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%3A%5C%5CUsers%5C%5Czhangbufang%5C%5CDesktop%5C%5C%E9%A1%B9%E7%9B%AE%5C%5C115e%5C%5C%E6%96%87%E7%A8%BFreview%5C%5CDocs%5C%5CR2-2106920.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 |
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# 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.**

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

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.**

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| --- | --- | --- |
| 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. |
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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.

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| **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** **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.**

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

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Apple | No | No need to introduce any signalling changes |
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**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. |
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**Summary:**

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#### 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.**

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

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

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| --- | --- | --- |
| 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. |
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**Summary:**

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#### 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.**

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| --- | --- | --- |
| 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. |
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**Summary:**

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### 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.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| OPPO | Yes |  |
| ZTE | Yes | This is for one-shot measurement error mitigation with PRU, see our comments in Q9 |
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**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.

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| **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** **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.**

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| --- | --- | --- |
| 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.**  |
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**Summary:**

TBD

# 4 Conclusion

TBD

# 5 References

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