE may have TA for CG-SDT, the TA can be applied for SRS transmission for UE in INACTIVE. But, we think this issue will be handled by RAN2. |
| Intel | Support |
| InterDigital | Support |
| Nokia/NSB | Support if SRS transmission is agreed for RRC\_INACTIVE UEs. |
| Xiaomi | Support |

### Round #2

Based on review of responses so far, majority of companies supported proposal in round #1 and modifications from ZTE seems to be acceptable for endorsement at upcoming GTW

**Proposal 3.4-2**

* From RAN1 perspective, TA procedures defined for CG-SDT support can be reused for SRS for positioning transmission by RRC\_INACTIVE UEs

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support |
| Xiaomi | Support |
| vivo | Support |
| Nokia/NSB | Support |
| OPPO | TA preocedure for CG-SDT is not completed in RAN2 so far. We can have a conclusion rather than an agreement as below  Conclusion   * It is up to RAN2 for the TA precedures for SRS for positioning transmission by RRC\_INACTIVE UEs. |
| LG | We prefer OPPO’s revision. |
| Huawei, HiSilicon | We support the proposal. The prosal itself is statement from “RAN1 perspective”, since overall objective is under RAN2 lead, RAN2 can still make the decision. We are not against OPPO’s update, but do not think the change is that needed. |
| Qualcomm | Support |
| Intel | Support |
| Ericsson | We prefer oppo’s conclusion. It is unclear what is RAN1 perspective on TA procedures, which are defined by RAN2. |
| ZTE | We more prefer FL proposal as it at least provides RAN1’s views. The conclusion does not help anything.  One another way is to combine FL proposal and OPPO’s revision as follows   * From RAN1 perspective, TA procedures defined for CG-SDT support can be reused for SRS for positioning transmission by RRC\_INACTIVE UE   + It is still up to RAN2 for determination |

## 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 |
| ZTE | This is RAN2 issue as well. How to configure SRS parameters including power control configuration, TA, spatial realtion, etc. should be discussed in RAN2, e.g. by RRC Release with SuspendConfig, or by RRC in RRC\_CONNECTED state. |
| Huawei, HiSilicon | Generally fine.  We think the similar wording can be used from power control.   * Spatial relation defined in Rel.16 for transmission of SRS for positionng by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs |
| CATT | Support. The wording from Huawei is fine to us. |
| Futurewei | Support |
| OPPO | It should be ensured that the spatial relation RS and pathloss are aligned. |
| vivo | Support in principle.  In addition to configure spatial relation RS, we think enabling SRS beam sweeping in inactive state can also be considered. |
| CMCC | Support |
| LG | As mentioned by ZTE, we also think that RAN1 may inform to RAN2 regarding SRS related parameters, and RAN2 will make final decision. |
| Intel | Support, OK with wording from Huawei |
| SONY | Support |
| InterDigital | Support |
| Nokia/NSB | We are okay but we prefer to reuse the spatial relation configuration for Rel-16 SRS resource for positioning. This issue needs further study and discussion. |
| Xiaomi | Support |

### Round #2

Based on review of responses so far, majority of companies supported proposal in round #1 and modifications from Huawei seems to be acceptable for endorsement at upcoming GTW

**Proposal 3.4-2**

* Spatial relation defined in Rel.16 for transmission of SRS for positionng by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support |
| Xiaomi | Support |
| vivo | Support  We would like to confirm spatial relation includes enabling SRS beam sweeping. and please change “positionng” to “positioning” |
| Nokia/NSB | Support |
| OPPO | OPPO |
| ZTE | Support |
| LG | Support |
| Huawei, HiSilicon | Support. The typo can be corrected. |
| Qualcomm | Support |
| Intel | Support |
|  |  |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Support |
| ZTE | Support in principle.  One question should be discussed is: Whehter DL RS other than SSB can be the reference of PL-RS or spatial relation? For example, can CSI-RS be the PL-RS of SRS in RRC\_INACTIVE? In our view, it may not be feasible as UE may not measure CSI-RS in RRC\_INACTIVE. |
| Huawei, HiSilicon | Just clarify that we are saying the *SRS-PosResource* and *SRS-PosResourceSet* IEs will be reused. |
| CATT | Support in principle. May need to check if all of the existing configuration parameters in R16 can be used for RRC\_INACTIVE state. |
| OPPO | Support in principle.  Not quite understand what the sub-bullt (FFS part) means. Is the intension to say that “the detailed configuration signalling for SRS for positioning is up to RAN2”? |
| vivo | Support |
| CMCC | Support |
| LG | we generally fine with the proposal 3.6-1 and we also agree with Huawei’s comment. |
| Intel | Support |
| SONY | Not sure if we want to completely reuse it or partly? (e.g, similar to CATT comment) Suggest to change:   * Configuration parameters introduced for SRS for positioning in Rel.16 are reused as the baseline for UEs in RRC\_INACTIVE state |
| InterDigital | Support |
| Xiaomi | We suggest to discuss the details of configuration parameters first |

### Round #2

Based on review of responses 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 (i.e. *SRS-PosResource* and *SRS-PosResourceSet* IEs)
  + FFS in RAN2 details of configuration signaling used for SRS for positioning

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support. Maybe simpler to say:   * *SRS-PosResource* and *SRS-PosResourceSet* IEs introduced in Rel.16 are reused for UEs in RRC\_INACTIVE state. |
| Xiaomi | Support |
| Apple | We are fine with the intention. |
| NTT DOCOMO | Support |
| vivo | Support |
| Nokia/NSB | Support |
| OPPO | We are fine with the proposal in principle. Usually, “FFS” indicate further discussion in RAN1 itslef, which is not the intention. Thus, some modification for the sublet is suggested as below:   * 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)   + ~~FFS in~~ It is up to RAN2 for the details of configuration signaling used for SRS for positioning |
| ZTE | We would like to add an FFS below, because UE may not detect CSI-RS in RRC\_INACTIVE  FFS whether some parameters should be restricted, e.g. whether CSI-RS can be PL-RS or reference RS of Spatial relation |
| LG | Agree with version of OPPO’s revision. |
| Qualcomm | OK with OPPO’s version |
| Intel | Support FL’s proposal |
| Ericsson | Is the intention to configure the SRS also while the UE is inactive state? We don’t really understand what the proposal will add to rel16. Maybe a conclusion based on CATT’s rewording is a better way forward. |
| ZTE | @Ericsson, we think gNB can only configure SRS in RRC connection state or probably in SDT active period. The intention of FL proposal is to reuse the existing RRC configuration for **SRS transmission** in RRC inactive state. To avoid misunderstanding, we suggest   * Configuration parameters introduced for SRS for positioning in Rel.16 are reused for the SRS transmission in RRC\_INACTIVE state (i.e. *SRS-PosResource* and *SRS-PosResourceSet* IEs) |

## 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
* [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.

### 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Alt. 2 together with “UE capabilities for this feature” |
| ZTE | Alt.1  All the issues listed under Alt.2 should be discussed in RAN2. Unless RAN2 send LS to ask something, we don’t think there is any open issue left from RAN1 perspective including UE capability which is also under discussion in RAN2. |
| Huawei, HiSilicon | In our view, we see any enhancement to treat DL-PRS measurement in RRC\_INACTIVE different from RRC\_CONNECTED go against the RAN2 conclusion on RRC state exposure to LMF. Therefore, we think Alt.1 should be the way forward. |
| CATT | Our preference is Alt.1. |
| Futurewei | The question should be whether any deviations from existing support for Connected state needed? If not, then I think it implies Alt 1 |
| OPPO | Some aspects listed in Alt.2 need further study, e.g., the reception of DL PRS and other DL signals/channels at the same time. UE capability also needs discussion. |
| Vivo | This issue is related to the discussion of UE capability. We think we can continue to discuss it along with UE capability at later stages. |
| CMCC | Prefer Alt. 1 |
| LG | We are fine with the proposal 3.7-1. Also, we prefer Alt.2. |
| Intel | Alt. 1, assuming that the triggering of the activation/deactivation needs more discussion. |
| Lenovo, Motorola Mobility | Support Alt. 2 |
| InterDigital | We support Alt 2. |
| Nokia/NSB | We are generally okay with this down-selection proposal. Our preference is Alt.2 |
| Xiaomi | Prefer Alt 2 |

### Round #2

Based on review of responses it seems both alternatives have equalt support and it is proposed to have short online debate to see if any progress can be made and better understand positions of the companies:

**Proposal 3.7-2**

* 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
    - UE capability for NR DL positioning support by RRC\_INACTIVE UEs

Comments from companies:

|  |  |
| --- | --- |
| Company Name | Comments |
| Xiaomi | Support the proposal and prefer Alt 2 |
| Nokia/NSB | Support |
| OPPO | Support the proposal and prefer Alt.2 |
| ZTE | Alt 1.  Further, we doubt the necessity of this proposal. Even we go for Alt 2, we should study those aspects case by case. At least from our side, the subbullets listed under Alt.2 should be discussed in RAN2 rather than RAN1. |
| LG | Agree with the proposal and we prfer Alt.2 |
| Huawei, HiSilicon | We support the proposal.  Not sure if the motivation is to down-select them now, and if so, we think following work in Alt.2 if needed (except UE capability) should be triggered by RAN2 first, and thus we support Alt.1. |
| Qualcomm | Alt. 2  At least the UE capability is an obvious thing that needs to be discussed in RAN1. This is a new feature, in a later release, no doubt a capability is needed. |
| Intel | Support, Alt. 1 |
| ericsson | We don’t really see a motivation for discussing this proposal. if the issue is incomplete, we can update the SR accordingly and identify issues to complete. |
|  |  |
|  |  |

## 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:

|  |  |
| --- | --- |
| 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. |
| ZTE | Not support. We never evaluated this kind of positioning solution. We doubt whether the performance requirement is satisfied. |
| Huawei, HiSilicon | To DCM/CMCC:  If using RACH is about to convey the messages to support positioning, we think it should be discussed by RAN2 directly.  If using RACH is about to conduct measurement via PRACH/preamble, we think as long as the TEI-17 UL E-CID is enhanced, it should be applicable to UE in RRC\_INACTIVE without specification impact, e.g. RAN paging triggered RRC Resume procedure. |
| OPPO | Not support |
| vivo | Not support. We can reuse UL framework in connected state, that is, SRS for positioning is preferred. |
| CMCC | OK to de-prioritize this issue. |
| LG | One of advantage of using RACH is that the resource can be used by UE in INACTIVE without timing advance command.  Hence, we think RACH preamble is a good candidate for UL positioning and DL+UL positioning for UE in INACTIVE. |
| SONY | Down-prioritize |
| InterDigital | We are supportive of the proposal. |
| Nokia/NSB | Do not support. After introducing SRS for RRC\_Inactive, we can have further discussion if needed. |
| Xiaomi | Support. We share same view as LG that RACH preamble can be transmitted without TA command. |
| NTT DOCOMO | We support to introduce RACH preamble transmission for NR postioning (at least UL positining). We believe RACH based positioning is beneficial to obtain gNB Rx-Tx measurements with low latency since NW can measure gNB Rx-Tx time difference without any dedicated signalling.  TO HW:  Thank you for your comment. Our intention is the latter in your comment (i.e. using RACH is about to conduct measurement via PRACH/preamble). In addition, we have similar understanding as you (e.g. if TEI-17 UL E-CID enhancement is accepted, there is no spec impact in order to enable measurement via PRACH/preamble). |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Support |
| ZTE | OK but this is not needed to be included in the reply LS |
| Huawei, HiSilicon | Agree in principle. |
| CATT | Support |
| Futurewei | Not sure why this agreement is needed. Are we saying RAN1 should not discuss where applicable? |
| OPPO | Share the similar view as Futurewei |
| vivo | OK |
| LG | We are on the same page with Futurewei and OPPO. We think that some enhancements related with measurement report such as triggering/activation/deactivation can be handled by RAN1. To put this perspective, we think that RAN1 needs to discuss it and it might be useful for progress. |
| SONY | OK |
| InterDigital | The FL’s proposal is beneficial since it indicates which WG leads the discussion. Perhaps it can be rephrased as follows, to allow some room for RAN1 to disucss if necessary.  Proposal   * Discussions related to details of NR positioning measurement reporting by RRC\_INACTIVE UEs are ~~up to~~ led by RAN2 |
| Nokia/NSB | We do not think making agreement is necessary on this proposal. |
| Xiaomi | OK |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| ZTE | This is related with proposal 3.2.1 where whethe all of aperiodic, semi-persistent and periodic SRS are supported. We think it is better to discuss this issue first.  For periodic SRS activation, we think it can be used by RRC Release message but it is up to RAN2.  For semi-persistent SRS and aperiodic SRS, DL SDT should be used to activate/trigger SRS in RRC\_INACTIVE state. |
| Huawei, HiSilicon | We believe this can be done by RAN2, if the triggering is not based on DCI, e.g. MAC CE. |
| CATT | It may depend on the signaling details for activation and deactivation. Both RAN1 and RAN2 may need to be involved. |
| OPPO | It depends on what types of SRS for positioning are supported for a RRC\_INACTIVE UE. Thus, we should discuss the type of SRS |
| Xiaomi | It may depend on what types of SRS are supported for UE in RRC\_INACTIVE state, then corresponding singaling need to be introduced. |
|  |  |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | 2nd order details; suggest to de-prioritize for now |
| ZTE | This issue should be handled by RAN2 first |
| Huawei, HiSilicon | RAN2 is also discussing the possibility of separate UL BWP for CG-SDT, and we think SRS can reuse the discussion. |
| CATT | Share the similar view as ZTE and Huawei. |
| OPPO | In Rel-16, the PRS reception is not depending on some specific BWP. Thus, we would like to know why we need to connect BWP0 and PRS |
| vivo | We think we can discuss this issue after the progress (separate UL BWP for CG-SDT) from SDT. |
| LG | We think that RAN2 firstly discusses which BWP is used for UE in INACTIVE. This issue (PRS/SRS relationship with BWP0) can be de-prioritize in RAN1. |
| Nokia/NSB | Low priority for now. |
|  |  |

## 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
* [Lenovo, Motorola Mobility [19]]:
  + RAN1 to support separate capabilities of UEs performing RRC\_INACTIVE positioning.

### 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | We are supportive of having UE capability for Positioning in RRC inactive |
| ZTE | This issue has been raised in RAN2 previous meeting. We suggest to discuss it in RAN2 first.  Technically, we don’t support this kind of UE capability as RAN2 has agreed RRC active/inactive sate is transparent to LMF. That is, LMF is not aware of UE’s RRC state. So even UE reports such capability, what should LMF do?  If this capability is willing to be reported to gNB, we also don’t think it is necessary. Rel-16 UE has supported PRS processing in RRC\_INACTIVE sate. The new thing here is measurement report. |
| Huawei, HiSilicon | We don’t think a new capability is useful since LMF does not differentiate UE RRC state as per RAN2 conclusion. Neverthelss, the proposal would be fine for us. |
| OPPO | We support to have some kind of UE capability. Otherwise, how does NW know a UE can support it or not? |
| vivo | Agree with FL to discuss UE capability at later stage. |
| LG | It seems better that RAN2 disucsses UE capability for NR positioning for UE in INACTIVE. |
| Lenovo, Motorola Mobility | Support a separate UE capability for RRC\_INACTIVE positioning UEs since this can help the LMF better distinguish UEs with such a Rel-17 and beyond capability. |
| InterDigital | We are ok with the proposal. |
| Nokia/NSB | It is unclear to us. The LMF does not know the current state of UEs, so we are not sure if we need to define the UE capability for RRC\_Inactive UEs. |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Nokia/NSB | In our view, at least we need a consensus on whether or not to support the same positioning accuracy with the RRC\_INACTIVE. Or are we just going to discuss the required feature to support the positioning functionality for the RRC\_INACTIVE UEs? |
|  |  |
|  |  |
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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:

|  |  |
| --- | --- |
| **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. |

### Round #1

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

**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:

|  |  |
| --- | --- |
| Company Name | Comments |
| ZTE | OK |
| Huawei, HiSilicon | We support the intention to provde the reply to RAN2 if RAN1 is able to make progress. Yet we could also reply even if we cannot conclude it this meeting, since in general the higher layer parameter list can include the on-demand parameters, and an early RAN2 LS can indicate such information. |
| CATT | We may decide whether to send LS to RAN2 based on the outcome of discussion during the meeting. |
| Futurewei | Should be decided when agreements are made and available. We don’t need to agree an LS apriori. |
| OPPO | We share similar view as other companies that LS depends on the outcome of RAN1 discussion. |
| Intel | Support |
| InterDigital | We are ok with the proposal. |
| Nokia/NSB | We do not agree with this proposal. Sending an LS to RAN2 is up to RAN1 outcome. |

### Round #2

This section is reserved to discuss draft LS reply to RAN2 once more progress is made by RAN1.

**Proposal 4.1-2**

* TBD

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:

|  |  |
| --- | --- |
| |  | | --- | | - 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. |
| ZTE | Support List#1 and #2.  Based on LS, RAN1 only need to discuss what kind of parameters can be contained in the on-demand request. As for preconfiguration issue, RAN2 will handle it. |
| Huawei, HiSilicon | We assume that the preconfiguration does not reply on RAN1 at all. Why do we need List#3 and List#4?  RAN2 agreement below:   |  | | --- | | - 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. |   For the preconfiguration, UE will only select preconfiguration ID. No need to discuss the parameters.  One potential implemention based on our understanding would be a new field nr-OdAssistanceDataList is used to provide the list of pre-defined configurations under the assistance data for a specific method, e.g. NR-DL-TDOA-ProvideAssistanceData, where each configuration is the same structure as the Rel-16 *NR-DL-PRS-AssistanceData* with potential extention of a field *odConfigID*.  NR-DL-TDOA-ProvideAssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-AssistanceData-r16 NR-DL-PRS-AssistanceData-r16 OPTIONAL, -- Need ON  nr-SelectedDL-PRS-IndexList-r16 NR-SelectedDL-PRS-IndexList-r16 OPTIONAL, -- Need ON  nr-PositionCalculationAssistance-r16  NR-PositionCalculationAssistance-r16  OPTIONAL, -- Cond UEB  nr-DL-TDOA-Error-r16 NR-DL-TDOA-Error-r16 OPTIONAL, -- Need ON  ...,  [[  nr-OdAssistanceDataList-r17 SEQUENCE (SIZE(1..maxPreconf-r17)) OF NR-DL-PRS-AssistanceData-r16 OPTIONAL  ]]  }  NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,  nr-DL-PRS-AssistanceDataList-r16 SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF  NR-DL-PRS-AssistanceDataPerFreq-r16,  nr-SSB-Config-r16 SEQUENCE (SIZE (1..nrMaxTRPs-r16)) OF  NR-SSB-Config-r16 OPTIONAL, -- Need ON  ...,  [[  odConfigID-r17 INTEGER (1..xx) OPTIONAL  ]]  } |
| CATT | Support List#1 and #2. |
| OPPO | Supprt List#1 and #2. For the case with predefined PRS configurations, UE only needs to indicate which configuration is recommended. |
| vivo | We think a list for provision of (possible/allowed) on-demand DL-PRS configurations that the gNB can support from a gNB to an LMF should be discussed except the above 4 lists. That is, what parameters are helpful for LMF to pre-configure on-demand DL-PRS.  In RAN2 agreement below, it was agreed to support the provision of (possible/allowed) on-demand DL-PRS configurations that the gNB can support from a gNB to an LMF.  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  Therefore, we suggest discussing these parameters that the gNB can support from a gNB to an LMF for pre-configurations |
| LG | We have the similar view as ZTE. In terms of the RAN1 perspective, We need to fill the List#1 and #2. Regarding the pre-configured set, we think it needs to be handled by RAN2. |
| Intel | Support all 4 lists, given that parameters for the lists 3 and 4 need to be provided to RAN2 |
| SONY | Support List#1 and List#2 |
| Lenovo, Motorola Mobility | List#1 and List#2 as initial basis. FFS List#3 and List#4 |
| InterDigital | We support all four lists. |
| Nokia/NSB | Support all lists. For the case of pre-configured on-demand PRS, the UE can select preferable PRSs or TRPs which show better LoS environment, so a separattion discussion to make a list may be necessary. |
| Xiaomi | We can disucss List#1 and List#2 first. While for List#3 and List#4, it is only need to indicate which one is recommend according to the agreement of RAN#2. |

### Round #2

Based on received responses it seems companies have different understanding and interpretation of the RAN2 LS. From feature lead perspective, RAN1 needs to discuss/conclude on four cases/lists as it was described in Round-1 and provide input to RAN2 for each list given that parameters for List#1 and List#2 are proposed in RAN1 tdocs and RAN2 agreed on pre-configuration based on-demand DL PRS framework which is relevant to discussion on List#3 and List#4. Note that RAN2 has explicitly stated in LS the following:

|  |
| --- |
| * FFS if the UE can request a configuration with different parameters and exactly which parameters are flexible. * RAN1 is requested to define and provide the list of parameters for on-demand DL-PRS and inform RAN2 accordingly. |

Based on responses it seems some companies are OK to discuss parameters for List #1 and List#2 and have concerns to discuss parameters for List #3 and List#4 in RAN1. In order to avoid potential misunderstanding b/w WGs it can be recommended that RAN1 provides list of parameters as an input to RAN2 for all four lists. Otherwise, if it is not agreeable RAN1 needs to inform RAN2 that plans to work only on List #1 and List #2, while parameters for List#3 and List#4 are to be defined by RAN2.

**Proposal 4.2-2**

* Select one of the following alternatives
  + Alt.1:
    - The following lists of on-demand DL-PRS parameters are discussed/prepared by RAN1 and provided as input 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
  + Alt.2:
    - The following lists of on-demand DL-PRS parameters are discussed/prepared by RAN1 and provided as input 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
    - The following lists of on-demand DL-PRS parameters are up to RAN2:
      * 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 |
| CATT | Support Alt.2 |
| Xiaomi | Slightly prefer Alt 2 |
| vivo | Sorry, we will repeat our previous comments as there is no response.  We would like to know whether another list for provision of (possible/allowed) on-demand DL-PRS configurations is needed to be discussed in RAN1. That is, whether RAN1 needs to discuss what parameters are helpful for LMF to pre-configure on-demand DL-PRS(such as available time, available band).  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 |
| LG | Support Alt.2 |
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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:

|  |  |
| --- | --- |
| 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? |
| ZTE | We think all parameters are optional including preconfiguration ID. So RAN1 only needs to list the recommended parameters. RAN2 will discuss the exact signalling structure. |
| Huawei, HiSilicon | To QC, we think SCell information could serve as the so-call standalone on-demand PRS.  For preconfiguration (pre-defined configurations), it is not clear which level of preconfiguration agreed (overall AD, PFL, TRP, resource set, resource), but our understanding is that currently only the overall AD can work. It means that a list of overall AD (top level of assistance data) will be provided, and UE will select one overall AD (including reference and all non-reference TRP configurations), and RAN2 will work out other levels of preconfigurations if necessary. |
| vivo | In RAN2 agreements below, it was agreed that a new LPP assistance data IE can contain a set of possible on-demand DL-PRS configurations where each on-demand DL-PRS configuration has an associated identifier. We think it means the pre-configuration of on-demand DL-PRS is packed in different levels and the associated identifier is used to identify which pre-configured on-demand DL PRS is needed.  Agreement:  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.  Therefore, for pre-configuration cases, the DL-PRS pre-configution ID is needed. In addition, ON/OFF indicator is also needed to ON/OFF each on-demand DL-PRS along with the pre-configution ID. |
|  |  |
|  |  |

### Round #2

The 14 companies expressed views on List 1(UE-initiated request) and List 2 (LMF initiated request) parameters for on-demand DL PRS.

The summary is provided in Table 1 and Table 2 for UE- and LMF-initiated requests respectively

Table 1: Parameters for UE-initiated on-demand DL PRS request

|  |  |  |
| --- | --- | --- |
| **Parameter** | **Example parameter definition** | **Supported by** |
| 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 periodicity and length are indicated separately | 12 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| Number of DL PRS frequency layers | Recommended number of DL PRS frequency layers | 9 out of 14 (Qualcomm, ZTE, CATT, vivo, CMCC, LGE, InterDigital, Lenovo/MotM, Apple) |
| DL PRS frequency layer indicator | Recommended DL PRS frequency layers | 3 out of 14 (CATT, OPPO, InterDigital) |
| DL-PRS Resource Bandwidth | Number of PRBs recommended for the DL-PRS Resource (allocated DL-PRS bandwidth) in multiples of 4 PRBs. | 12 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotM, Apple) |
| DL-PRS Subcarrier Spacing | Subcarrier spacing of the DL-PRS Resource | 2 out of 14 (CATT, InterDigital) |
| DL-PRS Start PRB | Start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer | 6 out of 14 (Qualcomm, CATT, vivo, LGE, InterDigital, Apple) |
| DL-PRS Point A | Absolute frequency of the reference resource block for the DL-PRS | 1(vivo) |
| DL-PRS CombSizeN | Resource element spacing in each symbol of the DL-PRS Resource | 9 out of 14 (Qualcomm, ZTE, CATT, OPPO, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotoM) |
| DL-PRS Cyclic Prefix | Cyclic Prefix length of the DL-PRS Resource | 1 (ZTE) |
| DL PRS resource ID(s) | List of recommended DL PRS Resource ID(s) per DL PRS Resource Set | 4 out of 14 (LGE, Nokia, InterDigital, Lenovo/MotoM) |
| DL PRS resource set ID(s) | List of DL PRS Resource Set ID(s) per DL PRS frequency layer per TRP | 5 out of 14 (Huawei/HiSilicon, LGE, Nokia, InterDigital, Lenovo) |
| DL PRS Periodicity and ResourceSetSlotOffset | Recommended periodicity of DL-PRS allocation in slots configured per DL-PRS Resource Set and the slot offset with respect to SFN #0 slot #0 | 13 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel,Nokia, InterDigital, Xiaomi, Lenovo/MotM, Apple) |
| DL PRS Resource Repetition Factor | Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set | 12 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LG, Intel, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| 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 | 10 out of 14 (Qualcomm, ZTE, CATT, vivo, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotM, Apple) |
| Number of DL PRS Resource Symbols per DL PRS resource | Recommended number of symbols per DL-PRS Resource within a slot | 11 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotM, Apple) |
| DL PRS Resource Power | Recommended average EPRE of the resource elements that carry the PRS in dBm that is used for PRS transmission. The UE assumes constant EPRE is used for all REs of a given DL-PRS resource. | 1 out of 14 (ZTE) |
| DL PRS Muting Option 1 | Recommended DL-PRS muting configuration of the TRP for the Option-1 | 4 out of 14 (OPPO, Intel, InterDigital, Apple) |
| DL PRS Muting Option 2 | Recommended DL-PRS muting configuration of the TRP for the Option-2 | 4 out of 14 (OPPO, Intel, InterDigital, Apple) |
| DL PRS QCL information (DL-PRS-QCL-Info) | QCL indication with other DL reference signals for serving and neighbouring cells per DL PRS Resource | 11 out of 14 (ZTE, Huawei/HiSilicon, CATT, OPPO, vivo, CMCC, LG, Nokia, InterDigital, Xiaomi, Lenovo/MotM,) |
| Number of TRPs | Recommended number of TRPs [total or per frequency layer] | 8 out of 14 (Qualcomm, ZTE, vivo, CMCC, Nokia, InterDigital, Lenovo MotoM) |
| Number of DL PRS resources per DL PRS resource set | Recommended number of DL PRS resources per DL PRS resource set [per frequency layer] | 9 out of 14 (Qualcomm, ZTE, CATT, vivo, CMCC, Nokia, InterDIgital, Lenovo/MotoM, Apple) |
| Beam directions | Recommended beam directions | 10 out of 14 (Qualcomm, ZTE, vivo, CMCC, Intel, Nokia, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| ON/OFF indicator of the DL PRS | Recommended indication to switch ON/OFF DL PRS transmission [per frequency layer or per TRP or per DL PRS resource set or per DL PRS resource] | 1 out of 14 (vivo) |
| dl-PRS-ID(s) | Along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP | 1 out of 14 (CMCC) |
| nr-PhysCellID | The physical cell identity of the associated TRP | 2 out of 14 (ZTE, Nokia) |
| nr-CellGlobalID | Identifies the globally unique identity of a cell in NR, of the associated TRP | 1 out of 14 (ZTE) |
| nr-ARFCN |  | 0 |
| New parameter (proposed by HW) | Priority order of TRPs and PRS resource sets | 2 out of 14 (Huawei/HiSilicon, Lenovo/MotoM) |
| New parameter (proposed by HW) | Scell information |  |
| new parameter (proposed by OPPO) | TRP indication (to refer to some TRP(s)) | 2 out of 14 (OPPO, Lenovo/MotoM) |
| New parameter (proposed by vivo) | Angle measurement window | 1 out of 14 (vivo) |
| New parameter (proposed by LG) | Resource indication  (if CG-based PUSCH is supported for measurement report) | 1 out of 14 (LG) |

Table 2 Parameters for LMF-initiated on-demand DL PRS request

|  |  |  |
| --- | --- | --- |
| **Comments** | **Parameter definition** | **Supported by** |
| 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 periodicity and length are indicated separately | 13 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, Nokia/NSB, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| Number of DL PRS frequency layers | Recommended number of DL PRS frequency layers | 7 out of 14 (Qualcomm, ZTE, vivo, CMCC, LGE, Lenovo/MotoM, Apple) |
| DL PRS frequency layer indicator | Recommended DL PRS frequency layers | 2 out of 14 (OPPO, vivo) |
| DL-PRS Resource Bandwidth | Number of PRBs recommended for the DL-PRS Resource (allocated DL-PRS bandwidth) in multiples of 4 PRBs. | 13 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, Nokia/NSB, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| DL-PRS Subcarrier Spacing | Subcarrier spacing of the DL-PRS Resource | 0 |
| DL-PRS Start PRB | Start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer | 7 out of 14 (Qualcomm, CATT, vivo, LGE, InterDigital, Lenovo/MotoM, Apple) |
| DL-PRS Point A | Absolute frequency of the reference resource block for the DL-PRS | 2 out of 14 (vivo, Lenovo/MotoM) |
| DL-PRS CombSizeN | Resource element spacing in each symbol of the DL-PRS Resource | 10 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, LGE, Intel, Xiaomi, Lenovo/MotoM, Apple) |
| DL-PRS Cyclic Prefix | Cyclic Prefix length of the DL-PRS Resource | 1 out of 14 (ZTE) |
| DL PRS resource ID(s) | List of recommended DL PRS Resource ID(s) per DL PRS Resource Set | 3 out of 14 (vivo, LGE, Nokia) |
| DL PRS resource set ID(s) | List of DL PRS Resource Set ID(s) per DL PRS frequency layer per TRP | 4 out of 14 (vivo, LGE, Nokia, Lenovo/MotoM) |
| DL PRS Periodicity and ResourceSetSlotOffset | Recommended periodicity of DL-PRS allocation in slots configured per DL-PRS Resource Set and the slot offset with respect to SFN #0 slot #0 | 13 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, Nokia/NSB, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| DL PRS Resource Repetition Factor | Recommended number of DL-PRS Resource repetitions for a single instance of the DL-PRS Resource Set | 12 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, CMCC, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| 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 | 9 out of 14 (Qualcomm, ZTE, CATT, vivo, LGE, Intel, Xiaomi, Lenovo/MotoM, Apple) |
| Number of DL PRS Resource Symbols per DL PRS resource | Recommended number of symbols per DL-PRS Resource within a slot | 11 out of 14 (Qualcomm, ZTE, CATT, OPPO, vivo, LGE, Intel, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| DL PRS Resource Power | Recommended average EPRE of the resource elements that carry the PRS in dBm that is used for PRS transmission. The UE assumes constant EPRE is used for all REs of a given DL-PRS resource. | 1 out of 14 (ZTE) |
| DL PRS Muting Option 1 | Recommended DL-PRS muting configuration of the TRP for the Option-1 | 4 out of 14 (OPPO, vivo, Intel, Lenovo/MotoM) |
| DL PRS Muting Option 2 | Recommended DL-PRS muting configuration of the TRP for the Option-2 | 4 out of 14 (OPPO, vivo, Intel, Lenovo/MotoM) |
| DL PRS QCL information (DL-PRS-QCL-Info) | QCL indication with other DL reference signals for serving and neighbouring cells per DL PRS Resource | 11 out of 14 (ZTE, Huawei/HiSilicon, CATT, OPPO, vivo, CMCC, LGE, Nokia/NSB, InterDigital, Xiaomi, Lenovo/MotoM) |
| Number of TRPs | Recommended number of TRPs [total or per frequency layer] | 7 out of 14 (Qualcomm, ZTE, vivo, CMCC, Nokia, Lenovo/MotoM, Apple) |
| Number of DL PRS resources per DL PRS resource set | Recommended number of DL PRS resources per DL PRS resource set [per frequency layer] | 9 out of 14 (Qualcomm, ZTE, CATT, vivo, CMCC, Nokia, InterDigital. Lenovo/MotoM, Apple) |
| Beam directions | Recommended beam directions | 11 out of 14 (Qualcomm, ZTE, Huawei/HiSilicon, vivo, CMCC, Intel, Nokia/NSB, InterDigital, Xiaomi, Lenovo/MotoM, Apple) |
| ON/OFF indicator of the DL PRS | Recommended indication to switch ON/OFF DL PRS transmission [per frequency layer or per TRP or per DL PRS resource set or per DL PRS resource] | 4 out of 14 (Huawei/HiSilicon, vivo, InterDigital, Lenovo/MotoM) |
| dl-PRS-ID(s) | Along with a DL-PRS Resource Set ID and a DL-PRS Resources ID to uniquely identify a DL-PRS Resource. This ID can be associated with multiple DL-PRS Resource Sets associated with a single TRP | 0 |
| nr-PhysCellID | The physical cell identity of the associated TRP | 2 out of 14 (ZTE, Nokia) |
| nr-CellGlobalID | Identifies the globally unique identity of a cell in NR, of the associated TRP | 1 out of 14 (ZTE) |
| nr-ARFCN |  |  |
| new parameter (proposed by OPPO) | TRP indication (to refer to some TRP(s)) | 2 out of 14 (OPPO, Lenovo/MotoM) |
| New parameter (proposed by vivo) | Angle measurement window | 1 out of 14 (vivo) |

To progress discussion further, it is recommended to focus on parameters that have more that 50% support and continue on other parameter later on.

The following parameters have received ≥50% of support.

* UE initiated on-demand DL PRS request
  1. Start/end time of DL PRS transmission (12 of 14)
  2. Number of DL PRS frequency layers (9 of 14)
  3. DL PRS resource bandwidth (12 of 14)
  4. DL-PRS CombSizeN (9 of 14)
  5. DL PRS Periodicity and ResourceSetSlotOffset (13 of 14)
     + Note some companies believe that only periodicity is needed
  6. DL PRS Resource Time Gap (10 of 14)
  7. Number of DL PRS Resource Symbols per DL PRS resource (11 of 14)
  8. DL PRS QCL information (11 of 14)
  9. Number of TRPs (8 of 14)
  10. Number of DL PRS resources per DL PRS resource set (9 of 14)
  11. Beam directions (10 out of 14)
* LMF initiated on-demand DL PRS request

1. Start/end time of DL PRS transmission (13 of 14)
2. Number of DL PRS frequency layers (7 of 14)
3. DL-PRS Resource Bandwidth (13 of 14)
4. DL-PRS Start PRB (7 out of 14)
5. DL-PRS CombSizeN (10 out of 14)
6. DL PRS Periodicity and ResourceSetSlotOffset (13 of 14)
7. DL PRS Resource Repetition Factor (12 out of 14)
8. DL PRS Resource Time Gap (9 out of 14)
9. Number of DL PRS Resource Symbols per DL PRS resource (11)
10. DL PRS QCL information (DL-PRS-QCL-Info) (11)
11. Number of TRPs (7 of 11)
12. Number of DL PRS resources per DL PRS resource set (9 of 14)
13. Beam directions (11 of 14)

**Proposal 4.3-2**

* The following list of on-demand DL PRS parameters is supported for UE-initiated on-demand DL PRS request
  1. DL PRS Periodicity
     + FFS ResourceSetSlotOffset
  2. Start/end time of DL PRS transmission
  3. DL PRS resource bandwidth
  4. Number of DL PRS Resource Symbols per DL PRS resource
  5. DL PRS QCL information
  6. DL PRS Resource Time Gap
  7. Beam directions
  8. Number of DL PRS frequency layers
  9. Number of DL PRS resources per DL PRS resource set
  10. DL-PRS CombSizeN
  11. Number of TRPs
  12. DL PRS Resource Repetition Factor
  13. [DL-PRS Start PRB]
  + FFS other parameters
* The following list of on-demand DL PRS parameters are supported for LMF-initiated on-demand DL PRS request

1. Start/end time of DL PRS transmission
2. DL-PRS Resource Bandwidth
3. DL PRS Periodicity
   * + FFS ResourceSetSlotOffset
4. DL PRS Resource Repetition Factor
5. Number of DL PRS Resource Symbols per DL PRS resource
6. DL PRS QCL information (DL-PRS-QCL-Info)
7. Beam directions
8. DL-PRS CombSizeN
9. DL PRS Resource Time Gap
10. Number of DL PRS resources per DL PRS resource set
11. Number of DL PRS frequency layers
12. DL-PRS Start PRB
13. Number of TRPs
    * FFS other parameters

Companies are invited to provide comments on parameters which are not acceptable and reason (please refer to Table 3 and Table 4 below). In addition, companies are invited to provide commend on example definitions of parameters and exchange of views in Table 5

Table 3 Non-acceptable parameters for UE-initiated request (if any)

|  |
| --- |
| **Comments** |
| 1. DL PRS Periodicity [and ResourceSetSlotOffset]    * [Huawei, HiSilicon] Brief Reason: gNB PRS transmission occasion is complicated, as it involves multiple gNBs at the same time, and it affect the overall interference management, other signal transmission (SSB, Paging, common CORESET, System information, and even CSI-RS/TRS) that are fundamental to communication. We do not think changing this parameter based on a UE request is feasible from real deployment.      + [Response from Company Name]:    * [ZTE] We don’t support slof offset, it is nothing related with positioning performance. 2. Start/end time of DL PRS transmission    * [Huawei, HiSilicon] Brief Reason: gNB PRS transmission occasion is complicated, as it involves multiple gNBs at the same time, and it affects the overall interference management, other signal transmission (SSB, Paging, common CORESET, System information, and even CSI-RS/TRS) that are fundamental to communication. Why would UE make such a request? Is UE clear how long it will measure the PRS without even knowing how many PRS resources that it is about to process?      + [Response from Company Name]:    * [Nokia/NSB] PRS transmission start/end should be up to network decision. Especially, DL PRS resource is not only for a specific UE but is for multiple UEs for multiple cells. It is difficult for gNB to satisfy each UE's request of start/end time. Especially, the request of the end time may not necessary from the UE. The UE just needs to stop measurement for the PRS if it is not necessary.      + [Response from ZTE]: We think start/end time of DL PRS transmission recommended from UE or LMF is very beneficial, e.g. UE can request this parameter based on the current measurement gap configuration in order to request proper time window for PRS transmission. Further, a proper window can avoid collision between some other important DL signals and PRS from neighbour cells. Furthermore, this is just from UE request, if gNB is reluctant to satisfy the request in some scenarios, it is still up to gNB. 3. DL PRS resource bandwidth    * [Huawei, HiSilicon] Brief Reason: Why would UE request this rather than using its PRS bandwidth capability? 4. Number of DL PRS Resource Symbols per DL PRS resource    * [Huawei, HiSilicon] Brief Reason: The number of symbols (including comb size) should be a network deployment considering potential coverage of the PRS. How it can be varying based on a UE request? How could UE make a proper recommendation? 5. DL PRS QCL information    * [Company Name] Brief Reason 6. DL PRS Resource Time Gap    * [Huawei, HiSilicon] Brief Reason: What is the benefit of UE making such a request?    * [Nokia/NSB] The necessity is unclear to us. Is this related to UE’s processing capability? 7. Beam directions    * [Huawei, HiSilicon] Brief Reason: If it is about providing the beam direction information, we do not think it is needed, since for UE-A, we haven’t agree to introduce this, and for UE-B, the beam direction is anyway provided as if not, UE needs to check the UDM. If it is aboiut providing the PRS in a specific beam direction, how would UE know the desired beam direction in the first place?    * [CATT] Brief Reason: To support this, UE needs to know the desired DL PRS direction for each TRP. It is unclear to us how the UE know the desired beam direction for each TRP.    * [ZTE] QCL assumption is sufficient (or one of QCL and beam is sufficient)    * [Xiaomi]we want to clarify what is the difference between DL PRS QCL information and beam directions. 8. Number of DL PRS frequency layers    * [Huawei, HiSilicon] Brief Reason: Why would UE request this rather than using its number of frequency layers capability? 9. Number of DL PRS resources per DL PRS resource set    * [Huawei, HiSilicon] Brief Reason: Why would UE request this rather than using its number of resources per set capability? 10. DL-PRS CombSizeN     * [Huawei, HiSilicon] Brief Reason: The comb size (including the number of symbols) should be a network deployment considering potential coverage of the PRS. How it can be varying based on a UE request? How could UE make a proper recommendation? 11. Number of TRPs     * [Huawei, HiSilicon] Brief Reason: Why would UE request this rather than using it number of TRP capability?     * [CATT] Brief Reason: It is unclear how the UE to decide the number of TRPs to request, and how the network to response the request. |

Table 4: Non-acceptable parameters for LMF initiated request (if any)

|  |
| --- |
| **Comments:** |
| 1. Start/end time of DL PRS transmission    * [Huawei, HiSilicon] and Brief Reason: We think providing ON/OFF should be sufficient, instead of “expected transmission duration”.    * [Company2 Name] and Brief Reason 2. DL-PRS Resource Bandwidth    * [Huawei, HiSilicon] and Brief Reason: The resource bandwidth is directly related to the QoS that 5GS can provide. Why would LMF recommend a transmission bandwidth?    * [Company2 Name] and Brief Reason 3. DL PRS Periodicity [and ResourceSetSlotOffset]    * [Huawei, HiSilicon] Brief Reason: gNB PRS transmission occasion is complicated, as it involves multiple gNBs at the same time, and it affects the overall interference management, other signal transmission (SSB, Paging, common CORESET, System information, and even CSI-RS/TRS) that are fundamental to communication. We do not think changing this parameter based on a LMF request is feasible from real deployment.    * [ZTE] periodicity is sufficient since it can help gNB to decide the proper PRS density in time domain. Slot offset is not necessary from our side. 4. DL PRS Resource Repetition Factor:    * [Huawei, HiSilicon] Brief Reason: Repetition factor is related to coverage consideration, and thus dynamic change of this is not possible. The change of repetition factor will inevitably affect other services that gNB is offering. 5. Number of DL PRS Resource Symbols per DL PRS resource    * [Huawei, HiSilicon] Brief Reason: The number of symbols (including comb size) should be a network deployment considering potential coverage of the PRS. 6. DL PRS QCL information (DL-PRS-QCL-Info) 7. Beam directions    * [ZTE] QCL is equivalent to beam direction, so one of them is sufficient.    * [Xiaomi]we want to clarify what is the difference between DL PRS QCL information and beam directions. 8. DL-PRS CombSizeN    * [Huawei, HiSilicon] Brief Reason: The comb size (including the number of symbols) should be a network deployment considering potential coverage of the PRS. 9. DL PRS Resource Time Gap    * [Huawei, HiSilicon] Brief Reason: We do not see the benefit for the request from LMF. 10. Number of DL PRS resources per DL PRS resource set     * [Huawei, HiSilicon] Brief Reason: The number of PRS in a set should consider the corresponding impact on the beam width and coverage. If the beam number is reduced, the beam width is supposedly wider, and coverage is totally different. If this is about select a subset of beams for transmission, why wouldn’t LMF use the ON/OFF indicator per PRS resource? 11. Number of DL PRS frequency layers     * [Huawei, HiSilicon] Brief Reason: Why would LMF request a TRP changing the number of DL PRS frequency layer, instead of simply using ON/OFF indicator per positioning frequency layer? 12. DL-PRS Start PRB     * [Huawei, HiSilicon] Brief Reason: Why would LMF care about radio resource?     * [ZTE] Don’t need it. The sart PRB does not impact positioning performance 13. Number of TRPs     * [Huawei, HiSilicon] If it is LMF requesting a gNB to turn on PRS on a specific number of serving TRPs, we do not understand how gNB would determine which TRPs should be turned on. Why wouldn’t LMF using ON/OFF indicator per TRP?     * [CATT] Brief Reason: It should be sufficient for LMF to provide gNB the beam directions, and the gNB decide which to TRPs to turned on, or the LMF directly request which TRP to turned on based on the TRP information available in LMF.     * [Xiaomi] If it is a request from LMF to gNB, LMF can only send request to the TRPs which need to transmit PRS. Thus the number of TRPs is uneccessary. |

Table 5: Comments on example definition of parameters (if any) and exchange of views

|  |  |
| --- | --- |
| Company Name | Comments on example definition of parameters (any) and exchange of views |
| Huawei, HiSilicon | We would like to clarify the understanding on some parameters that are currently optional in the assistance data (LPP/NRPPa):   * Interpretation 1: Requesting the parameter to be included * Interpretation 2: Requesting the parameter to be a specific value |
| Qualcomm | Thanks to the feature lead for the hard work summarizing the input from the companies.  Overall we support these lists as is with the following additions:  **• “DL PRS Resource Repetition Factor”: got support from 12/14 companies in UE-initiated, and it seems it is missing in the proposal.**  Also, we would like to ask the companies to consider to also add the “DL-PRS Start PRB” in the UE-initiated List:  • It got support from 7 companies in the LMF-initiaed but 6 companies in the UE-initiated PRS.  • We think that if the specification supports the LMF-initiated, it would make sense to have for UE-iniatiated also. |
| ZTE | We think start/end time of DL PRS transmission recommended from UE or LMF is very beneficial, e.g. UE can request this parameter based on the current measurement gap configuration in order to request proper time window for PRS transmission. Further, a proper window can avoid collision between some other important DL signals and PRS from neighbour cells. |
| OPPO | “DL PRS Resource Fepetition Factor ” is missing in the list of UE-initiated mechanism |
| vivo | Remove “are ” in the first FFS   * + FFS other parameters ~~are~~ |
| Intel | Support |
| CMCC | Regarding the start/end time of the DL PRS transmission, we share similar views as ZTE.  Regarding the DL PRS resource bandwidth, we think that it is beneficial for the request, particularly for the UE-iniaited one, as the UE can recommend the DL PRS BW based on its LCS QoS requirement, or the measurement quality.  Regarding the number of TRPs of the UE-initiated on-demand DL PRS, with further thinking, we think that instead of requesting of number of TRPs, it would be more proper to request on demand DL PRS under certain TRPs/beam directions due to the measurement performance. However, it seems that this can be achieved by QCL information. |
| ZTE2 | For both list 1 and 2,  One of beam direction and QCL is sufficient. We don’t need to support both.  Start PRB is not needed since it does not impact positioning performance. |

## 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:

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support. LMF may use the reported UE/gNB measurements to make the proper configuration for the on-demand PRS |
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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:

|  |  |
| --- | --- |
| Company Name | Comments |
| LG | If predefined PRS configuration is supported for on-demand PRS, it needs that RAN discusses how UE to request one configuration among the PRS configuration. In this time, RAN1 can wait the RAN2’s progress of supporting multiple predefined PRS configuration. |
| InterDigital | A question for clarification. Is the intention of hte prposal to discuss signaling required for UE-initiated on-demand PRS? Is LPP considered as one of the signaling methods? |
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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 |
| Huawei, HiSilicon | Our understanding on MTK’s proposal is about SRS time domain behaviour in RRC\_INACTIVE, which should have no relevant with on-demand PRS. |
| Nokia/NSB | In our understanding, support of SP/AP PRS is not in the scope of this WID. |
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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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | This is out of the scope of the on-demand PRS objective. |
| vivo | Support to introduce on-demand DL PRS measurement gap for pre-configuration on-demand DL PRS at least. Without on-demand measurement gap, the UE may measure and process PRS according to the previous measurement gap configuration with an unmatched length and periodicity.  For the on-demand DL PRS measurement gap, as far as we are concerned, it has more benefits (such as reduce latency, resolve mismatch)  Therefore, we suggest introducing on-demand DL PRS measurement gap for on-demand DL PRS. |
| InterDigital | We support the proposal. Since PRS is provided on-demand basis, the measurement gap configuration should also be aligned, i.e., on-demand basis. |
| ZTE | We think it is beneficial if LMF can recommend/request proper measurement gap from gNB since LMF has the information of PRS configuration of all TRPs. |
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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:

|  |  |
| --- | --- |
| Company Name | Comments |
| Qualcomm | Isnt that close to the multiple (allowable/possible) PRS configurations |
| ZTE | Up to RAN2 |
| Huawei, HiSilicon | Our understanding of the preconfiguration agreed by RAN2 is the first way.   * + - Preconfigure several lists of PRS configurations each consists of associated DL-PRS parameters, and each list is associated with an identifier   NR-DL-TDOA-ProvideAssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-AssistanceData-r16 NR-DL-PRS-AssistanceData-r16 OPTIONAL, -- Need ON  nr-SelectedDL-PRS-IndexList-r16 NR-SelectedDL-PRS-IndexList-r16 OPTIONAL, -- Need ON  nr-PositionCalculationAssistance-r16  NR-PositionCalculationAssistance-r16  OPTIONAL, -- Cond UEB  nr-DL-TDOA-Error-r16 NR-DL-TDOA-Error-r16 OPTIONAL, -- Need ON  ...,  [[  nr-OdAssistanceDataList-r17 SEQUENCE (SIZE(1..maxPreconf-r17)) OF NR-DL-PRS-AssistanceData-r16 OPTIONAL  ]]  }  NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,  nr-DL-PRS-AssistanceDataList-r16 SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF  NR-DL-PRS-AssistanceDataPerFreq-r16,  nr-SSB-Config-r16 SEQUENCE (SIZE (1..nrMaxTRPs-r16)) OF  NR-SSB-Config-r16 OPTIONAL, -- Need ON  ...,  [[  odConfigID-r17 INTEGER (1..xx) OPTIONAL  ]]  } |
| CATT | Up to RAN2 |
| OPPO | It is up to RAN2 |
| LG | We think multiple DL PRS configuration is up to RAN2. |

## 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.

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.

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