3GPP TSG-RAN WG2 Meeting #115-e R2-210xxxx

Online Meeting, Aug 9th – 27th 2021

**Agenda item: 8.11.4**

**Source: Ericsson**

**Title: [Post114-e][603][POS] Procedures and signalling for on-demand PRS (Ericsson)**

**Document for: Discussion and Agreement**

# 1 Introduction

This document is to kick off the following email discussion:

* [Post114-e][603][POS] Procedures and signalling for on-demand PRS (Ericsson)

 Scope: Progress the design of on-demand PRS:

* Stage 2 procedure for the on-demand PRS request and configuration (can consider P9 of R2-2106467)
* Triggering conditions (if any are to be specified) for UE-originated and LMF-originated DL-PRS request
* Need for signalling from the UE of explicit parameters defining a requested DL-PRS configuration
	+ Does not include definition of the parameters that could be requested

 Intended outcome: Report to next meeting

 Deadline: Long/(August 6th, 0900 UTC)

The agreements so far in this area have been provided in section 6 for reference/recap.

# 2 Contact Information

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| Company | Contact: Name (E-mail) |
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# 3 Discussions

In this section, we attempt to gather input on discussions that were incomplete in the RAN2 #114e with regards to trigger conditions and need for explicit signalling [6].

## 3.1 Triggering Conditions

### 3.1.1 Triggering Conditions for UE

In previous meeting there were proposals from several companies suggesting to have a trigger condition and this was also captured in the summary document [6]:

* Define the triggering criteria for UE-initiated on-demand PRS, e.g., threshold for measurement quality, confidence level, etc., to provide a guideline for UE to determine an on-demand PRS request [1].
* The QoS in LPP RequestLocationInformation message can be used to trigger UE to send on-demand PRS request [2].
* Enable the LMF to request an activation/deactivation for the on-demand DL-PRS resources based on the UE measurements of configured DL-PRS resources [3].
* RAN2 to capture UE-initiated triggers based on at least positioning QoS requirements, measurement quality, change in radio conditions and UE assistance information in Stage 2 specifications. FFS how to include LMF-initiated triggers in Stage 2 text proposal [4].
* On demand PRS can be triggered to meet the required positioning service level.

Further, there was a proposal which was formulated as part of summary document [6]:

* Proposal: A UE may require criteria or event in order to trigger an on-demand DL-PRS request to the LMF. FFS Details of the on-demand DL-PRS trigger criteria.

**Question 1: Do companies agree with above Proposal: should on-demand PRS be possible to trigger from the UE based on defined events or criteria?**

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| Company | Agree with Proposal Yes/No | Comments |
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### 3.1.2 Additional input for Triggering Conditions for UE

If the answer to the above Question 1 is Yes; then to get further progress, it would be good to get additional input.

Based upon above proposal, it appears it is mainly the below two.

1. Based upon measurements, if after measurement, the measurement Quality (uncertainties, error and confidence level) is not up to satisfactory level, below threshold
2. Positioning QoS requirement is not met

Above a) and b) would boil down to essentially same KPI. That is when positioning measurements is computed and location is estimated, the measurement quality and confidence level is obtained, and the results can be cross checked to see whether positioning QoS is met or not. Further, if there is any fluctuation in radio condition, it would be reflected in the positioning measurements results and also in terms of measurement quality and confidence level of the measurements.

Hence, the above options can be written based upon:

* The trigger condition to request on-demand PRS from UE (UE operating in UE-based Positioning mode) is based upon Measurements and measurement qualities (uncertainties, errors and confidence level) which leads to not meeting a positioning QoS**.** Implying the trigger is based upon positioning QoS.

**Question 2: Is the trigger condition based upon positioning QoS agreeable for UE-based positioning? If agreeable, this means that when UE’s positioning QoS is not fulfilled, UE may initiate request of on- demand PRS. Another way to view the question would be, why would UE initiate on-demand PRS while its required positioning QoS is met?**

*Note: For UE-Assisted, it is LMF which computes the location and verifies whether QoS is met or not. Hence, UE-Assisted should be part of LMF-triggered on-demand PRS.*

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### 3.1.3 Triggering Conditions for LMF

For UE-Assisted

LMF needs to serve multiple UEs and thus it needs to take into account the measurement qualities (uncertainties, errors, confidence level) from several UEs. It needs to determine whether positioning QoS is satisfied or not for multiple UEs involved in positioning whilst ensuring PRS transmission overhead is energy efficient. LMF should strive towards a resource efficient configuration (save power, PRS overhead reduction).

Thus, the same trigger that is applicable to UE-bases should be applicable to UE-assisted i.e Positioning QoS should be also be valid for LMF when LMF computes the positioning for UEs operating in UE-assisted positioning mode.

**Question 3: Do companies agree that the computed Positioning QoS and PRS overhead reductions (energy savings) are the trigger condition for LMF for UE-Assisted?**

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For UE-Based

For UE-based, the trigger would come from the UE to request the change of PRS configurations. Hence, another trigger for LMF would be based upon request received from UEs operating in UE-based positioning mode.

**Question 4: Do companies agree that the on-demand request received from UEs operating in UE-based (QoS not met) and PRS overhead reductions are the trigger condition for on-demand PRS trigger from LMF?**

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## 3.2 Need of Explicit Signalling

When there are fewer UEs that need to be positioned, it may be possible to configure UE specific PRS [11]; i.e PRS parameters tuned/optimized to the UE needs; for example, the PRS BW, periodicity, PRS resources (including number of Frequency layer, TRPs, Resource sets and resources). It is possible to obtain feedback from UE on its preferred configuration and also for LMF to reconfigure PRS parameters with dedicated signalling based upon some trigger conditions such as measurement quality/QoS. When the number of UEs scale, then instead of dedicated signalling rather a common broadcast which shall work for majority (or all) UE is preferred.

In FR2, the PRS might need to be transmitted in a beamformed fashion to compensate the higher path loss at higher carrier frequencies and therefore the beam sweeping procedures need to be followed, such as SS/PBCH, System Information (SI) or paging [10]. The PRS transmission to all beam sweeping directions results in an unnecessary transmission of PRSs. The UE may pop up in any corner of the beam and NW has to be opportunistic to identify the suitable TRPs/beams for the DL-PRS configurations. It may be difficult to broadcast beforehand or prepare the UE specific configuration beforehand.



Figure 1: Non-beamformed (left) and beamformed (right) PRS transmission [10]

**Question 5: Do companies agree with the need of explicit signalling to reconfigure DL-PRS parameters?**

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# 4 Stage 2 Procedures

In this section, we attempt to come with an overall on-demand PRS procedure. In order to ascertain the stage 2 procedure, there are few questioners that require input.

## 4.1 On-Demand PRS

The On-demand PRS involves two scenarios which were also briefly touched upon during online session

1. On-demand PRS implies configuring PRS on need basis. This would also imply that there is no PRS being transmitted or PRS has been deactivated. If LCS client request for Positioning (GMLC, UE LCS client), the LMF needs to determine the suitable PRS configuration.
2. Another scenario is where PRS is already being transmitted and either the UE may request or LMF may need to change the current configuration

### 4.1.1 PRS is currently not transmitted

From a UE perspective, scenario a) is equivalent to a situation that already happens in real LTE PRS deployments: When PRS is being transmitted but LMF is unsure about the TRPs/Cells to be included in the assistance data. Thus, E-CID is considered as a pre-requisite procedure to provide LMF such information. For on-demand PRS, it may happen that the PRS is not currently being transmitted and based upon pre-requisite procedure such as E-CID (SSB and CSI-RS RSRP [7]) results, the LMF may request to gNBs for the initiation of DL-PRS transmissions.

Additionally, on-demand request is used to activate PRS which were potentially deactivated, this request/feedback should not be based on DL PRS reference signal but based on some other reference signal information. The simplest approach is that UE provides RSRP feedback per TRP per beam (e.g., SSB), which the network utilizes to switch ON DL-PRS [7].



1. The AMF transfers the location services request to an LMF which was received from an LCS client either in GMLC or in UE. If the LCS client is in UE, it may include measurement report (CSI-RS and SSB RSRP, E-CID report) as part of MO-LR request message [9]. The LCS client in UE may also provide other details such as number of TRPs, beam direction, start time and duration for the DL-PRS transmission which may also be forwarded from AMF to LMF [9].

Note: Positioning QoS is already part of LCS service request. (TS 38.305, 7.3.2)

1. If the client is GMLC or the measurements not available in step 1, the LMF may request for measurements to UE.
2. The UE provides the requested measurements to LMF, if not already provided in step 1.
3. LMF determines the needed DL-PRS transmission resources.
4. LMF request for DL-PRS transmission from different gNBs (TRPs) which may include serving and other TRPs.
5. The gNBs provide an acknowledgement to the LMF for initiating the PRS transmission; or may indicate failure if unable to initiate PRS transmission.
6. In case of success, the LMF prepares the DL-PRS configuration accordingly and provides to the UE.

Editor’s Note: The steps are mere suggestion based upon contribution of various companies during previous meetings and companies are requested to provide comments below.

**Question 6: Do companies agree on a high level with the above steps?**

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### 4.1.2 PRS is already transmitted

In this case, the assumption is that when the LCS client wants to position the UE; the DL-PRS is already being transmitted. RAN2 has already agreed that there can be multiple pre-defined configurations and UE may request one of the pre-defined configurations. Further, LMF may also change the current configuration with a different pre-defined configuration.



1. LMF provides Assistance Data (DL PRS configuration) to the UE via LPP dedicated signalling.

1a. Alternatively, or in addition to step 1, DL PRS configuration is provided to UE via RRC broadcast (posSIBs).

1. UE performs positioning measurements based upon received DL PRS Configurations from either LPP or RRC broadcast. If UE is operating in UE-based positioning mode and certain condition such as Positioning QoS is not met, the UE initiates On-demand PRS request.
2. UE sends an on-Demand PRS request with its preferred configuration such as configuration index or request to increase resource/decrease DL-PRS resources.
3. LMF determines whether there is need to change DL-PRS configuration. The LMF may decide based upon input received from multiple UEs.
4. LMF requests the serving and non-serving gNBs/TRPs for changing the current DL-PRS configuration via NRPPa.
5. The gNBs/TRPs provide the DL-PRS transmission update in the NRPPa response message accordingly.
6. LMF provides the on-demand DL-PRS configuration to the UE via LPP.

7a. Alternatively, or in addition to step 7, LMF provides the on-demand DL-PRS configuration to the gNBs via NRPPa for broadcast.

7b. gNBs provide the configuration to the UE via RRC Broadcast

Editor’s Note: The steps are mere suggestion based upon contribution of various companies during previous meetings and companies are requested to provide comments below.

**Question 7: Do companies agree on a high level with the above steps?**

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| Company | agree with above Yes/No | Comments |
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In order to describe the stage 2 procedure and to identify correct wordings; we would like to get some input from companies for the case when PRS is already being transmitted.

NW behaviour

When multiple PRS configurations have been defined and notified to UE, the request from UE may include the index of the pre-defined DL-PRS configuration. One question that arises and was also discussed briefly online as what should be the NW/LMF behaviour if it receives such request from UE?

1. Is LMF obliged to change the configuration even if it received request from just one UE?
2. Is UE request considered as preferred configuration from UE and it is up to NW implementation as when and how NW acts upon such request?
3. If several UEs request the same configuration index; then LMF may request gNBs to change the configuration.
4. It is anyway up to NW implementation

**Question 8: Companies are invited to provide input on which option is best suited here. Please select multiple options if necessary?**

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UE Behaviour 1

The different DL-PRS classification/configuration could be as suggested below [10].

*Table 1 – DL PRS pre-configuration associated with QoS and radio conditions*

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| *QoS Requirement / Radio Condition* | *Pre-configured PRS Configuration* |
| ***A:*** *High-accuracy and low-latency positioning*  | ***#1:*** *a configuration with large bandwidth and short periodicity* |
| ***B:*** *Medium accuracy and latency positioning*  | ***#2:*** *a configuration with medium bandwidth and periodicity* |
| ***C:*** *Low-accuracy and high-latency positioning*  | ***#3:*** *a configuration with small bandwidth and large periodicity* |
| ***D:*** *Positioning with large UL/DL path loss* | ***#4:*** *a configuration with large power* |

The classification of DL-PRS configurations may be based upon above where one set of configuration contains low periodicity and high BW whereas another category may contain high periodicity and low BW.

Question 7: In such multiple-DL PRS configuration; how to ensure, UE is not always requesting configuration that is configured with lowest periodicity and highest BW? Example: If UE was provided with configuration C, how to ensure UE does not ask for configuration A when configuration B would have been sufficient for the UE?

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UE Behaviour 2

**Question 10: What happens if UE request is not fulfilled by LMF or LMF is unable to provide preferred configuration?**

Please indicate (also multiple) options and any comments.

1. Should UE request again after certain interval
2. (Pre) configured wait time by LMF
3. decided by UE
4. Should UE perform the measurement based upon the configuration that has been currently provided and not request further after one attempt/request?
5. Shall a NACK be required by UE from LMF incase if LMF is not able to fulfil?
6. Should UE log the request and upload it as part of SON reporting so NW can learn the UE preferred/desired configuration at a certain location if NW does not accept UE request.

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UE Capability

There was also suggestion that on-demand PRS should have UE capability in contribution [12]. If so, what would be the UE behaviour if LMF wants to change the configuration based upon a request from some other UE? Assume that the current PRS configuration was requested by a first UE. A second UE requests another PRS configuration and LMF changes the configuration accordingly. In this case, what should be the behaviour of the first UE? One Option can be:

* On-demand PRS functionality is supported by default. The NW updates the essential changed PRS configuration parameters to each UE (either via broadcast or via dedicated signaling). The essential parameters that has been changed should be notified to UE and that should be discussed by RAN1.

**Question 11: Do companies agree that capability is needed? Further, please provide additional comments.**

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Additional Assistance Data from UE

The trigger condition such as Positioning QoS or measurement quality and confidence may be impacted because of some factors such as some DL-PRS Resources belonging to certain PFL, TRP, Resource set may yield poor performance such as poor RSRP, NLOS, interference, poor GDOP, ranging errors etc. For DL-TDOA in Rel-16 before reasons have been provided as error causes from UE to LMF. In order for LMF to make wise decision, UE may provide additional assistance data.

Currently for NR-DL-TDOA positioning method of any error encountered during positioning then the UE provides below information to the LMF.

#### *NR-DL-TDOA-TargetDeviceErrorCauses*

The IE *NR-DL-TDOA-TargetDeviceErrorCauses* is used by the target device to provide NR DL-TDOA error reasons to the location server.

-- ASN1START

NR-DL-TDOA-TargetDeviceErrorCauses-r16 ::= SEQUENCE {

 cause-r16 ENUMERATED { undefined,

 assistance-data-missing,

 unableToMeasureAnyTRP,

 attemptedButUnableToMeasureSomeNeighbourTRPs,

 thereWereNotEnoughSignalsReceivedForUeBasedDL-TDOA,

 locationCalculationAssistanceDataMissing,

 ...

 },

 ...

}

-- ASN1STOP

The same scheme can be followed also for requesting new PRS configuration by UE.

-- ASN1START

PRS-ConfigurationRequestCauses ::= SEQUENCE {

 cause-r17 ENUMERATED { poor-RSRP,

 nlos-ReferenceTRP,

 nlos-MeasuredTRPs,

 poor-GDOP,

 rangingErrors,

 interference,

 ...

 },

 measurementTimestamp UTC

 ...

}

-- ASN1STOP

**Question 12: Do companies agree that additional assistance data is helpful? Further, please provide additional comments.**

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Further corresponding to the above cause, the UE can also be specific for which TRPs/ResourceSets/Resources that resulted in poor RSRP. Below UE reports the PFL, TRPs, ResourceSet and Resources in descending order of worse contributors for RSRP.

-- ASN1START

PoorRSRP-ContributorPFL-List-r17 ::= SEQUENCE (SIZE(1..4)) OF PoorRSRP-ContributorPFL-r17

PoorRSRP-ContributorPFL-r17 ::= SEQUENCE {

 positioningFrequencyLayerID-r17 INTEGER (1..4),

 trp-ContributorList-r17 SEQUENCE (SIZE (1..64)) OF TRP-Contributor-r17

}

TRP-Contributor-r17 ::= SEQUENCE {

 trpID-r17 INTEGER (0..255),

 resourceSetList-r17 SEQUENCE (SIZE (1..2)) OF ResourceSet-Contributor

}

ResourceSet-Contributor ::= SEQUENCE {

 resourceSetID-r17 INTEGER (0..7),

 resourceList-r17 SEQUENCE (SIZE(1..64)) OF INTEGER (1..64)

}

-- ASN1STOP

**Question 13: Do companies agree that providing worst offenders or best performer list to the NW can help NW to optimize PRS transmission? Further, please provide additional comments.**

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Additional Measurement Configuration to obtain feedback from UE for a sufficiently large set of PRS resource per TRP

As motivated in [7], UE feedback for on-demand PRS does not necessarily need UE support for new measurements; existing measurements can be reused instead. However, new configurations on existing measurements might be needed, which account for reporting a sufficiently large set of PRS resource per TRP measurements as part of UE feedback for on-demand PRS. UE feedback is crucial for on-demand PRS to understand whether the latest PRS resource allocation can meet the positioning requirements. As such, the UE feedback for this operation is feedback based on the PRS strength or quality received at the UE, such as PRS RSRP/RSRQ.

**Question 14: Do companies agree on the motivation for additional measurement configuration from UE such that UE provides feedback on the measurement quality of the latest PRS resource allocation?**

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##

# 5 Conclusion

TBD

# 6 Agreements

**RAN2-113bise**

Agreements:

UE-initiated on-demand PRS request is enabled by enhancing LPP RequestAssistanceData. FFS how much control the network has over the UE request.

The UE-initiated mechanism is enabled by the UE request triggering a request from the LMF, and the actual PRS changes are requested by the LMF irrespective of whether the procedure is UE- or LMF-initiated.

Put the stage 2 description for UE-initiated and LMF-initiated PRS request under the same framework.

**RAN2-114e**

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.

The new LPP assistance data IE from Proposal 2 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.)

# 7 References

1. R2-2105217, "Discussion on on-demand PRS", Huawei.
2. R2-2105562, "Positioning enhancement to on-demand DL PRS", Xiaomi.
3. R2-2105734, "On-demand PRS", Fraunhofer.
4. R2-2105603, "On-Demand DL-PRS Support", Lenovo.
5. R2-2105704, "Considerations on positioning PRS On-demand", Sony.
6. R2-2106467***,*** Summary on agenda item 8.11.4 on on-demand PRS, Qualcomm
7. R2-2103998, On-demand PRS transmission considerations, Nokia
8. R2-2105969, "On demand PRS", Ericsson
9. R2-2103901, "On-Demand DL-PRS", Qualcomm
10. R2-2106355, Pre-configuration and initiation of on-demand PRS associated with QoS/radio conditions”, Nokia
11. R1-1906526, “Discussion on physical-layer procedures to support NR positioning measurements”, CMCC
12. R2-2104803, "Further discussion on on-demand PRS", CATT.