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

Online Meeting, August 16th – 27th 2021

**Agenda item: 8.11.1**

**Source: CATT**

**Title: [AT115-e][610][POS] PRUs (CATT)**

**WID/SID: NR\_pos\_enh-Core**

**Document for: Discussion and Agreement**

# 1 Introduction

This document is to kick off the following email discussion:

* [AT115-e][610][POS] PRUs (CATT)

Scope: Discuss the LS in R[2-2106920](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2106920.zip) and related contributions and reply to RAN1 (and include SA2 if potential impact to them is identified).

Intended outcome: Report in R2-2108940 and reply LS in R2-2108941

Deadline: Tuesday 2021-08-24 0800 UTC

This email discussion continues to discuss the PRUs for positioning enhancement based on the LS from RAN1 and related contributions in AI 8.11.7 others, and to achieve an reply LS to RAN1 as well as SA2 if potential impact to them is identified.

# 2 Contact Information

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |
| --- | --- |
| Company | Contact: Name (E-mail) |
| OPPO | youxin@oppo.com |
| Apple | ssirotkin@apple.com |
| ZTE | pan.yu24@zte.com.cn |
| Huawei, HiSilicon | Yinghaoguo@huawei.com |
| Xiaomi | lixiaolong1@xiaomi.com |
| vivo | tingting.zhong@vivo.com |
| Lenovo, Motorola Mobility | rthomas7@lenovo.com |
| InterDigital | jaya.rao@interdigital.com, fumihiro.hasegawa@interdigital.com |
| CATT | lijianxiang@datangmobile.cn |
| Ericsson | ritesh.shreevastav@ericsson.com, [fredrik.gunnarsson@ericsson.com](mailto:fredrik.gunnarsson@ericsson.com) |
| Fraunhofer | [Birendra.ghimire@iis.fraunhofer.de](mailto:Birendra.ghimire@iis.fraunhofer.de) |
| Nokia | mani.thyagarajan@nokia.com |
| Spreadtrum | Huifang.fan@unisoc.com |

# 3 Discussion

## 3.1 PRUs Type

According to the LS [1], RAN1 has evaluated the use of positioning reference units (PRUs) with known locations for positioning which have at least the following functionalities:

* + PRU may support, at least, some of the Rel-16 positioning functionalities of UE, if agreed, which is up to RAN2. The positioning functionalities may include, but not limited to, the following:
    1. Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
    2. Transmit the UL SRS signals for positioning

It seems that at least UE with known location can be acted as PRU. However, whether for TRP or part of gNB with known location can also be considered as PRU is not addressed in RAN1 LS. During the online discussion, some companies also point out the issue. Thus, it is better to continue the discussion of the PRUs types at first and figure out the types of the PRUs.

In general, there are the following two options on the PRUs type：

* **Option 1**: The PRU is considered only as UE.
* **Option 2**: The PRU is considered only as part of a gNB, i.e., TRPs.
* **Option 3**: The PRU is considered either as UE or gNB, i.e., TRPs.

**Question 1-1: Which option do companies preferred to support?** **Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Option 1/ Option 2/Option 3 | Comments |
| OPPO | Option 2 | The most significant characteristic of PRU is that the location is known in advance, which is not align with UE. The TRP usually located in a fixed position, it is more applicable and easier to obtain the known location.  And as the terminology of PRU is introduced by RAN1, we prefer to check with RAN1 to clarify the type of PRU instead of discussing in RAN2 since the type will largely influence the spec impact in RAN2/RAN3/SA2. |
| Apple | Option 1 (with comments) | Whether (and how) the location of a PRU is known has no standards impact in our view. It can be pre-configured by OAM, for example.  At any rate, there is no need to introduce signalling changes for that – precisely because the location is known and doesn’t change. |
| ZTE | Option 3 | PRU is not only a UE but can also be a TRP. However, we can focus on UE-type PRU first, which may be the main application. |
| Huawei, HiSilicon |  | RAN2 can only discuss supporting PRU as UE, whether PRU can be supported as one type of gNB should be discussed in RAN3.  But we think it is more suitable for the PRU to be modelled as UE since the location of the PRU can be changed such that it is easy to deploy for the adjustment of timing errors of different TRPs and easy to deploy for ensuring LOS environment between the device and the TRPs |
| Xiaomi | Option 3 | We think both UE and TRP can be treated as PRU.  Special UEs can work as PRU and TPR with fixed location is also feasible for PRU. |
| vivo | Option 1 with comments | Considering that PRU can transmit the UL SRS signals for positioning, we think it is more reasonable to consider PRU as UE.  However, that does not imply that normal UE has the capability of PRU. |
| Lenovo, Motorola Mobility | Option 3 | Given the existing LPP functionality, prioritizing the PRU as a UE can be initially considered. However, we also see benefits for considering TRPs as PRUs for differential error correction. |
| InterDigital | Option 3 | Our preference is UE as PRU since it can provide UE-side information for calibiration via measurements or SRS. However considering TRP as PRU is also useful since the benefits can be similar in terms of calibration, error correction and improving positioning accuracy of other target UEs. |
| Intel | Option 1 | Based on RAN1 LS, we think it is more like a UE.  “PRU may support, at least, some of the Rel-16 positioning functionalities of UE, if agreed, which is up to RAN2. The positioning functionalities may include, but not limited to, the following:   * + 1. Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)     2. Transmit the UL SRS signals for positioning   ”  Regarding whether it could be a TRP, that can be discussed in RAN3. |
| CATT | Option 3 (with comments) | At least the PRUs can be UE, but whether the PRUs can be part of gNB need to be confirmed with RAN1 in the response LS. |
| Qualcomm | Option 3 | Both can be supported with minimal specification impacts if LPP is used as positioning protocol in both cases.  RAN1 made the following agreement at RAN1#104-e:   * + "[…] FFS: The device with the known location being a UE and/or a gNB […]   However, this FFS should be resolved in RAN2/3. |
| Ericsson | Option 1 | From the RAN1 LS description, the PRU is not a new entity per se, and can be addressed with new UE location type (reporting both position estimate and positioning measurements), and associated capability. If a PRU is expected to imply a more functionality, then it is outside the scope of the WID  Furthermore, GNSS UE measurements associated to local environment feared events are also naturally within scope here as an ability associated to a capability as well. |
| Fraunhofer | Option 1 | A PRU with a UE like functionality can be addressed within the scope of the UE. The UE needs to report position estimate and measruements. |
| ESA | Option 3 (ideally), Option 1 (minimum) |  |
| Nokia | Option 1 | We view PRU as similar to a reference station used in differential GNSS techniques where the receiver capability is used to perform measurements used for corrections. In the case of terrestrial positioning we can also use the transmission capability for UL positioning. RAN1 mentioned some of the positioning capabilities envisioned for PRU but the stated measurements and reference signal transmission all leads to PRU being best modelled as a UE. Also, for simplicity of the solution and architecture it is best to choose one option rather than model it as both UE and TRP. |
| Spreadtrum | Option 1 | Based on RAN1 LS, PRU have the following functionalities: provide the positioning measurements and transmit UL SRS signals. Thus, it is suitable for the PRU to be modelled as UE. |

**Summary:**

TBD

## 3.2 How to manage PRUs

### Background:

According to RAN1 LS [1], the PRUs with known location just provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences) and transmit the UL SRS signals for positioning, in order to enhance the positioning performance.

So there is not any location service request from PRU or location service client to obtain the location of PRUs by triggering LCS procedure for the PRUs. Several contributions [2][4][5][6][9] address an essential issue that how to manage the PRUs, i.e., how can LMF aware of the available PRUs in the network? So that the LMF can further trigger the LPP or NRPPa positioning sessions to the target PRUs to obtain the measurement from PRUs.

### Impact to SA2

As for the issue on how to manage the PRUs, two aspects, e.g., UE act as PRUs or part of gNBs should be discussed.

* **UE-type PRUs**

For the case that UE act as the PRUs, the following candidate solutions are proposed in the contributions of [2][5][9]:

* **Option 1: PRU Access Registration[2] [5] [9]**

**Option 1-a：PRU registration to LMF [9]**

The PRU registers to the gNB and the 5G Core Network like a normal UE. As part of this registration procedure, the UE provides an indication to the serving AMF whether the device can function as a Position Reference Unit. The serving AMF then registers the PRU at an LMF using a new PRU Registration Request service operation towards an LMF.

**Option 1-b：PRU registration to AMF [2]**

PRU initiate the service registration procedure to the AMF, including the PRU capability as well as the known location information. When LMF needs PRUs info, it can send request to AMF to retrieve available PRUs. PRUs also can update its registration if the PRU is not static, so AMF can maintain all the available PRUs with related information dynamically.

* **Option 2: PRU Registration by using Supplementary Services message[2] [5] [9]**

PRU registers with an LMF using a new Supplementary Services message pair. The LMF and PRU can then exchange LPP messages via the serving AMF.

* **Option 3: LMF obtains available PRU info via LPP procedures, i.e. based on capability exchange**

It is also mentioned about the impact to SA2 in [4]:

A PRU could be a UE-like device, but the location is already known by itself, which means that there may be no LCS request for the UE to trigger the LMF to instigate the LCS procedure for the PRU, including any LPP/NRPPa messages for the PRU, i.e., MO-LR is not needed for this type of UE. Also, since the location of the UE is known to the UE and while for the network side, the request of the UE’s location, antenna orientation, and measurement are from LMF, rather than an external LCS client, for the maintenance of the Location Service in the network, it should be further investigated how this can be modelled under the current positioning framework. We think this falls within the expertise of SA2. [4]

**Rapporteur’s comments:**  In rapporteur’s understanding, all candidate solutions seem to be SA2 scope, e.g., the newly introduced Supplementary Services, or the registration procedure to AMF and the interaction between AMF and LMF. These candidate solutions mentioned above seems out of RAN2’s scope. Therefore, rapporteur would like to suggest an LS to SA2 to figure out how to support PRUs, e.g. how to manage the PRUs in the network.

Please also find the summary of impact to SA2 in contributions. [2][4][5][9]

**Proposal 2: RAN should first work on the stage2 and then send the baseline of general procedure for the support of PRU to SA2. [4]**

**Proposal 4: Option 3(AMF manage PRUs) is recommended to help LMF select available PRU(s) and inform SA2 on RAN2’s agreement. [2]**

**Observation 2: LMF should be aware of PRUs in the network. Otherwise, LMF will don’t know to initiate the positioning procedure to which UEs. [5]**

**Observation 3: There are several solutions for enabling LMF to be aware of PRUs in the network, which is out of RAN2 scope. [5]**

* **Enhance the current NAS Registration Request with an additional bit indicating the PRU functionality.**
* **Introduce new Supplementary Services (SS) LCS messages(e.g., Positioning Reference Unit Registration Request message).**

**Proposal 3: LS to SA2 to study how to enable the LMF to be aware of PRUs in the network. [5]**

**Observation 6: With Solution 2 (using a new Supplementary Services message pair) and Solution 3 (PRU is considered as part of a gNB), PRU-specific changes to RAN2 Stage 3 specifications (e.g., LPP) would not necessarily be required.**

**Proposal 3: In the case the Positioning Reference Unit (PRU) is considered as a "UE" from LMF perspective, adopt Solution 2 (using a new Supplementary Services message pair) for PRU registration at an LMF.**

**Proposal 4: Sent an LS to RAN3 and SA2 with the RAN2 agreements. [9]**

**Question 2-1: Do companies agree that SA2 should be involved to figure out how to support PRUs? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Agree/Disagree | Comments |
| OPPO | See comments | If RAN2 agreement shows that PRU registration procedure involves AMF, we are fine to send LS for further work. |
| Apple | See comments | RAN3 (and maybe SA5) may need to get involved, but not SA2.  This is because there is no need to introduce any new signalling, but rather manage PRUs via OAM. |
| ZTE | Agree | PRUs can have an impact on the registration to LMF/AMF, i.e., registration as a special UE. It needs to be specified by SA2. |
| Huawei, HiSilison | Agree |  |
| Xiaomi | Disagree | For the UE type PRU, we think the UE should be static or semi-static, so LMF can acquire the PRU information by implementation, such as which UE is PRU and the location of the PRU, so we think the proposed solutions are not necessary. |
| vivo | Agree | All solutions above are in the SA2 scope. |
| Lenovo, Motorola Mobility | See Comments | Our understanding is that the LMF can configure PRU based on capability information and then perform the legacy procedures to obtain the reference measurements at least in the case of the UE acting as a PRU. |
| InterDigital | See comments | For the LMF to be aware of the PRU and subsequently configure and assign any identifiers related to PRU operation, the registration of the PRU is to be initially fasciliated via the AMF. The registration of the PRU may require some SA2 involvement. Beyond that the procedures (e.g. LPP/NRPPa) for supporting the PRU can be handled by RAN2 and/or RAN3. |
| Intel | Disagree | We added option 3. Based on this, no SA2 impact. To our understanding, it should be similar to MDT. And then the LMF should only request the PRU to provide known location when PRU is requesting the location. I assume PRU is controlled by operator, and then option 3 should work well, i.e. UE can simply indicate capability over LPP that it can serve as a PRU. |
| CATT | Agree | All candidate solutions above have impacts on SA2.  To Apple:  When the PRUs can be mobile, OAM pre-configure doesn't meet this scenario.  To intel:  How does LMF trigger the LPP procedures? |
| Qualcomm | Agree | Since the LMF is the consumer of the PRU location information, this needs to be specified in SA2 (i.e., a LMF cannot be a LCS client currently and cannot initiate location requests autonomously). |
| Ericsson | Disagree | We share the view with Intel and think Option 3 is the natural one and the only one that fits the WID scope. With a specific capability associated to the support of a new location type, it is enough to interact via LPP. That could be accommodated within the existing WID and does not involve SA2 |
| Fraunhofer | Disagree | We agree with Intel and Ericsson views that option 3 fits well with the WID scope. |
| ESA | Disagree | Interaction via LPP could allow excahge of measurements between the UEs and attempt differential positioning (with high accuracy). |
| Nokia | See comments | This discussion is already jumping in to specific solutions and architecture assumptions. We need to first understand the requirements for a PRU. PRU shall be capable of measurements (specific measurements identified by RAN1) and the exact location of the PRU shall be known, are quite clear from RAN1 discussion. We need to understand if the PRU has other UE like requirements given that it can have limited positioning functionality, what the mobility requirements are etc. Also, can LMF act as the corrections computation entity and, if so, does LMF have the function to obtain or consume the PRU location information? And, where is this manageability requirement for PRU coming from and why? It looks like we do need to check with RAN3 and SA2 for architecture inputs and we may have to ask RAN1 for any additional requirements that are considered for PRUs before we discuss higher layer protocol (LPP, LCS, SS) impacts. |
| Spreadturm | Agree | The positioning procedure for PRU is triggered by LMF, this needs to be specified in SA2. |

If Question 2-1 is confirmed, then an LS is required to SA2 to ask them to study how to support/manage the PRUs in the network. As for the content of the LS to SA2, rapporteur propose a draft LS as the following.

|  |
| --- |
| **3GPP TSG-RAN WG2 Meeting #115 electronicR2-210xxxx**  **Online, Aug 16 – Aug 27, 2021**  **Title:** [Draft] **LS to SA2 on network management of UE-typed PRUs**  **Response to:**  **Release:** Rel-17  **Work Item:** NR\_pos\_enh  **Source:** CATT (to be RAN2)  **To:** SA2  **Cc:** RAN1, RAN3  **Contact Person:**  **Name:** Jianxiang Li  **E-mail Address:**   [**lijianxiang@datangmobile.cn**](mailto:lijianxiang@datangmobile.cn)  **Attachments:** None  **1. Overall Description:**  RAN2 is discussing on the Positioning Reference Units (PRUs) for enhancing positioning performance based on RAN1’s LS on Positioning Reference Units (PRUs) for enhancing positioning performance (R1-2106326).  RAN2 agreed that the PRU can be UE-type at least, FFS gNB-type (TBC).  RAN2 addressed an essential issue that how to manage the PRUs.  RAN2 would like to ask SA2 the following question: how can LMF be aware of the available PRUs in the network so that the LMF can further trigger the LPP or NRPPa positioning sessions to the target PRUs? (TBC)  **2. Actions:**  **To SA2**  **ACTION:** RAN2 respectfully requests SA2 to discuss on how to support PRUs in the network and provide answers to the questions above.  **3. Date of Next TSG-RAN2 Meetings:**  3GPP RAN2#116-e 1 November – 12 November 2021 Electronic Meeting |

**Question 2-2: Do companies agree with the above draft LS to SA2?** **Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Agree/disagree | Comments |
| OPPO | No | We have not reach consensus on the type of PRU, and we think it would be straightforward to copy the RAN2 agreements in the LS instead of writing as following：  *“RAN2 agreed that the PRU can be UE-type at least, FFS gNB-type (TBC).”* |
| Apple | No | No need to liaise SA2 at all |
| ZTE | agree |  |
| Huawei, HiSilicon | Disagree | RAN2 does not need to identify the issues for SA2, but only need to request SA2 to finish their part of work |
| Xiaomi | disagree | See our comments in Q2-1. |
| vivo | Agree |  |
| Lenovo, Motorola Mobility | Disagree | RAN2 has to confirm and agree on the general PRU functionality before sending any clarification LS to SA2. |
| InterDigital | Disagree | Similar understanding with Oppo and Lenovo in that whether the LS to SA2 is needed and what should be its content can be determined after first agreeing in RAN2 on supporting PRU operation. |
| Intel | Disagree | If it can be supported via existing LPP procedure, i.e. option 3 above, no LS is needed. |
| CATT | Agree |  |
| Qualcomm | Agree | We should include the RAN2 agreements (if any) to SA2. The RAN1 LS was also cc:SA2, so they are aware of the ongoing discussions. |
| Ericsson | Disagree | A more comprehensive PRU type is not considered by within the scope of the WID. Same view as Intel that Option 3 above is enough so no LS is needed |
| Fraunhofer | No | Alternatively send an LS to SA2 informing them of RAN2 decision to go for option 3, if this is agreed.  As part of Rel. 17, it would be sufficient to address it via LPP procedures. As a part of capability exchange, the PRU could signal the LMF the capabilities it supports. |
| Nokia | Disagree | Too early to agree on the specific text proposed in the LS. We do need to have a RAN2 consensus first whether a PRU is a UE or TRP. We also need to ask RAN1 for complete requirements for a PRU for the way they envisioned to use the PRS for improving positioning accuracy. |
| Spreadtrum | Disagree | We should include the RAN2 agreements (if any) to SA2. And we request SA2 to finish their part of work. |

**Summary:**

TBD

* **Part of gNBs act as PRUs**

If RAN2 agreed that part of gNBs acts as PRUs, the issue on how to manage the part of gNB-typed PRU also need be addressed. The contributions [5][9] propose that the PRU management can be performed by a deployment/operator, similar to the provisioning of gNB information to an LMF (typically via some Operation&Maintenance functionality). However, according to rapporteur’s view, once part of gNBs is used as PRUs if supported, then the discussion on how to manage the PRUs are within RAN3’s scope.

RAN2 may further discuss it later based on Q1-1.

## 3.3 LPP impact to support PRU

### Background:



Figure 1: positioning with envolvement of PRU

After LMF can be aware of the available PRUs in the network, the possible positioning procedures related with the PRU may include:

1: PRU positioning procedure, where LMF may interact with PRU to exchange the capability/assitance data/measurement/location/antenna orientation information.

2: UE positioning procedure, where the LMF/UE/gNB perhaps use the PRU related information to compensate the Tx/Rx errors.

we will further discuss the LPP possible impact to support the PRUs including the PRU positioning procedure and UE positioning procedure involvement with PRU related assistance information.

### 3.3.1 Possible LPP impacts within PRU positioning procedure

There are five issues to support PRU positioning procedure from LPP perspective which are summarized based on companies’ contributions. [2][4][5][6][7][8][9]

#### Issue 1: The PRU Capability transfer between LMF and PRU

As for the PRU capability transfer between LMF and PRU, the following three possible solutions are:

* **SA2 dependent solutions:**
* **Solution 1: Include the PRU capability information within the Supplementary Services message [9];**
* **Solution 2: Include the PRU capability information within the NAS Registration Request message [4][5];**
* **SA2 independent solutions**
* **Solution 3: Reusing the current LPP Request/Provide Capability message with enhancement to include PRU specific capabilities [2][6][7][8];**

Solution 1 or solution 2 is tring to include the PRU capability information within the Supplementart Services message or the NAS Registration Request message, which may be valid only after SA2 has concluded how to manage the PRUs.

As for the solution 2, in general the capability transfer procedure between LMF and PRU can reuse the current LPP Request/Provide Capability message, except some PRU specific capability e.g., whether PRU is static or dynamic, PRU’s mobie state informarion when it is dynamic, may need to be introduced within the LPP Request/Provide Capability message.

**Rapporteur comment:** since both solution 1 and solution 2 depend on SA2’s discussion, thus we prefer either to postpone the capabilities discussion until SA2 has decided the solutions on how to manage the PRUs, or we discuss if solution 3 can be supported by RAN2 now.

**Question 3-1**: **Do companies agree to postpone the capabilities discussion until SA2 has decided the solutions on how to manage the PRUs? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | Yes |  |
| Apple | No (with comments) | There is no need to postpone this discussion “till we hear from SA2”, because there is no need to involve SA2. |
| ZTE | yes | The capabilities transfer should be postponed since PRU’s feature is not cleared. |
| Huawei, HiSilicon | Yes | The capability may be defined as NAS capability or LPP capability. This can only be determined when we have the whole procedure and it is up to SA2 to decide |
| Xiaomi | See comments | We think there is no need to enhance the signalling procedures to acquire the PRU capability, since only special UE can be treated as PRU, and LMF can acquire the PRU information based on implementation. So it is not necessary to involve SA2. |
| vivo | Yes | Because the PRU capabilities can be transmitted to LMF before LMF initiates the PRU-terminated positioning. |
| Lenovo, Motorola Mobility | See comments | RAN2 should firstly discuss all three solutions before deciding to involve SA2. |
| InterDigital | No, with comments | We think whether to support SA2 dependent or independent solutions should be first decided in RAN2 |
| Intel | No | As we do not see the need to send LS to SA2. |
| CATT | Yes | Either of options may work from RAN2’s perspective. It’s up to SA2’s decision at first. |
| Qualcomm | Yes | The overall PRU framework need to agreed first. |
| Ericsson | No | A UE capability representing a new location type could be possible to fit within the WID. No need to send an LS to SA2 |
| Fraunhofer | No | If we agree to proceed with option 3, then SA2 response is not necessary. Given the time limitiations, we should avoid unnecessary latency between WGs. |
| ESA | No | We agree with Fraunhofer |
| Nokia | See comments | Agree to postpone discussion not because we need to get SA2 solutions from SA2 but we need to first understand the requirements for PRU and also have a reference architecture consensus (be it from RAN3 or SA2). |
| Spreadtrum | Yes | This part can be postpone untile we have the whole procedure of PRU. |

If you do not agree with question 3-1, then RAN2 may discuss the candidate solution 3 here. And of course, companies may submit other candidate solutions in the future.

**Question 3-2**: **Do companies agree with solution 3 if the answer to question 3-1 is no? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Apple | No | No need to introduce any signalling changes |
| Xiaomi | No | We think there is no need to enhance the signalling procedures to acquire the PRU capability and LMF can acquire the PRU information based on implementation. |
| Lenovo, Motorola Mobility | Yes | We support that a separate UE capability be discussed for PRUs at least in the case of UEs acting as a PRU. The PRU needs reports its known location (if available) to be considered as a valid PRU, which is different to the current normal positioning capabilities. |
| InterDigital | Yes | We think the existing LPP Capability Transfer procedure can be used for requesting and providing certain capability information of the UE (for the case of UE as PRU) such as the positioning method used for determining its location, accuracy/uncertainty information of its location, etc. Such information can be useful to LMF for deciding whether and when the PRU can be used for assisting the LMF. |
| Intel | Yes |  |
| Qualcomm | No | There is no need to modify LPP for PRU support. This would increase the ASN.1 footprint/memory also for normal UEs. |
| Ericsson | Yes | However, since PRU is not a specific 3GPP node type, it would be a capability associated to a UE ability |
| Frauhofer | Yes | In Rel. 17, the current LPP messages can be enhanced. |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. |
|  |  |  |
|  |  |  |
|  |  |  |

**Summary:**

TBD

#### Issue 2: The assistance data information transfer between LMF and PRU

As for the assistance data information transfer between LMF and PRU, it seems that all contributions [2][4-10] propose that no PRU specific additions seem required for the assistance data delivery and the LPP request/provide assistance data procedure can be reused to provide the assistance data to PRU.

**Question 4**: **Do companies agree that the current LPP request/provide assistance data procedure can be reused for the assistance data information transfer between LMF and PRU? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | No | It depends on the type of PRUs, and for TRP-based PRU, NRPPa signalling may be required. |
| Apple | yes |  |
| ZTE | Yes | UE-type PRU can be treated as normal UE with more capabilities, such as reporting its coordinate. When PRU performs measurements, it should be same as normal UE rather than other newly-introduced signaling. |
| Huawei, HiSIlicon | Yes | We think LPP message/posSIB is the only way for the LMF to deliver the PRS configuration to the UE |
| Xiaomi | Yes |  |
| vivo | Yes | No PRU-specific additions seem required for the assistance data delivery. So the assistance data transfer procedure for PRU-terminated positioning is the same as that for normal UE positioning. |
| Lenovo, Motorola Mobility | Yes | Assuming that the PRU can be a UE, then no specific assistance data enhancements are needed apart from differentiating assistance data between normal and PRU UEs ( if needed). |
| InterDigital | Yes, with comments | With the understanding that the PRU may be a ‘special’ UE (e.g. its reported measurements may be richer and more reliable than a normal UE), it is possible that additional assistance data is provided by LMF to the PRU via LPP signalling. This is to ensure that the quantity and quality of measurements made by PRU is consistently maintained at a level which would be necessary for it to operate as PRU. |
| Intel | Yes |  |
| CATT | Yes |  |
| Qualcomm | Yes | All LPP functionality can be reused. There is no need to make any PRU specific changes/additions to LPP. |
| Ericsson | N/A | The PRU is not a recognized type. Our conclusion is that it can operate as a normal UE with a specific ability, so the existing assistance data is sufficient for for RAT dependent and RAT independent AD |
| Fraunhofer | Yes | LPP mechanism can be used. However, if additional assistance data is needed for enhancing the UE functionality as a PRU other than that is needed for normal UE, then this can be addressed. |
| ESA | Yes | We think LPP is sufficient. Same as Ericsson, we think this could be beneficial to RAT\_independent as well as reporting of GNSS measurements and several local environments (e.g. multipath) is already supported. |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. |
| Spreadtrum | Yes |  |

**Summary:**

TBD

#### Issue 3: The PRU known location/antenna orientation information transfer between LMF and PRU

As for the PRU specific known location/antenna orientation information transfer between LMF and PRU, the following three possible solutions are summarized here:

* **SA2 dependent solutions:**
* **Solution 1: Include the PRU known location/antenna orientation information within the Supplementary Services message [9];**
* **Solution 2: Include the known location/antenna orientation information within the NAS Registration Request message [9];**
* **SA2 independent solutions**
* **Solution 3: Reusing the current LPP request/provide location information message with enhancement to include PRU known location/PRU antenna orientation information[2][5][6][7][8][10];**
* **Solution 4: Reusing the current LPP Request/Provide Capability message with enhancement to include PRU known location/antenna orientation information [9];**

Solution 1 or solution 2 is tring to include the PRU capability information within the Supplementart Services message or the NAS Registration Request message, which may be valid only after SA2 has concluded how to manage the PRUs.

As for the solution 3/4, in general the location information transfer procedure between LMF and PRU can reuse the current LPP request/provide location information or LPP request/provide capability message, except some PRU specific information e.g., PRU known location/antenna orientation, may need to be further introduced.

**Rapporteur commet:** since both solution 1 and solution 2 depend on SA2’s discussion, thus we prefer either to postpone the discussion until SA2 has decided the solutions on how to manage the PRUs, or RAN2 to start to evaluate solution 3 and solution 4.

**Question 5-1**: **Do companies agree to postpone the known location/antenna orientation information discussion until SA2 has decided the solutions on how to manage the PRUs? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | Yes |  |
| Apple | No (with comments) | There is no need to postpone, but the there is no need to introduce any signalling changes at all. |
| ZTE | Yes | We think the known location/antenna orientation information is part of the PRU’s capability, so this should be discussed together with Q3 |
| Huawei, HiSilicon` | Yes |  |
| Xiaomi | see comments | The know location/antenna orientation can be acquired based on implementation, so the above solutions are not necessary. |
| vivo | No | We think Solution 3 is sufficient. SA2 just need to research how to enable LMF to be aware of PRU and the PRU’s specific location is not needed to be reported before LMF initiates the PRU-terminated positioning. |
| Lenovo, Motorola Mobility | No | The known location of a PRU is pre-requisite to determine the necessary corrections. As such it depends on whether the location is already available, e.g. if the PRU is a UE. This LMF request and response signalling of the known location can performed via existing LPP messages or via the gNB RRC procedures (e.g. *LocationInfo* message). We don’t think there is any dependency on SA2 on how the PRU provides its known location to the LMF. |
| InterDigital | No | We think the known location/antenna configuration can be provided to LMF using an SA2 independent solution indicated above. As such, it is not necessary to wait for SA2 and postpone any of such discussions in RAN2. |
| Intel | No | We think solution 3 is sufficient. |
| CATT | No |  |
| Qualcomm | Yes | As mentioned above, any LPP changes applicable to PRUs only should (and can) be avoided. |
| Ericsson | No | A UE can already today be requested to provide its position estimate, which is enough to provide LMF with the information via LPP. Solution 3 is generically applicable |
| Fraunhofer | No | See Q3-1. |
| ESA | No | We think this ability is already supported |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. |
| Spreadtrum | Yes |  |

**Question 5-2**: **Which candidate solution do you prefer if the answer to question 5-1 is no? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Solution 3/ Solution 4/ FFS | Comments |
| OPPO | Solution 5, left to implementation. | We prefer to discuss how the known location is obtained first.  If the PRUs get its known location via GNSS, we wonder the difference between normal UEs and PRUs since majority UE supports GNSS positioning; and if PRU gets the known location via non-3GPP, i.e. up to implementation. In that case, we think no specification impact is needed from RAN2 perspective. |
| Apple | Neither | There is no problem to solve – the location is known, so there is no need to signal it. |
| Xiaomi | None | It can be left to implementation. |
| vivo | Solution 3 | If the location of PRU is stored in itself, then the LPP message Request/Providelocationinformation can be reused for LMF to acquire the location-related info. |
| Lenovo, Motorola Mobility | See comments | See response in Q5-1 |
| InterDigital | Solution 3 | We think the existing LPP location information transfer procedure can be used for the PRU to provide the known location information/antenna orientation info to LMF |
| Intel | Solution 3 |  |
| CATT | Solution 3 | Solution 3 has less impact on RAN2, since the location information is already included within the provide location information message.  Moreover, as we know, the PRU can be mobile, which means that the known location of the PRU can be dynamic, and LMF need to obtain the update known location of the PRU, if needed. Thus, we do not think the PRU known location is PRU specific capability and provided to the network when registration. |
| Qualcomm |  | This depends on the overall PRU solution. But PRU specific changes should not be made to LPP. |
| Ericsson | Solution 3 |  |
| Fraunhofer | Solution 3 |  |
| ESA | Solution 3 |  |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. |

**Summary:**

TBD

#### Issue 4: More positioning measurement information transfer between LMF and PRU

As for the positioning measurement information transfer between LMF and PRU, in general the current LPP request/provide location information message can be reused.

**Question 6**: **Do companies agree that the current request/provide location information message can be reused for the positioning measurement information transfer between LMF and PRU? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | No | It depends on the type of PRUs, and for TRP-based PRU, NRPPa signalling may be required. Thus, how the known location is obtained should be discussed first. |
| Apple | Yes |  |
| ZTE | Yes | Same as Q4 that UE-type PRU and target UE should have the same signalling procedures. |
| Huawei, HiSilicon | Yes |  |
| Xiaomi | Yes |  |
| vivo | Yes | The current ProvideLocationInformation message is already used to include the measurement information. |
| Lenovo, Motorola Mobility | Yes | The existing signalling can be used to provide the reference measurements. |
| InterDigital | Yes |  |
| Intel | Yes | antenna orientation information, etc should be contained in provide location information message. |
| CATT | Yes |  |
| Qualcomm | Yes | No LPP changes are needed. LPP can be used for both types of PRUs ("gNB" or "UE"). |
| Ericsson | Yes | The positioning measurement reporting procedure is enough for both RAT dependent and RAT independent measurements. The latter is also highly relevant for reporting characteristics about the GNSS local environment |
| Fraunhofer | Yes | Yes and in the context of integrity discussions, this message can be used to convey information about spoofing, interference and jamming detected by the UE (as optional part). |
| ESA | Yes | We agree with Fraunhofer and Ericsoon. LPP is ready to support both RAT-D and RAT-I. In the context of PRU the information that can already be transferred could be used to improve accuracy or gain knowledge about feared events in a cluster/nearby zone. |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. |
| Spreadtrum | Yes | LPP can be used to transfer measurement information. |

**Summary:**

TBD

#### Issue 5: Enhancement: PRU report the measurement corrections to the LMF

[5][8] propose a scenario that the Tx/Rx timing errors is calculated by PRU, and they think that the Tx/Rx timing errors should be directly sent to LMF under this scenario. In other words, this issue is equivalent to whether support the PRU to calculate the measurement corrections based on its known location and the obtained positioning measurement results. Rapporteur think this is indeed within the scope of RAN1. RAN2 should confirm with RAN1 before making further discussions.

**Question 7: Do companies agree to confirm with RAN1 on whether support PRU to calculate the measurement corrections and report it to LMF? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | Yes |  |
| Apple | TBD | We need to figure out more general questions first |
| ZTE | Yes, with comments | We think the PRU reports measurement results to LMF is enough, LMF should be responsible for calculating the measurement corrections. Confirm with RAN1 about the information is fine, too. |
| Huawei, HiSIlicon | No | We think this is under the scope of RAN1 to decide. If RAN1 thinks it is useful, RAN2 can define appropriate LPP signalling to support it. |
| Xiaomi | No | In the LS, RAN1 said RAN1 has not identified specification enhancements needed in RAN1 specifications, so there is no need to ask RAN1 to confirm the issue in question 7. And we think this can be discussed directly in RAN1. |
| vivo | Yes | We think just like LMF/UE-based positioning and LMF/UE-based integrity, there can be LMF/UE-based measurement correction. |
| Lenovo, Motorola Mobility | See comments | According to our contribution [8], we did not propose that the corrections be calculated within the PRU itself. Rather, we propose that known location of a PRU UE be updated autonomously to the LMF (since a UE can be mobile and the known location may change from time to time). Furthermore, reporting additional confidence level/quality information of the known location to the LMF is important assistance information for calculating the corrections at the LMF. |
| InterDigital | Yes, with comments | We think that apart from measurements the PRU can report additonal information such as confidence level/uncertainty of measuremnets and any detected errors that can be useful to LMF for determining any corrections to apply to the measurements provided by other target UEs. This issue may also be relevant to ongoing discussions about TEG (timing error group) since TEG is used to assist error detection/eliminiation. Thus, we also see no issue in confirming with RAN1 on whether the PRU can calculate measurement corrections and report them to LMF. |
| Intel |  | It can be discussed in RAN1 directly. |
| CATT | Yes | Whether PRU can calculate the measurement corrections and report it to LMF is within the scope of RAN1. |
| Qualcomm | No | According to RAN1, PRUs just provide measurements. LMF calculates any correction information desired. |
| Ericsson | N/A | The question is too narrow, since timing error group related measurements are discussed in RAN1 and can be an ability to report by any UE indicating this as a capability |
| Fraunhofer | TBD | This needs to be discussed in RAN1. |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. We should ask RAN1 for complete, known requirements for a PRU. Whether PRU has the requirement to compute corrections is something RAN1 can clarify as part of the PRU requirements. |
| Spreadtrum | TBD | This needs to be discussed in RAN1 |

**Summary:**

TBD

### 3.3.2 Possible LPP impacts within UE-based positioning procedure with compensation

Based on the measurements provided by the PRU, UE and gNB, and the known locations of the PRU and TRPs, the LMF may be able to derive the corrections of the UE/gNB measurements (similar to GNSS differential correction). For UE-based, the compensation may need to be done in UE side, since UE is responsible for location calculation.

According to rapporteur’s view, the issus has potential impact to RAN2, i.e., extra information for compensation in UE-Based will be transferred via LPP.

**Question 8: Do companies agree to confirm with RAN1 if it is valuable to provide the correction information from LMF to UE for UE-based positioning? Please specify the reasons or comments if any.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | Yes |  |
| ZTE | Yes | This is for one-shot measurement error mitigation with PRU, see our comments in Q9 |
| Huawei, HiSilicon | No | If there is adjustment needed, with the help of PRU, the adjustment should be reflected by the positioning calculation assistance information itself, rather than a separate parameter to indicate the adjustment. In this case, there is no spec impacts. |
| Xiaomi | No | Whether UE needs correction information or not is RAN1 issue, and can discuss it directly in RAN1. |
| vivo | Yes | For UE-based positioning, the compensation may need to be done on the UE side because UE is responsible for location calculation. |
| Lenovo, Motorola Mobility | Yes | Since the LMF supports the differential correction calculation for UE-assisted methods, it’s natural to consider such corrections calculated at the LMF be delivered to the UE in the case of UE-based positioning. |
| InterDigital | Yes | It is understandable that any correction/compensation can be provided by LMF to UE, possibly as assistance data, when supporting UE-based positioning. |
| Intel |  | This should be discussed in RAN1 directly. |
| CATT | Yes | When the LMF derives the corrections of the UE/gNB measurements (similar to GNSS differential correction), for UE-based, UE is responsible for location calculation within the compensation. However RAN1 doesn't mention UE-Based aspect, so we prefer to confirm with RAN1 on UE-based method. |
| Qualcomm |  | I understand this is the assumption in RAN1 anyhow. |
| Ericsson | N/A | This would be a UE-based enhancement that is outside the scope of the WID for RAT dependent positioning but can be studied in later releases if agreed. For RAT-independent (GNSS) it is within the WID as part of the local environment. |
| Fraunhofer | N.A | For RAT dependent positioning, the discussion needs to be done with RAN1. For the RAT-independent, this is already within the scope of the WID as part of the local environment. |
| ESA |  | Agree with Ericsson, for RAT-I this could be addressed under local feared events and the impact to LPP is expected to be minimal (e.g. extension of GNSS Measurement List IE or a new IE). |
| Nokia | See comments | See our comments to Q2-1 and Q3-1. We should ask RAN1 for complete, known requirements for a PRU. Whether PRU has to support UE-based positioning or whether PRU must be capable of getting corrections from LMF are all requirements that RAN1 can clarify as part of the PRU requirements. |
| Spreadtrum | See comments | For UE-based positioning, we are not sure what correction information needs to be send to UE from LMF since the compensation may need to be done in UE side and UE is responsible for location calculation. |

**Summary:**

TBD

## 3.4 draft LS to RAN1

Based on the discussions in section 3.1/3.3, rapporteur proposes RAN2 should indicate the questions on PRUs raised by RAN2 as well as the agreement made during this meeting on PRUs to RAN1. Based on this, rapporteur propose a draft LS as the following.

|  |
| --- |
| **3GPP TSG-RAN WG2 Meeting #115 electronicR2-2108941**  **Online, Aug 16 – Aug 27, 2021**  **Title:** [Draft] **Response LS to RAN1 on the Positioning Reference Units (PRUs) for positioning enhancement**  **Response to: R2-2106920 (R1-2106326)**  **Release:** Rel-17  **Work Item:** NR\_pos\_enh  **Source:** CATT (to be RAN2)  **To:** RAN1  **Cc:** RAN3, SA2  **Contact Person:**  **Name:** Jianxiang Li  **E-mail Address:**   [**lijianxiang@datangmobile.cn**](mailto:lijianxiang@datangmobile.cn)  **Attachments:** None  **1. Overall Description:**  RAN2 thanks RAN1 for their LS on Positioning Reference Units (PRUs) for enhancing positioning performance.  RAN2 has analysed the impact of the introduction of PRU on RAN2 specification, and would like to inform RAN1 about our initial progress as follows:   * Supporting a UE to be PRU will bring the following impact on RAN2 specification.   TBC (we will add it based on agreements made after the online discussion)  In addition, RAN2 would like to ask RAN1 the following questions for clarification   1. Whether to support a gNB to be a PRU? (TBC based on email discussions progress on Question 1) 2. Whether to support PRU to calculate the measurement corrections and report the corrections to LMF? (TBC based on email discussions progress on Question 7) 3. Based on the measurements provided by the PRU, UE and gNB, and the known locations of the PRU and TRPs, the LMF may be able derive the corrections of the UE/gNB measurements (similar to GNSS differential correction. Does RAN1 think it is valuable, or necessary, for LMF to provide the information of the corrections to UE for UE-based positioning? (TBC based on email discussions progress on Question 8) 4. There are two options to mitigate measurement errors with PRU:    * 1. Option 1: one-shot measurement error mitigation with PRU. There are several TRPs and a PRU. The measurement error is generated only by TRPs and the PRU. And the measurement error can be used in the measurement of target UE subsequently      2. Option 2: real-time measurement error mitigation with PRU. There are several TRPs, a PRU and a target UE. The measurement error is canceled by differential operation between measurement results of the target UE and measurement results of the PRU.   RAN2 would like RAN1 to confirm which options is agreed and needed further specification impact analysis.  **2. Actions:**  **To RAN1**  **ACTION:** RAN2 respectfully requests RAN1 to take the above information into consideration in their future work and provide answers to the questions above  **3. Date of Next TSG-RAN2 Meetings:**  3GPP RAN2#116-e 1 November – 12 November 2021 Electronic Meeting |

**Question 9: Do companies agree with the draft LS to RAN1? Please specify the reasons and comments on the draft LS as well.**

|  |  |  |
| --- | --- | --- |
| Company | Agree/disagree | Comments |
| OPPO | See comments | We think RAN2 can identify the corresponding spec impact after RAN1 clarifies the questions provided in the draft LS. Thus, the LS only need to contain the questions for clarification.  And we prefer to add one more question:   1. How PRU obtain its known location? 2. What is the type of PRU? |
| ZTE | see comments | In RAN1 discussion, many companies provided real-time measurement error mitigation with PRU. So there are two cases now:   1. One-shot measurement error mitigation with PRU   There are several TRPs and a PRU. The measurement error is generated only by TRPs and the PRU. And the measurement error can be used in the measurement of target UE subsequently.   1. real-time measurement error mitigation with PRU   There are several TRPs, a PRU and a target UE. The measurement error is canceled by differential operation between measurement results of the target UE and measurement results of the PRU.  The above 2 cases have different spec impact in RAN2. For example, if in case 1, in UE-based method, LMF only needs to tell UE the measurement errors; However in case 2, in UE-based method, LMF needs to tell target UE the measurement results of PRU for differential operation.  **Therefore, we suggest to make it clear to RAN1 that which case we are talking about.** |
| Huawei, HiSilicon | Disagree | Please see the reply inlined above |
| Xiaomi | See comments | We think the following response is enough.  RAN2 has analysed the impact of the introduction of PRU on RAN2 specification, and would like to inform RAN1 about our initial progress as follows:   * Supporting a UE to be PRU will bring the following impact on RAN2 specification.   TBC (we will add it based on agreements made after the online discussion)  In addition, RAN2 would like to ask RAN1 the following questions for clarification   1. Whether to support a gNB to be a PRU? (TBC based on email discussions progress on Question 1)   And the bullets 2 to 4 can be discussed in RAN1 directly. |
| vivo |  | It is too early to discuss it. Because we should discuss it after we have the agreements for all other questions. |
| Lenovo, Motorola Mobility | No | No need to send an LS to RAN1 at this stage. RAN2 has been tasked to determine the specification impacts and further discussion is needed. |
| InterDigital | See comments | We think the draft LS to RAN1 proposed by the rapporteur can be used as a starting point, which can then be updated based on discussion in RAN2 on whether and what specification enhancements for supporting PRU.  We have one comment:  “Whether to support a gNB to be a PRU? (TBC based on email discussions progress on Question 1”...Depending on the outcome of Question 1, the question may be rephrased to ask RAN1 whether there can be benetfits for supporting a gNB as a PRU. |
| Intel | No | RAN1 can discuss this directly. |
| CATT | Yes | We need to imform RAN1 on the agreement and status in RAN2. |
| Qualcomm | Not yet | Any RAN2 agreements we will make should be communicated to RAN1, RAN3 and SA2. |
| Ericsson | Disagree | This LS addresses many aspects that has not yet been studied in RAN2 and it is premature to indicate information to RAN1 without properly study this topic. Also, since an entity such as a PRU is not part of the WID scope, it is not recommended to discuss items related to a PRU in LSs. Instead, RAN2 can comment on what can be feasible within the current WID, where certain abilities tied to associated capabilities can be introduced for any UE implementing these abilities |
| Fraunhofer | No |  |
| Nokia | No | I think we are hastily trying to agree some solution without proper analysis and discussion. In this meeting, the best we can do is to attempt to see if PRU is a UE or a TRP. If we cannot reach consensus on this, we can ask for RAN3 and SA2 inputs also to see if that helps in reaching consenses whether PRU is a UE or TRP. Apart from this, we can only ask RAN1 what other requirements does a PRU have other than measurements and SRS transmission and how the PRU fits in to the overall solution for enhancing positioning accuracy. |
| Spreadtrum | Not yet | It is too early to send the LS to RAN1 at this stage. Because we should discuss it after we have the agreements for all other questions. |

**Summary:**

TBD

# 4 Conclusion

TBD

# 5 References

1. R[2-2106920](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2106920.zip) LS on Positioning Reference Units (PRUs) for enhancing positioning performance (R1-2106326; contact: CATT) RAN1 LS in Rel-17 NR\_pos\_enh To:RAN2, RAN3 Cc:SA2
2. R[2-2107143](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2107143.zip) Discussion on Positioning Reference Units (PRUs) for positioning enhancement CATT discussion Rel-17 NR\_pos\_enh-Core
3. R[2-2107357](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2107357.zip) Discussion on PRU of positioning Spreadtrum Communications discussion Rel-17
4. [R2-2107501](file:///C:\Users\mtk16923\Documents\3GPP%20Meetings\202108%20-%20RAN2_115-e,%20Online\Extracts\R2-2107501%20Discussion%20on%20positioning%20enhancement.docx) Discussion on positioning enhancement Huawei, HiSilicon discussion Rel-17 NR\_pos\_enh-Core
5. R[2-2107647](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2107647.zip) Discussion on support for Positioning Reference Unit vivo discussion Rel-17 NR\_pos\_enh-Core
6. R[2-2107689](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2107689.zip) Discussion on supporting Positioning Reference Units InterDigital, Inc. discussion Rel-17 NR\_pos\_enh
7. R[2-2107831](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2107831.zip) Discussion on the Positioning Reference Units (PRUs) OPPO discussion Rel-17 NR\_pos\_enh-Core
8. R[2-2108131](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2108131.zip) Support of Positioning Reference Units Lenovo, Motorola Mobility discussion Rel-17
9. R[2-2108386](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2108386.zip) Signalling and Procedures for supporting Positioning Reference Units Qualcomm Incorporated discussion
10. R[2-2108398](file:///C:\Users\zhangbufang\Desktop\项目\115e\文稿review\Docs\R2-2108398.zip) On the Positioning Reference Units aspects Ericsson discussion