3GPP TSG-RAN WG2 Meeting #114-e DRAFT-***R2-2106467***

Electronic Meeting, May 19 – 27, 2021

**Agenda item:** 8.11.4

**Source:** Qualcomm Incorporated

**Title:** Summary on agenda item 8.11.4 on on-demand PRS

**Document for:**  Discussion

# 0. Introduction

This document summarizes the following contributions submitted for Agenda Item 8.11.4: On-demand DL-PRS:

[1] R2-2104803, "Further discussion on on-demand PRS", CATT.

[2] R2-2104848, "Discuss on-demand PRS", vivo.

[3] R2-2104924, "Support of on-demand PRS request", Intel.

[4] R2-2105134, "Discussion on UE-initiated on-demand PRS", Apple.

[5] R2-2105217, "Discussion on on-demand PRS", Huawei.

[6] R2-2105221, "Stage-2 TP for on-demand PRS", Huawei.

[7] R2-2105305, "Discussion on procedures for On-demand PRS for DL-based positioning", InterDigital.

[8] R2-2105306, "Discussion on procedure for On-demand PRS for DL+UL based positioning", InterDigital.

[9] R2-2105338, "Discussion on on-demand DL-PRS, OPPO.

[10] R2-2105547, "Discussion on on-demand PRS", Spreadtrum.

[11] R2-2105562, "Positioning enhancement to on-demand DL PRS", Xiaomi.

[12] R2-2105603, "On-Demand DL-PRS Support", Lenovo.

[13] R2-2105704, "Considerations on positioning PRS On-demand", Sony.

[14] R2-2105734, "On-demand PRS", Fraunhofer.

[15] R2-2105969, "On demand PRS", Ericsson .

[16] R2-2106084, "On-Demand DL-PRS", Qualcomm.

[17] R2-2106354, "UE feedback for on-demand PRS", Nokia.

[18] R2-2106355, "Pre-configuration and initiation of on-demand PRS associated with QoS/radio conditions", Nokia.

[19] R2-2106370, "Support of on-demand DL PRS for positioning efficiency", Samsung.

[20] R2-2106379, "On-demand DL PRS transmission and reception", Convida.

[21] R2-2106424, "Discussion on restriction of on demand PRS", ZTE.

[22] R2-2106425, "Discussion on on demand PRS", ZTE.

The items and proposals discussed in the various contributions are grouped as follows:

1. General Signalling Aspects

- Signalling between UE and LMF

- Signalling between LMF and NG-RAN

2. Information Transferred between UE, gNB, and LMF

- On-demand DL-PRS configuration information

- UE assistance information/measurements

3. On-demand DL-PRS trigger criteria

4. Overall Procedure

5. Outgoing Liaisons

6. Other Aspects / Proposals

# 1. General Signalling Aspects

## 1.1 Signalling between UE and LMF

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| CATT [1] | Proposal 2: LMF provides available DL-PRS resources to UEs before UE sends the on-demand PRS request. Only the UEs who received the available DL-PRS can be allowed to imitate the on-demand PRS, and the requested PRS configuration should be based on the available PRS provided by LMF. |
| vivo [2] | Proposal 2: Support UE-initiated request PRS by sending a preconfigured set index number to LMF and LMF determines the new PRS configuration. |
| Intel [3] | Proposal 1: The UE can only send the on-demand PRS request if LMF enables this via LPP message ProvideAssisntanceData.Proposal 2: The LMF shall configure allowed configuration sets to the UE via LPP message ProvideAssisntanceData. The UE can only select the requested parameters within the sets. |
| Apple [4] | Proposal 3 LPP Assistance Data includes a set of preconfigured DL-PRS IDs which are not transmitted but can be triggered on-demand. |
| Huawei [5] | Proposal 7: For the UE-initiated on-demand PRS, LMF can provide some recommendation to UE by enhancing the existing LPP ProvideAssistanceData, e.g., PRS configuration that can be requested for on-demand PRS. Proposal 8: UE can down-select from the parameters from what LMF’s recommendation with different granularities of frequency layer, TRP, PRS resource set and PRS resource.  |
| InterDigital [7] | Proposal 1: Support configuring of candidate PRS parameters and/or candidate PRS configurations in assistance data that can be indicated by UE in on-demand PRSProposal 4: Support UE-initiated on-demand PRS request to change/update parameters to be applied in a DL-PRS transmissionProposal 5: Support UE-initiated on-demand request to indicate a PRS configuration to be applied in a DL-PRS transmissionProposal 6: Support semi-static on-demand PRS request from UE to LMF |
| Oppo [9] | Proposal 6: Both explicit PRS configuration and configuration index can be carried in on-demand request. Proposal 7: If on-demand PRS request including configuration index is agreed, the mapping between PRS configuration and index should be distributed to UE in advance.  |
| Xiaomi [11] | Proposal 1: The candidates of PRS configuration for on-demand PRS request can be included in positioning sib.Proposal 3: The network can provide the indication to UE to indicate whether the UE can send on-demand PRS or not. |
| Lenovo [12] | Proposal 4: Existing RequestAssistanceData and ProvideAssistanceData LPP messages can be enhanced to support UE-initiated on-demand DL-PRS for all DL-based positioning methods.Proposal 5: UE can at least request an updated DL-PRS configuration per positioning method. |
| Ericsson [15] | Proposal 3: On demand PRS is subject to the complete NW deployment and not limited to few subsets or pre-configured selection.Proposal 1: UE provides the reasons as why current configuration is not suitable. |
| Qualcomm [16] | Proposal 1: For on-demand DL-PRS, the LPP Request Assistance Data message can include the explicit parameter list for a desired DL-PRS configuration (e.g., as defined in LPP IEs *NR-DL-PRS-AssistanceData* and *NR-DL-PRS-Info* and as summarized in Table 7.x.5-1 in section 3 below).Proposal 2: Define a new LPP assistance data IE containing a set of possible DL-PRS configurations which can be requested by the UE on demand; e.g., IE *On-Demand-DL-PRS-Configurations*. Each DL-PRS configuration in IE *On-Demand-DL-PRS-Configurations* has a set of associated DL-PRS parameters (e.g. defining bandwidth, duration, power, periodicity, frequency range, muting, etc. as defined by LPP IEs *NR-DL-PRS-AssistanceData* and *NR-DL-PRS-Info* [3]) and a unique identifier.Proposal 3: Define a new posSIB type containing the new LPP IE *On-Demand-DL-PRS-Configurations*. Proposal 4: For on-demand DL-PRS, the LPP Request Assistance Data message can include an index/pointer/identifier corresponding to an element in the new LPP IE *On-Demand-DL-PRS-Configurations* defining the requested on-demand DL-PRS. |
| Nokia [18] | Proposal 1: For NR positioning, RAN should support on-demand PRS by conditioning its initiation with positioning QoS and/or radio conditions. The network establishes this conditioning by preconfiguring multiple PRS, each mapped to a specific positioning QoS and/or radio condition, and an ID. The UE or the network can initiate on-demand PRS matching to the given QoS and/or radio conditions in a positioning session, by simply indicating its ID, based on the pre-configuration.Proposal 2: On-demand PRS pre-configuration associated with QoS/radio conditions is broadcast by the network to the UEs, by re-using the existing procedures for broadcast of assistance data for positioning with some enhancements.Proposal 3: The UE or LMF initiates on-demand PRS using LPP signalling, where they indicate the ID of the PRS configuration they select based on the pre-configuration that associates PRS configurations with QoS and/or radio conditions. The LMF then activates the determined on-demand PRS configuration at the gNB(s) via NRPPa signalling. |
| Convida [20] | Proposal 2: RAN2 should discuss and evaluate some of the potential solutions and procedures associated with on-demand PRS (re-)configuration.  |

On-demand DL-PRS request principles:

There are two basic methods for the on-demand DL-PRS request discussed/proposed:

(a) The on-demand DL-PRS request can include explicit parameter defining a DL-PRS configuration (e.g., as defined by parameters in LPP IE *NR-DL-PRS-AssistanceData*) (Huawei, InterDigital, Oppo, Qualcomm).

(b) The on-demand DL-PRS request can include an identifier pointing to a pre-defined DL-PRS configuration (vivo, Intel, Apple, InterDigital, Oppo, Qualcomm, Nokia).

**Proposal 1:** The on-demand DL-PRS request in an LPP Request Assistance Data message can include:

(a) explicit parameter defining a DL-PRS configuration (e.g., as defined by parameters in LPP IE *NR‑DL-PRS-AssistanceData*), or

(b) an identifier pointing to a pre-defined on-demand DL-PRS configuration.

(c) On demand PRS is subject to the complete NW deployment and not limited to few subsets or pre-configured selection; UE can request new PRS config by sending reasons as why current config is not suitable.

On-demand DL-PRS preconfiguration:

If an on-demand DL-PRS request can include an identifier pointing to a pre-defined DL-PRS configuration, the possible/allowed on-demand DL-PRS configurations (together with an (unique) identifier) would have to be provided to the UE in advance. This could be achieved via LPP Provide Assistance Data (Intel, Huawei), or via broadcast (Xiaomi, Qualcomm, Nokia).

**Proposal 2:** 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.

NOTE: This new IE does not define the currently active DL-PRS configuration.

**Proposal 3:** The new LPP assistance data IE from Proposal 2 can be included in an LPP Provide Assistance Data message and/or in a new posSIB.

## 1.2 Signalling between LMF and NG-RAN

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| --- | --- |
| Intel [3] | Proposal 3: To support PRS configuration change, it is up to RAN3 on whether existing NRPPa message/procedure can be reused.  |
| Huawei [5] | Proposal 4: Allow RAN to provide indication of the PRS types (e.g. periodic, semi-persistent, aperiodic PRS) of the TRPs. Proposal 5: Enhance the NRPPa procedure to support LMF-initiated on-demand PRS request. |
| Oppo [9] | Proposal 2: RAN2 study on-demand PRS request including assistance information from UE, and leave the on-demand PRS request from LMF as well as PRS reconfiguration request/acknowledge to RAN3.  |
| Xiaomi [11] | Proposal 4: The TRP information request message can be enhanced for LMF to send on-demand PRS request.Proposal 5: The UE associated NRPPa transport message should be introduced for LMF to send on-demand PRS request Proposal 6: The gNB provides some candidates of PRS configuration to LMF and the LMF determine the on-demand PRS configuration from the candidates of PRS configuration. |
| Lenovo [12] | Proposal 6: Support aperiodic on-demand DL-PRS configurations to increase flexibility and support one shot location estimation.Proposal 7: The gNB may share prioritized a DL-PRS configuration set with the LMF based on its current resource allocation status and forward this to the UE for selection. |
| Qualcomm [16] | Proposal 5: Define a NRPPa procedure which allows an LMF to request a change of DL-PRS transmission from multiple gNBs/TRPs:- The request may include a list of explicit parameters for a desired DL-PRS configuration (e.g., as defined in LPP IEs *NR-DL-PRS-AssistanceData* and *NR-DL-PRS-Info* and as summarized in Table 7.x.5-1 in section 3 below).- The request may include an identifier pointing to a predefined DL-PRS configuration. |
| ZTE [21] | Proposal 2: A gNB shall re-configure the PRS configuration of a TRP if the new configuration fulfils the requirements of all LMFs connected to this gNB. |
| Ericsson [15] | Proposal 7: RAN2 to send an LS to RAN3 to provide solution/signalling for providing PRS beam utilization in NRPPa to reduce PRS overhead as provided in R2-2105973. |

NRPPa on-demand DL-PRS procedures:

It appears obvious that a NRPPa procedure is required to support on-demand DL-PRS configuration change. Whether an existing procedure can be reused or whether a new procedure should be defined seems a Stage 3 detail which should be discussed by RAN3. However, the required NRPPa functionality should be discussed in RAN2. From the available contributions and proposals, the NRPPa functionality may comprise:

- TRP capability transfer (e.g., supported PRS types, etc.) (Huawei)

- Provision of on-demand DL-PRS configurations to an LMF (Xiaomi, Lenovo)

- Providing on-demand DL-PRS configuration information to a gNB (Qualcomm) along with PRS beam utilization report in NRPPa to reduce PRS overhead (Ericsson)

**Proposal 4:** The NRPPa procedure(s) for on-demand DL-PRS should support at least the following functionality:

- 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 or PRS beam utilization report to reduce PRS overhead)

- Provision of (possible/allowed) on-demand DL-PRS configurations from a gNB to an LMF

- TRP capability transfer (e.g., whether the RAN node supports the reconfiguration of DL-PRS, etc.)

# 2. Information Transferred between UE, gNB, and LMF

## 2.1 On-demand DL-PRS configuration information

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| vivo [2] | Proposal 3: RAN2 should study start time and valid time for PRS configurationProposal 4: Support on-demand DL-PRS at least include ON/OFF request and specific parameters request. |
| Apple [4] | Proposal 1: LMF provides UE which TRPs can be triggered for on-demand PRS transmission in Assistance Data.Proposal 2: LMF provides UE which DL-PRS beam can be dynamically switch on/off in Assistance Data. |
| Huawei [5] | Proposal 3: The parameters for LMF-initiated on-demand PRS request can be decided in RAN2 include ON/OFF request for PRS request, and start time and validity time. Send an LS to RAN1 to discuss the rest of parameters. |
| InterDigital [7] | Proposal 10: Parameters in DL-PRS that can be dynamically changed by sending a request for on-demand PRS includes at least: PRS resource/resource-set, periodicity, repetition, muting, Tx power indication, number of beams, turn on/off beams, number of TRPs/gNBs, TRP/gNB IDs |
| Oppo | Proposal 4: It is up to RAN1 to decide which PRS parameter can be carried in the request for UE-initiated on-demand PRS. |

The specific on-demand DL-PRS parameter discussed in the various contributions comprise:

- start time and duration for the requested DL-PRS configuration (vivo, Huawei)

- turning DL-PRS on/off (vivo, Huawei)

- TRP-IDs/number of TRPs (Apple, InterDigital)

- Beam On/Off (Apple, InterDigital)

- PRS resource/resource-set, periodicity, repetition, muting, Tx power indication, number of beams (InterDigital)

**Proposal 5:** The on-demand DL-PRS request can include the following explicit parameters:

- start time and duration for the requested DL-PRS configuration

- request for turning DL-PRS on/off

- requested TRP-IDs/number of TRPs for DL-PRS

- request for turning DL-PRS beams on/off

- requested DL-PRS resource/resource-set, periodicity, repetition, muting, Tx power indication, number of beams

NOTE: Additional parameter may be provided by RAN1 (see Proposal 10)

## 2.2 UE assistance information/measurements

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| CATT [1] | Proposal 6: RAN2 to discuss UE may provide assistance information to LMF, e.g., beam index, channel state information, RRM measurement results to LMF in order to help LMF initiate the on-demand PRS more accurately. |
| Huawei [5] | Proposal 2: UE/gNB can send RRM measurements and the positioning measurements of the PRS to the LMF, with which the LMF makes suggestions on PRS transmission to the gNB. No stage3 impacts are needed for the measurement report.Proposal 9: The current spec can already support sending assistance information of PRS or RRM measurement to LMF for PRS transmission based on the information collected from the UE. |
| InterDigital [7] | Proposal 2: Support configuring of measurement conditions that can be monitored by UE (e.g. RSRP on DL-PRS) for identifying the PRS parameters/configurations in the on-demand PRS. FFS on the set of measurements conditions to be configured in UEProposal 3: Support sending of measurement conditions from LMF to UE as assistance data using enhancements of existing LPP procedures and signalling (e.g. LPP ProvideAssistanceData) Proposal 8: Support LMF-initiated reconfiguration of PRS based on indication/feedback sent by UE (e.g. measurement report/location estimates)Proposal 9: Support activation of pre-configured PRS by the LMF based on indication/feedback sent by UE (e.g. measurement report/location estimates) Proposal 11: UE indicates in the measurement reports sent to LMF the information on the PRS configurations used (i.e. non-on-demand PRS/on-demand PRS) during measurements Proposal 12: UE receives an indication from the LMF to report measurements made using only on-demand PRSProposal 13: For UE-based positioning, UE includes whether on-demand PRS is used to estimate location information |
| Xiaomi [11] | Proposal 7: The following assistance information can be considered for UE to send on-demand DL PRS request:• PRS-RSRP indication with low quality • TRP id or beam id for low quality of PRS-RSRP• Preferred frequency band width • Preferred PRS period• Low power indication |
| Lenovo [12] | Proposal 8: Support the following UE assistance information to LMF for providing an updated DL-PRS configuration:• Indication of course location information, e.g. TRP/beam(group) indices.• Indication of change in radio conditions, e.g. beam-failure indication, candidate beams for re-selection.• Indication of measurement quality metrics such as LOS/NLOS and other relevant quality estimates to LMF. |
| Fraunhofer [14] | Proposal 1: 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.Proposal 2: Enable the LMF to provide UE with assistance information to trigger measurement on certain on-demand DL-PRS configurations based on the measurement of configured DL-PRS. |
| Ericsson [15] | Proposal 1: UE provides the reasons as why current configuration is not suitable.Proposal 6: RAN2 to discuss what sort of feedback and how those feedbacks can be provided by UE identifying the needed TRPs/beams for DL-PRS transmission to ensure 3gpp ecosystem provides energy efficient solution.Proposal 8: GDOP results, DL-PRS RSRP and positioning ranging error/uncertainties are provided to LMF by UE.Proposal 9: RAN2 to discuss ways on how UE operating in UE based mode can provide feedback in order to obtain suitable DL-PRS configurations.Proposal 10: LOS/NLOS classification, if known, is used to identify suitable TRPs from a certain location. |
| Nokia [17] | Proposal 1: For LMF-initiated on-demand PRS, LMF should properly configure target UE on when and whether the target UE updates the UE feedback for on-demand PRS using the LPP-RequestLocationInformation message. The UE responds with UE feedback for on-demand PRS and acknowledges update of configuration using the LPP-ProvideLocationInformation message.Proposal 2: RAN2 to agree the mode of update of UE feedback for on-demand PRS, namely updates provided in periodic or in an event-based fashion, or both. |
| ZTE [22] | Proposal 2: The current defined PRS measurement report can be used for on demand PRS feedback. No new IEs or messages are needed. |

The UE assistance information/measurements discussed in the various contributions and proposals summarized above can be grouped into two main categories:

- RRM measurement results

- Position measurement results and associated quality metrics

Deciding on detailed parameter appear not possible at this stage, since the motivation/need as well as it's relation to on-demand DL-PRS is for the most part unclear.

**Proposal 6:** A UE can provide assistance information/measurements to an LMF to assist an LMF in the determination of appropriate on-demand DL-PRS.
The assistance information/measurements may comprise:

- RRM measurement results

- Position measurement results and associated quality metrics

NOTE: New measurements (if any) would need to be discussed in RAN1.

The signalling and procedures for providing assistance information/measurements to an LMF can make use of existing LPP transactions and procedures (Huawei, Nokia, ZTE).

**Proposal 7:** For providing the assistance information/measurements to an LMF for the determination of appropriate on-demand DL-PRS configurations, the existing LPP procedures are used (e.g., LPP Request/Provide Location Information, etc.).

# 3. On-demand DL-PRS trigger criteria

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| CATT [1] | Proposal 2: LMF provides available DL-PRS resources to UEs before UE sends the on-demand PRS request. Only the UEs who received the available DL-PRS can be allowed to imitate the on-demand PRS, and the requested PRS configuration should be based on the available PRS provided by LMF.Proposal 3: RAN2 to discuss the issue on how to control the numbers of on-demand PRS request initiated per UE in one positioning session.Proposal 4: The interval between two consecutive on-demand PRS requests initiated by UE can be discussed if the interval between two consecutive on-demand PRS request should be controlled. |
| Huawei [5] | Proposal 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.  |
| Oppo [9] | Proposal 3: It is left to UE implementation to trigger the request for UE-initiated on-demand PRS. |
| Xiaomi [11] | Proposal 2: The QoS in LPP RequestLocationInformation message can be used to trigger UE to send on-demand PRS request. |
| Lenovo [12] | Proposal 1: 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. |
| Sony [13] | Proposal 3: On demand PRS can be triggered to meet the required positioning service level. |
| ZTE [21] | Proposal 1: RAN2 shall limit the frequency of PRS request for both UE-initiated and LMF-initiated on demand PRS. Detail can be FFS. |

The On-demand DL-PRS trigger criteria discussed in the various contributions and proposals summarized above can be grouped into the following main categories:

- Trigger criteria based on the allowed amount of DL-PRS requests in a particular unit of time

- Trigger criteria based on measurements/quality

- Trigger criteria based on LCS QoS

- Left to UE implementation

Given that the on-demand DL-PRS request is carried in an LPP Request Assistance Data message/MO-LR request, it is not quite clear why additional/separate criteria specifically for on-demand DL-PRS are needed (i.e., at the end it’s a regular LPP Request Assistance Data message).

**Proposal 8:** 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. .

# 4. Overall Procedure

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| CATT [1] | Proposal 1: RAN2 to discuss the overall procedure of UE initiated on-demand PRS as described in figure 1 as baseline for further discussion.Proposal 7: The overall procedure of LMF initiated on-demand PRS request as described in figure 2 can be discussed as baseline for further discussion on LMF initiated on-demand PRS. |
| Intel [3] | Proposal 4: To capture the on demand PRS procedure in the stage 2 specification.  |
| Huawei [5] | Proposal 1: Adopt the TP of on-demand PRS for TS 38.305 in the Appendix. And send an LS to SA2. |
| Oppo [9] | Proposal 1: On-demand PRS procedure shown in the figure can be studied as a baseline. |
| Qualcomm [16] | Proposal 6: Agree on the Text Proposal in section 3 as baseline for Stage 2.  |
| Convida [20] | Proposal 3: RAN2 should update 38.305 with some of the high-level procedures outlined in Figure 2-1 and we volunteer to facilitate an email discussion to draft a running CR.  |

Multiple companies provided an overall Stage 2 procedure description with various level of details. Below is a high-level block diagram of an overall procedure (this block diagram is supposed to be a superset of the individual company contributions).



The blocks 1-9 above which are considered in the individual contributions are indicated by the green cell in the table below:

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| --- | --- | --- | --- | --- | --- | --- |
| Block/Step | CATT[1] | Intel[3] | Huawei[5] | Oppo[9] | Qualcomm [16] | Convida[20] |
| 1. |  |  |  |  |  |  |
| 2. |  |  |  |  |  |  |
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| 9. |  |  |  |  |  |  |

**Proposal 9:** The Stage 2 overall procedure for on-demand DL-PRS should show the following blocks/steps as outlined in the Figure above:

1. Possible on-demand DL-PRS preconfiguration provisioning (posSI)

2. LCS Service Request

3. Nlmf\_Location\_DetermineLocationRequest

4. Possible LPP procedures

5. On-demand DL-PRS reconfiguration procedures

6. LPP procedures and possible NRPPa procedures

7. Nlmf\_Location\_DetermineLocationResponse

8. LCS Service Request

9. Possible On-demand DL-PRS reconfiguration procedures (possible switch-back to original DL-PRS configuration)

NOTE: Individual NRPPa and LPP procedure details (if needed) may be shown in separate sections (as common practice in Stage 2).

# 5. Outgoing Liaisons

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| Huawei [5] | Proposal 1: Adopt the TP of on-demand PRS for TS 38.305 in the Appendix. And send an LS to SA2.Proposal 3: The parameters for LMF-initiated on-demand PRS request can be decided in RAN2 include ON/OFF request for PRS request, and start time and validity time. Send an LS to RAN1 to discuss the rest of parameters. |
| Oppo [9] | Proposal 5: RAN2 send LS to RAN 1 on the content of on-demand PRS request. |
| Spreadtrum [10] | Proposal 2: RAN2 to inform RAN3 about the requirement of modifying NRPPa signalling to support on-demand PRS. |
| Lenovo [12] | Proposal 2: Send LS to RAN1 to provide recommendations and feedback on the DL-PRS configuration parameters to be dynamically updated using the on-demand DL-PRS mechanism.  |
| Ericsson [15] | Proposal 7: RAN2 to send an LS to RAN3 to provide solution/signalling for providing PRS beam utilization in NRPPa to reduce PRS overhead as provided in R2-2105973. |
| Samsung [19] | Proposal 1: RAN2 sends LS to RAN1 to request for the information on the granularity of DL PRS to be dynamically turned on/off at the TRP level.  |
| ZTE [22] | Proposal 1: RAN2 shall send an LS to RAN1 to trigger the discussion about on demand PRS parameters.  |

Multiple companies proposed to send Liaison Statements to other 3GPP groups:

 SA2: Inform SA2 on overall Stage 2 procedure for on-demand DL-PRS (Huawei)

 RAN1:Request on-demand DL-PRS configuration information/parameter (Huawei, Oppo, Lenovo, Samsung, ZTE)

 RAN3:Request to define NRPPa signalling for on-demand DL-PRS (Spreadtrum, Ericsson)

**Proposal 10:** Discuss and decide whether the following LSs should be sent from this RAN2 meeting:

- Inform SA2 on the overall Stage 2 procedure for on-demand DL-PRS

- Request from RAN1 a definition/specification of possible on-demand DL-PRS request parameter(s)

- Request RAN3 to define NRPPa procedures for on-demand DL-PRS (e.g., based on Proposal 4, Proposal 9)

# 6. Other Aspects / Proposals

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| CATT [1] | Proposal 5: RAN2 to discuss whether the exception that UE doesn’t receive the response from LMF after UE sends the request to LMF should be taken into consideration. |
| vivo [2] | Proposal 1: LMF-initiated request on-demand PRS can be prioritized studied.Proposal 5: Support on-demand SRS (e.g. Group sets of SRS configuration, at least ON/OFF request) for UL positioning. |
| Apple [4] | Proposal 4: UE shall be allowed to provide location measurements w/o waiting for the updated Assistance data as long as DL-PRS IDs are pre-configured. |
| InterDigital [7] | Proposal 7: Support dynamic on-demand PRS request from UE to gNB. |
| InterDigital [8] | Proposal 1: Support on-demand PRS request for multi-RTT methodProposal 2: Support configuring of measurement conditions that can be monitored by UE for identifying the PRS parameters/configurations and/or SRSp configurations to be used in multi-RTT positioning method. FFS on the set of measurements conditions to be configured in UEProposal 3: Support UE-initiated on-demand PRS request to dynamically update the spatial relation between SRSp and PRS in a multi-RTT positioning method |
| Spreadtrum [10] | Proposal 1: The updated PRS transmission of on-demand PRS shouldn’t to modify the original PRS transmission occasion. |
| Lenovo [12] | Proposal 3: RAN2 to support dedicated delivery of assistance data (DL) and UE assistance/feedback (UL) for on-demand DL-PRS in RRC\_INACTIVE state. SDT framework can be used to support these mechanisms. |
| Sony [13] | Proposal 1: On-demand PRS can be transmitted in relation with the legacy / periodic PRS transmission. Both on-demand and periodic PRS can be multiplexed in FDM and TDM.Proposal 2: Support semi-persistent and a-periodic transmission and reception of DL PRS that can be used for DL-TDOA and Multi-RTT. |
| Ericsson [15] | Proposal 2: To minimize signalling, NW may indicate that the UE logs its preferred configuration or worst contributor. Proposal 4: RAN2 to agree the objective of on demand PRS irrespective of UE-initiated or LMF initiated is for the NW to learn and optimize the DL-PRS configuration to serve all the UEs in the NW.Proposal 5: RAN2 to agree to provide solution which leads to reduction of energy consumption for DL-PRS transmission. |
| Samsung [19] | Proposal 2: RAN2 agrees that the fulfillment of UE’s request for on-demand DL PRS transmission to the network is up to the network implementation.  |
| Convida [20] | Proposal 1: RAN2 to prioritize further evaluation and discussion of detailed solutions and procedures for on-demand transmission and reception of DL PRS, regardless of the entity initiating the PRS transmission requests.  |

# 7. Summary

To further progress the work on On-demand DL-PRS, it is suggested to make decisions on the following proposals:

**Proposal 1:** The on-demand DL-PRS request in an LPP Request Assistance Data message can include:

(a) explicit parameter defining a DL-PRS configuration (e.g., as defined by parameters in LPP IE *NR‑DL-PRS-AssistanceData*), or

(b) an identifier pointing to a pre-defined on-demand DL-PRS configuration.

**Proposal 2:** 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.

NOTE: This new IE does not define the currently active DL-PRS configuration.

**Proposal 3:** The new LPP assistance data IE from Proposal 2 can be included in an LPP Provide Assistance Data message or in a new posSIB.

**Proposal 4:** The NRPPa procedure(s) for on-demand DL-PRS should support at least the following functionality:

- 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)

- Provision of (possible/allowed) on-demand DL-PRS configurations from a gNB to an LMF

- TRP capability transfer (e.g., whether the RAN node supports the reconfiguration of DL-PRS, etc.)

**Proposal 5:** The on-demand DL-PRS request can include the following explicit parameter:

- start time and duration for the requested DL-PRS configuration

- request for turning DL-PRS on/off

- requested TRP-IDs/number of TRPs for DL-PRS

- request for turning DL-PRS beams on/off

- requested DL-PRS resource/resource-set, periodicity, repetition, muting, Tx power indication, number of beams

NOTE: Additional parameter may be provided by RAN1 (see Proposal 10)

**Proposal 6:** A UE can provide assistance information/measurements to an LMF to assist an LMF in the determination of appropriate on-demand DL-PRS.
The assistance information/measurements may comprise:

- RRM measurement results

- Position measurement results and associated quality metrics

NOTE: New measurements (if any) would need to be discussed in RAN1.

**Proposal 7:** For providing the assistance information/measurements to an LMF for the determination of appropriate on-demand DL-PRS configurations, the existing LPP procedures are used (e.g., LPP Request/Provide Location Information, etc.).

**Proposal 8:** Before deciding on specific On-demand DL-PRS trigger criteria, the intended purpose of such criteria should be agreed first.

**Proposal 9:** The Stage 2 overall procedure for on-demand DL-PRS should show the following blocks/steps as outlined in the Figure above:

1. Possible on-demand DL-PRS configuration provisioning (posSI)

2. LCS Service Request

3. Nlmf\_Location\_DetermineLocationRequest

4. Possible LPP procedures

5. On-demand DL-PRS reconfiguration procedures

6. LPP procedures and possible NRPPa procedures

7. Nlmf\_Location\_DetermineLocationResponse

8. LCS Service Request

9. Possible On-demand DL-PRS reconfiguration procedures (possible switch-back to original DL-PRS configuration)

NOTE: Individual NRPPa and LPP procedure details (if needed) may be shown in separate sections (as common practice in Stage 2).

**Proposal 10:** Discuss and decide whether the following LSs should be sent from this RAN2 meeting:

- Inform SA2 on the overall Stage 2 procedure for on-demand DL-PRS

- Request from RAN1 a definition/specification of possible on-demand DL-PRS request parameter(s)

- Request RAN3 to define NRPPa procedures for on-demand DL-PRS (e.g., based on Proposal 4, Proposal 9)