3GPP TSG-RAN WG2 #116-bis R2-21xxxxx

Electronic meeting, 2022-01-17 - 2021-01-25

**Agenda item: 8.11.4**

**Source: Ericsson**

**Title: [Post116-e][601][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:

* [Post116-e][601][POS] Procedures and signalling for on-demand PRS (Ericsson)

Scope: Discuss the level of network control of the UE request for on-demand PRS, and the content of the UE request:

* Whether the UE is required to receive on-demand PRS parameters before requesting PRS
* Other network control mechanisms for the UE’s request for on-demand PRS (prohibit timer, reattempt timer, stop message)
* Whether the UE can request preferred PRS configurations that go beyond what the network indicated (if the network indicated anything)
* Whether the UE can request explicit on-demand PRS parameters from the network, and if so, the content of the request
  + Taking RAN1 conclusions into account
* Whether posSI can be the response to the on-demand PRS request

Intended outcome: Report to next meeting

Deadline: Dec 17th

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

# 2 Contact Information

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# 3 Discussions

## 3.1 Explicit Indication

## RAN1 Input

RAN1 has agreed on below On-Demand PRS list.

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| RAN1#106-e Agreement  At least the following list of on-demand DL PRS parameters is supported for UE-initiated and LMF-initiated on-demand DL PRS requests:   1. DL PRS Periodicity 2. DL PRS resource bandwidth 3. DL PRS QCL information   Conclude on remaining parameters at RAN1#106-bis-e  RAN1#106bis-e Agreement   1. The following list of parameters is supported for UE-initiated and LMF initiated on-demand DL PRS request 2. Start/end time of DL PRS transmission 3. DL PRS resource repetition factor 4. Number of DL PRS resource symbols per DL PRS resource 5. DL-PRS CombSizeN 6. Number of DL PRS frequency layers 7. ON/OFF indicator (for LMF initiated request only)   FFS values for requested on-demand DL PRS parameters and whether parameters are resource-specific, TRP-specific, or PFL-specific |

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| --- |
| RAN1#107-e Agreement  **Agreement**   * From RAN1 perspective, for LMF-initiated request of on-demand DL PRS, the following group of on-demand DL PRS parameters is defined and signaled   + per resource set per positioning frequency layer per FR  1. DL PRS Periodicity 2. DL PRS Resource Bandwidth 3. DL PRS Resource Repetition Factor 4. Number of DL PRS Resource Symbols per DL PRS Resource 5. DL-PRS CombSizeN   Two options for indication of DL PRS QCL-Info, either   * + Option 1: per resource set per positioning frequency layer per FR * LMF recommends a list of QCL sources   + Option 2: per resource set per positioning frequency layer per FR     - LMF requests to provide the QCL information in the assistance data in NRPPa   + per FR     - Number of DL PRS frequency layers   + either per resource set per positioning frequency layer or per UE     - Start/end time of DL PRS transmission   + either per resource, or per resource set, or per UE     - ON/OFF indicator (for LMF initiated request only)   **Agreement**   * From RAN1 perspective, for UE-initiated request of on-demand DL PRS, the following group of on-demand DL PRS parameters is defined and signalled   + per positioning frequency layer per FR  1. DL PRS Periodicity 2. DL PRS Resource Bandwidth 3. DL PRS Resource Repetition Factor 4. Number of DL PRS Resource Symbols per DL PRS Resource 5. DL-PRS CombSizeN    * per FR 6. Number of DL PRS frequency layers    * per UE 7. Start/end time of DL PRS transmission   Two options for indication of DL PRS QCL-Info, either   * + Option 1: per resource set per positioning frequency layer per FR     - UE recommends a list of QCL sources   + Option 2: per resource set per positioning frequency layer per FR     - UE requests to provide the QCL information in the assistance data |

## ASN.1

Considering the above 1 and 2 DL-PRS parameters (Periodicity and BW), the indexing from NW side may be provided as an example below.

For simplicity for DL-PRS-Periodicity instead of exact 37.355 definition; a simple illustration is kept.

-- ASN1START

onDemandPRS-IndexList-r17 ::= SEQUENCE (SIZE (1..maxNumberOfIndex)) OF onDemandPRS-Index-r17

onDemandPRS-Index-r17 ::= SEQUENCE {

dl-PRS-Periodicity ENUMERATED {p1, p2, p3, p4} OPTIONAL,

dl-PRS-ResourceBandwidth INTEGER (1..63) OPTIONAL

}

-- ASN1STOP

|  |
| --- |
| NW Provided Index  Index 1 can be:  dl-PRS-Periodicity p1  dl-PRS-ResourceBandwidth 10  Index 2 can be:  dl-PRS-Periodicity p2  dl-PRS-ResourceBandwidth 20  Index 3 can be:  dl-PRS-Periodicity p3  dl-PRS-ResourceBandwidth 30 |

The question here is; is UE allowed to request only using Index or can UE request be for example:

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| --- |
| UE Request  dl-PRS-Periodicity p3  dl-PRS-ResourceBandwidth 10 |

Please note the DL-PRS parameters and values that are requested are still within what NW provides/supports.

From NW perspective, the index is not written in stone/fixed and it should be allowed to be changed further depending upon several factors; one of them should be based upon UE’s input. The NW should be able to take into account the granular reporting (precise request) and thus provide a new Index or replace current index with the new index/configuration; for example:

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| Index 4:  dl-PRS-Periodicity p3  dl-PRS-ResourceBandwidth 10 |

Further, RAN1#107e agreement says below:

* for UE-initiated request of on-demand DL PRS, the following group of on-demand DL PRS parameters is defined and signalled
  + per positioning frequency layer per FR

1. DL PRS Periodicity
2. DL PRS Resource Bandwidth
3. DL PRS Resource Repetition Factor
4. Number of DL PRS Resource Symbols per DL PRS Resource
5. DL-PRS CombSizeN
   * per FR
6. Number of DL PRS frequency layers
   * per UE
7. Start/end time of DL PRS transmission

This suggests that explicit signaling is allowed from RAN1 perspective.

**Question 1: Companies are invited to provide input on whether explicit indication is allowed or not; at least for the case when the UE request is within the allowed parameters and values?**

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| Company | Yes/No | Comments |
| Fraunhofer | No | We prefer that the NW provides different indices for the parameter and value combination. The NW can still provide different parameter values for a given parameter under different indices.  Furthermore, under an index, PRS from multiple TRPs could be grouped together so that they can be requested together. As an example, when a UE makes a demand of BW of 50 MHz and periodicity of 20 ms, it could request that it is transmitted from a group of TRPs bundled with its serving / camped cell.  We agree with Rapporteur’s comment that the configuration pointed by the index could be flexibly changed by the network. |
| CATT | Yes for that UE request is within the allowed parameters and values | UE request of explicit indications is more flexible compared with pre-configured DL-PRS ID only. However, the UE request must be within the available DL-PRS configurations pre-configured by NW, so as to reduce the latency and improve the efficiency of on-demand PRS. |
| vivo | Yes | So far, we have agreed to 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. On top of this, including some explicit parameters in the on-demand PRS configuration request may increase the flexibility of on-demand PRS. The explicit parameters can be a list of value range to ensure the request is still within the NW capability. In this case, we shall further discuss how to design the on-demand PRS configuration from LMF to UE.  From our understanding, the identifier and explicit parameter can be incorporated. In detail, the identifier is per PRS configuration and the value range is per parameter in PRS configuration. For PRS configuration associated with one identifier, some parameters can be explicit values, the other parameters can be value ranges. The UE shall request the on-demand PRS with an identifier. For each parameter with a value range in the PRS configuration corresponding to the requested identifier, the UE can explicitly indicate the requested value which is within the value range. For example:  configuration 1 can be:  dl-PRS-onDemandID = 1  dl-PRS-Periodicity Range = (8, 32, 64, 160) in slots  dl-PRS-ResourceBandwidth = 20 MHz  configuration 2 can be:  dl-PRS-onDemandID = 2  dl-PRS-Periodicity = 32 slots  dl-PRS-ResourceBandwidth Range = (40, 50, 80, 100) in MHz  The UE can request:  dl-PRS-onDemandID = 1  dl-PRS-Periodicity = 8 slots  or  dl-PRS-onDemandID = 2  dl-PRS-ResourceBandwidth = 40MHz  In conclusion, the combination of identifier and explicit parameter is beneficial for flexibility and overhead reduction of on-demand PRS signaling. |
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## 3.2 Request beyond NW Indication

Based upon the discussion during last meeting, some of the companies view that UE should not request on-Demand PRS assistance data if NW has not indicated the support of On-Demand PRS. Further, their view is that the UE request should be limited to the parameters that NW provides saying these can be changed dynamically and further may provide the range (min, max) within which the UE request should be bounded to. For example; the maximum value that the NW indicates for supporting on-Demand PRS (for example if NW indicates, NW can support DL-PRS BW enumerated {n5, n10, n20, n50}; i.e UE should not request BW larger than n50. But, from RAN1 perspective, it is still an FFS: “FFS values for requested on-demand DL PRS parameters”. It may be possible that UE request any value in the value range that RAN1 specifies.

In some cases (or in some deployment), it may be beneficial to know what kind of PRS UE prefers. If there is large variation between what UE requests and what NW supports; NW (Operators) can take measures to improve the situation. For example, UE demands 64 resources per resource set per TRPs whereas NW says it can only transmit 8 resources per resource set per TRP

There are few Options here; for example; UE can request any PRS characteristics (From RAN1 list) and sends value of its preference (value range decided by RAN1) or RAN2 decides on the content. The Options are listed below

1. Ask/Wait for RAN1 input to see the value range and whether UE can send any value in the range
2. RAN2 decide that UE can request only the parameters that NW indicates and their value range is within the value range that NW supports.
3. RAN2 decides that UE can request any parameters from the RAN1 agreed parameter list based upon the values that are already in the range from Rel-16 specifications; example UE can be configured up to 4 frequency layers, 256 DL PRS IDs (TRPs), BW Integer (1 to 64) etc. Hence, the request range is based upon already existing range.

**Question 2: Companies are invited to provide input on which of the above Options they prefer on whether UE can request preferred PRS configurations that go beyond what the network indicated?**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Fraunhofer | None | We prefer that the UE provides measurements on certain Rel. 16 DL-PRS, and this information can be used by LMF to trigger on-demand PRS from the network. |
| CATT | Option b | We think that UE can only request the on-demand PRS parameters that NW indicates and their value range is within the value range that NW supports. There is a left issue that RAN2 does not decide the content of the available DL-PRS that NW pre-configured to UE. From our perspective, the available DL-PRS can be designed as a parent set of the parameters that UE can on-demand. |
| vivo | Option b | We think RAN2 can decide this issue from signaling perspective. Option b can avoid meaningless message exchange between TRP, LMF and UE when the NW does not support on-demand PRS. |
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## 3.3 Pre-requisite for On-demand PRS Request

MO-LR is service request that the UE can send to initiate location service request. It can embed LPP messages in such LCS message. The LPP message may contain request for Assistance data. For example; the UE may request AD for A-GNSS positioning method using this mechanism. In Rel-16 though, as part of periodic AD request for GNSS RTK; a control parameter was introduced; i.e the NW provides the capability whether it supports periodic AD transfer or not. UE will know if it can request periodic RTK AD based upon NW indication. In the same analogy one may consider that on-Demand PRS is advance feature build upon already existing DL-PRS request where a control parameter (capability) or what NW supports in terms of on-Demand PRS should be indicated beforehand.

Using MO-LR for the very first time with all the needed DL-PRS characteristics and also RRM Measurements will help to reduce latency if NW happens to select DL-PRS based Positioning method or supports such DL-PRS configurations. There is certainly benefit, but of-course there are questions as well as should it be designed in this way. Should it be part of control parameter or capability exchange before triggering on-Demand PRS?

Another aspect is that UE may append RRM measurements as part of also regular DL-PRS AD request. This would be useful also to trigger on-Demand PRS request.

One final remark is that in order to send the UE preferred DL-PRS attributes for On-Demand Request an explicit indication would be needed; as it would be the 1st message.

**Question 3: Companies are invited to provide input on whether capability exchange procedure be needed (i.e NW should provide beforehand whether on demand PRS is supported and on what DL-PRS attributes can be changed before UE makes an explicit request)?**

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| Company | Yes/No | Comments |
| Fraunhofer | No | From our perspective, the UE can request AD for on-demand PRS as a part of request assistance data. |
| CATT | No | No additional signaling is needed, because we already agreed that NW provide the available DL-PRS configurations to UE, which can be used as the pre-requisite for on-demand PRS request. |
| vivo | No | The network can proactively provide the on-demand configuration via broadcasted posSIB or dedicated LPP message. Only after receiving the on-demand configuration, the UE can request the on-demand PRS. NW doesn't have to provide beforehand whether on-demand PRS is supported with an extra indication or capability exchange procedure. |
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**Question 4: A follow up question is whether provision for UE to request DL-PRS AD (legacy Rel-16) along with appending RRM measurements be supported. Benefit is that it can save latency and it can still trigger On-Demand PRS transmission?**

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| Company | Yes/No | Comments |
| Fraunhofer | Yes | The measurements (as we also mentioned in Q2) could help LMF to trigger the relevant on-demand PRS (for example: finer beams for AoD methods) based on outcome of the measurement of wider beams (e.g. SSBs. The measurement on DL-PRS appended on DL-PRS AD could be used by LMF to make on-demand PRS to the NG-RAN node (for example, bandwidth, QCL, periodicity etc). |
| CATT | No | LMF may request UE to provide the existing POS or RRM measurement results to NW, assisting the LMF initiated on-demand PRS. But there is no specification impact and no need to append within the on-demand PRS request from UE, because current LPP procedure already supports it. |
| vivo | No | UE can request DL-PRS AD and send RRM measurements at the same time as the LPP transactions within a session may occur in parallel. Therefore, no need to piggyback the RRM measurement in the requestAD message. |
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## 3.4 Network Control Mechanisms

From the previous summary discussion of on-Demand PRS [R2-2111256], the below proposal was marked for further discussion.

*Proposal 4: Network control of UE-initiated on-demand PRS is supported. The following options are to be downselected:*

* *Option A: UE can only request on-demand PRS based on prior reception of on-demand PRS configuration sets.*
* *Option B: Configuration of a prohibit timer*
* *Option C: Reattempt timer*
* *Option D: Stop message indication from the LMF*
* *Note: If error indication in Proposal 3 is supported, Option D is not required.*

For completeness the Proposal 3 is also listed below [R2-2111256]

* *Error indication is supported for a partial or completely unfulfilled on-demand PRS request.*

Generally, for any spontaneous UE request a prohibit timer is considered beneficial. From the above Options, it appears Option C and D may also be able to prohibit the UE from sending the request. It is unclear from Option A though as how it will stop UE from sending the several request even if it is based upon only allowed list. It is not guaranteed that NW will accept the request. Hence, UE may be encouraged to send the request again. From NW side, it is possible to also send an abort message if UE happens to send several requests, this may be considered similar as stop or error indication.

It is suggested that companies evaluate if such prohibit functionality is needed and if so which of the Options are preferred.

• Option A: UE can only request on-demand PRS based on prior reception of on-demand PRS configuration

* Option B: Configuration of a prohibit timer

• Option C: Reattempt timer

• Option D: Stop or Error or Abort message indication from the LMF

• Option E: None

**Question 5: Companies are invited to provide input on which option is best suited here?**

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| --- | --- | --- |
| Company | Agree with Proposal Yes/No | Comments |
| Fraunhofer | Agree, Option A | UE can only request on-demand PRS based on prior reception of on-demand PRS configuration. |
| CATT | Agree, Option A&B/C | From device perspective, the option A is the combination of Q3, i.e., the pre-requisite for on-demand PRS request and Q2, i.e., whether UE can request preferred PRS configurations that go beyond what the network indicated. And we agree that only UEs that have been provided the available DL-PRS configurations can initiate the on-demand PRS request, and the contents of the on-demand PRS request must be within the available DL-PRS provided by NW.  From multi-UEs management perspective, we support B or C because NW should restrict too frequent on-demand PRS request from UEs by configuring the prohibit timer or reattempt timer. The timer can be configured to the UE when the available on-demand PRS is sent to UE. |
| vivo | Agree, Option A&B/C with clarification | The NW may reject the on-demand PRS request as the radio resource is temporarily not available, e.g., RAN overload.  To avoid massive signaling, the UE shall not request another PRS configuration despite whether the previous request is accepted or not. Therefore, Option C shall be clarified that the reattempt timer can be included in the response no matter the NW accepts or rejects the on-demand PRS request. If so, we think either Prohibit timer or reattempt timer can work and the only difference is the Prohibit timer is in the configuration and the reattempt timer is in the response. |
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## 3.5 posSI response to on-demand PRS request

During email discussion of stage2 [R2-2111375], the below proposal was discussed and has been currently been marked as an FFS. We try to conclude in this email discussion.

Proposal 2: For On-Demand PRS, to discuss whether posSI can be the response for On-Demand PRS request.

Similar to the functionally of on-Demand PRS, another feature “On-Demand SIB/PosSIB” request in dedicated mode has been specified in RRC in Rel-16. The behaviour described in RRC allows NW to deliver the requested SIB either via RRCReconfiguration Message or Broadcast. In fact, UE is expected to monitor the broadcast whereas NW may deliver via dedicated signalling. Rapporteur’s view is that to some extent, this behaviour should be applicable also for on-Demand PRS.

If NW is already providing the PRS configuration via poSIB and UE happens to request another configuration via LPP dedicated signaling, the NW should be allowed to send the content either via posSIB (by changing to new configuration) or via LPP.

We need to also note that there has previously below agreement as captured in the Note below. Thus, NW may simply abort the ongoing LPP procedure and/or send the configuration via posSI.

NOTE 1: It is up to Network (LMF) implementation on the steps to follow (accept/reject/ignore) on receiving UE-initiated On-Demand PRS request.

It was further mentioned that the NW may not know UE capability of posSI; however, as such there is no capability associated for broadcast. Yes, there is subscription associated with posSIBs and the posSIB may be encrypted; thus UEs with only valid subscription can avail that. The same though is also applicable for connected mode where LMF may check the UE’s subscription and deny the request if UE does not have valid subscription [Reference provided from SA2 spec in [Annex](#_6_Annex)]. Hence, as such there should be no reason to deny a NW implementation to send the response via broadcast.

**Question 6: Do companies agree with rapporteurs above reasoning that posSI can be the response for On-Demand PRS request and it is up to NW implementation to select the delivery mode?**

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| Company | agree with above Yes/No | Comments |
| Fraunhofer | Yes | Informing the UE about the ongoing on-demand PRS via posSib could be reused by other UEs, if they have similar demands. They could make better reuse the existing transmissions (i.e. they could indicate that they need the same index). |
| CATT | No | UE initiated on-demand PRS request is via the LPP request assistance data message, which is a class 1 message according to current specification, i.e., a LPP response is necessary. Thus, from our perspective, NW must provide the LPP provide assistance data as response of the on-demand PRS request from UE.  As for the posSI, it is natural that posSI will be updated accordingly when the DL-PRS configuration is changed. Just like the A-GNSS AD will be updated in posSI accordingly when it is changed. No need to specify the change of posSI because of the on-demand request. |
| vivo | No | RAN2 has agreed that on-demand PRS request is initiated via the existing LPP RequestAssistanceData message. In our view, the LPP RequestAssistanceData message is always followed by an LPP ProvideAssistanceData message as the response. Besides, responding to the on-demand PRS request via posSI may cause very frequent system information update and further cause the unnecessary consumption of UE power due to the reading of updated system information. |
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## 

# 5 Conclusion

Based on the discussion in the previous sections we propose the following:

# 6 Annex

TS 23.273 v17.2.0

4) The AMF invokes the Nlmf\_Location\_DetermineLocation service operation towards the LMF. The service operation includes an LCS Correlation identifier, the serving cell identity, the client type, an indication whether a location estimate, or location assistance data is requested, UE Positioning Capability if available, a list of MO-LR subscribed assistance data and any embedded LPP message(s) in the MO-LR Request. If the UE's location is requested, the service request may include an indication if UE supports LPP, the requested QoS and Supported GAD shapes. If location assistance data is requested, the embedded LPP message(s) will convey the requested types of location assistance data. If any of the procedures in clause 6.11.1 or 6.11.2 are used the service operation includes the AMF identity. Once an AMF has selected an LMF it must continue to use that LMF for the duration of the session.

# 7 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.)

**RAN2-115e**

Agreements:

Before providing available DL-PRS configuration to the UE, the LMF may obtain configuration information on what DL-PRS can be supported from one or more TRPs via NRPPa.

Capture the steps provided above as a baseline, along with a note indicating it remains FFS if the UE can send the MO-LR to request on-demand PRS.

FFS if we indicate to SA2 that MO-LR can be used to trigger on-demand PRS procedure.

It is up to Network (LMF) implementation on the steps to follow (accept/reject/ignore) on receiving request from UE for changing the DL-PRS configurations.

**RAN2-116**

Agreements:

RAN2 to agree to support the UE originated request of on-demand PRS via MO-LR for autonomous self location.

RAN2 to agree that UE can send an MO-LR Request message included in an UL NAS TRANSPORT message to the serving AMF including an LPP Request Assistance Data message which is used for on-demand DL-PRS transmission, and the MOLR-Type of this MO-LR Request message is “assistanceData”.

RAN2 to agree the following general stage 2 procedure as baseline for UE initiated on-demand PRS via MO-LR. [Figure 2 of R2-2109483, with the associated list of steps as given in section 5 of R2-2109483.] To be discussed in development of the running stage 2 CR (post-meeting) how much of this detail we need to capture in 38.305.

The UE may initiate an on-demand PRS request per positioning method including DL-TDoA, DL-AoD and Multi-RTT, via the existing LPP RequestAssistanceData message.

There is no need for introducing a new LPP message to carry the on-demand PRS request.

# 8 References

1. R2-2111256***,*** Summary on agenda item 8.11.4 on on-demand PRS, Lenovo, Motorola Mobility
2. R2-2109483, [Post115-e][606][POS] MO-LR for on-demand PRS (CATT)
3. R2-2111375, Report of offline discussion [AT116-e][623][POS] 38.305 CR for RAT-dependent positioning (Intel)