3GPP TSG RAN WG1 Meeting #108e R1-2202497

**e-meeting, February 21st – March 3rd,, 2022**

**Source: Moderator (CATT)**

**Title: FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays**

**Agenda item: 8.5.1**

**Document for: Discussion and Decision**

# Introduction

This document provides a summary of the following email discussion for AI 8.5.1:

[108-e-R17-ePos-01] Email discussion for maintenance on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays – Ren Da (CATT)

* 1st check point: February 25
* Final check point: March 3

One of the RAN1 objectives of this work item is to:

* *Specify* ***methods****,* ***measurements****,* ***signalling, and procedures*** *for improving positioning accuracy of the Rel-16 NR positioning methods by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, including [RAN1]*
	+ DL, UL and DL+UL positioning methods
	+ UE-based and UE-assisted positioning solutions

The WI was closed in RAN#94e from RAN1’s perspective. The document covers the remaining issues related to related to the accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays based on the contributions [1-16]:

**Notes:**

* The following highlights will be used in this summary:
	+ “Pink highlights” are used for proposals with high priority
	+ “Turquoise highlights” are used for offline consensus/conclusion
	+ “Grey highlights” are used for proposals resolved in this meeting.

Note: The above priority highlights are used mainly as a suggestion of the priority for *online* discussion. The priority indications may be changed based on the received comments. During the email discussion, interested companies are encouraged to provide comments to all proposals regardless of the priority indications.

* When providing the comments, it would be helpful to indicate explicitly whether to“*support*”, or “*not support*”, or provide a suggestion of modification. A comment of “*high/low priority*” is only interpreted as a suggestion for the priority for email/online discussions. For a proposal with multiple options, it would be helpful to indicate which of the option(s) are “*supported*” and/or “*preferred*”.
* For a proposed enhancement, if we cannot reach a consensus, we may conclude that “*a consensus cannot be reached for the proposed enhancement*” for this email discussion in this meeting. It does not necessarily mean the proposed enhancement will not be further discussed in future meetings.

# Methods for mitigating UE/TRP Tx/Rx timing errors

## Reporting of SRS port IDs with the RTOA measurements

Submitted Proposals

* ***(Huawei, R1-2200920[1]) Proposal 1:*** *It is up to RAN3 to decide whether to support SRS port ID reporting associated with RTOA measurement.*

FL Comments

The proposal to support gNB to report the associated SRS port ID for improving the positioning performance was discussed in the previous meetings, but only a few companies provided the comments during the email discussions [17]. In [1], it suggests leaving the reporting of the SRS ports with RTOA measurement for RAN3. In FL’s understanding, the support of SRS port ID reporting has no impact on UE side.

### Question 2.1

*Companies are invited to provide their views on whether the following proposals should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Huawei, R1-2200920[1]) Proposal 1*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | We think that reporting port-specific RTOA can have benefits of supporting high accuracy positioning for the legacy UEs.The change is quite simple and can be directly discussed by RAN3.We support this proposal. |
| CATT | Yes |  | Support this proposal to be discussed by RAN3. |
| vivo |  | √ |  |
| Fraunhofer | Yes |  | Support the proposal for MIMO-SRS |
| OPPO |  | No | Is it only for SRS for MIMO, or for both SRS for MIMO and SRS for positioning? For SRS for positioning, the mechanism based on TEG has been supported. For SRS for MIMO, the mapping of SRS port(s) and the RF chain(s)/antenna(s) may be changed without notifying gNB. Thus, how about the performance for this case?  |
| ZTE |  |  | Interested companies can bring their proposals in RAN3. We don’t need to further discuss it in RAN1. |
| CMCC |  |  | Up to RAN3. |
| Huawei, HiSilicon2 |  |  | Reply to OPPO:Assuming a 2-port SRS resource, the RTOA measuremnets from 2 TRPs measuring the same port 1001 at the same time can be ideally UE Tx group delay free. A TRP may choose to measure both ports 1000 and 1001, and LMF may combine the all RTOA measurements for port 1000 associated with a transmission occasion and combine all RTOA meausrements for port 1001 assocaited with a transmission occasion, and jointly determine the UE location without specifying UE behaviour at all. |
| Ericsson | Yes |  | We are fine to leave this to RAN3. |
| NTT DOCOMO | Yes |  | Support this proposal to be discussed by RAN3. |
| LGE |  | O | We think RAN1 does not need to discuss the proposal.  |
| Intel |  | No | Low priority for maintenance phase in Rel-17  |

## Reporting of UE Tx TEGs

Submitted Proposals

* ***(Huawei, R1-2200920[1]) Proposal 4****: For static SRS-TEG association, UE may report the association before positioning SRS transmission.*

FL: Suggest focusing on whether to support the reporting of Tx TEG association before SRS transmission w/o defining the static/dynamic SRS-TEG association, since it is up to UE to determine the change of the TEG association based on RAN4’s LS. Further discussion in Proposal 3.2-1.

* ***(Huawei, R1-2200920[1]) Proposal 5****: For dynamic SRS-TEG association, UE shall only report the association for the previously transmitted SRS.*

FL: Suggest focusing on whether to support the reporting of Tx TEG association before SRS transmission w/o defining the static/dynamic SRS-TEG association, since it is up to UE to determine the change of the TEG association based on RAN4’s LS. Further discussion in Proposal 3.2-1.

* ***(Huawei, R1-2200920[1]) Proposal 6****: For triggered SRS-TEG association reporting, it is up to RAN2 to consider whether to support it.*

FL: Further discussion in Proposal 3.2-1.

* ***(Nokia, R1-2201634[7]) Proposal 3****: Allow UE to respond to a request for Tx TEG associations with an indication that it will report, or has already reported, directly to LMF (if responding to gNB) or to gNB (if responding to LMF).*

FL: Similar proposal was discussed in the previous meeting but it was lack of the support. It seems the issue is not critical. Suggest checking with all companies to see if we want to have further discussion in this meeting.

* ***(InterDigital, R1-2201824[9]) Proposal 1:*** *Support the UE to report the association information between UE Tx TEG and SRS resource for UL-TDOA at periodically configured reporting occasion only if there is a change in the Tx TEG association compared to the last reporting.*

FL: Similar proposal was discussed intensively in the previous meeting. Given that RAN1 has made the decision of supporting periodic reporting, and RAN4 to decide the UE determines the previous association information is no longer valid, Suggest checking with all companies to see if we want to have further discussion in this meeting.

* ***(InterDigital, R1-2201824[9]) Proposal 2:*** *Support the UE to report the association information between UE Tx TEG and SRS resource whenever the UE determines the previous association information is no longer valid.*

FL: Similar proposal was discussed intensively in the previous meeting. Given that RAN1 has made the decision of supporting periodic reporting, and RAN4 to decide the UE determines the previous association information is no longer valid. Suggest no further discussion in this meeting.

* ***(InterDigital, R1-2201824[9]) Proposal 3:*** *Support validity time for TEG, i.e., within the validity time, the UE may not report the TEG association information.*

FL: Similar proposal was discussed in the previous meeting but it was lack of the support. Suggest no further discussion in this meeting.

* ***(Qualcomm, R1-2202140[12]) Proposal 1****: For M-RTT, support a UE to report, within the UE Rx-Tx measurement report, the UE Tx TEG association for the SRS resources for positioning that have already been transmitted, together with the associated timestamp(s) for which a particular association is valid.*
	+ *Send an LS to RAN2 to continue the signaling design*

FL: Further discussion in Proposal 3.2-1.

* ***(LGE, R1-2202291[13]) Proposal 1:*** *Regarding measurement with different Rx TEGs at both UE and gNB, RAN1 should support that related information needs to be transmitted through location measurement request message (e.g. RequestLocationInformation for LPP and MEASUREMENT REQUEST for NRPPA)*

FL: High-layer message for Rx TEG reporting can be decided by RAN2/RAN3. Suggest no further discussion in this meeting.

FL comments

The time when LMF/gNB request UE to report UE TxTEG association and the time when UE transmits positioning SRS resources and the time when the gNB receives the SRS resources could all be different. For periodic reporting of UE TxTEG for UL-TDOA, the issue may not be critical since the LMF will obtain all of the updates of UE TxTEG association through the reportings, although it may cause positioning latency. For non-periodic reporting of UE TxTEG, than there may be a need to specify the time or time duration for the reporting of the UE TxTEG association.

### Question 2.2

*Please indicate whether any of the following proposals should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + ***P1:*** *(Nokia, R1-2201634[7]) Proposal 3: Allow UE to respond to a request for Tx TEG associations with an indication that it will report, or has already reported, directly to LMF (if responding to gNB) or to gNB (if responding to LMF).*
	+ ***P2:*** *(InterDigital, R1-2201824[9]) Proposal 1: Support the UE to report the association information between UE Tx TEG and SRS resource for UL-TDOA at periodically configured reporting occasion only if there is a change in the Tx TEG association compared to the last reporting.*
	+ ***P3:*** *(InterDigital, R1-2201824[9]) Proposal 2: Support the UE to report the association information between UE Tx TEG and SRS resource whenever the UE determines the previous association information is no longer valid.*
	+ ***P4:*** *(InterDigital, R1-2201824[9]) Proposal 3: Support validity time for TEG, i.e., within the validity time, the UE may not report the TEG association information.*
	+ ***P5:*** *(LGE, R1-2202291[13]) Proposal 1****:*** *Regarding measurement with different Rx TEGs at both UE and gNB, RAN1 should support that related information needs to be transmitted through location measurement request message (e.g. RequestLocationInformation for LPP and MEASUREMENT REQUEST for NRPPA)*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Partly |  | P1: Not clear why we need this. The understanding of the Tx TEG reporting is initiated by LMF, and it appears that the proposal is addressing the issue LMF already requested gNB to get the TEG association from the UE, while LMF additionally request UE to report it directly again.P2: We do not think this is needed. If there is such a need, we also need to define “change”.P3: This triggered TEG change report relies on a clear definition of “change” in the first place. And we would like to note that this report is indicating future association for the SRS not transmitted yet.P4: Why is this needed? If the association is not longer needed, network could simply request UE not to provide it any more. We think this should be directly discussed by RAN2.P5: No need to discuss this. This is purely RAN2/RAN3 business, and we believe this is already supported. |
| CATT |  |  | We prefer the P1~P5 to be low priority.  |
| vivo |  | √ |  |
| OPPO |  | No | For P1-\_4: The benefit is doubtable For P5: Not RAN1 issue |
| ZTE |  |  | P1: No. It’s up to LMF’s implementation. No further indication is needed.P2/P3/P4: No As we have already agreed in last meeting, it’s up to RAN2 to further design the details.P5:NoIt’s up to RAN2/RAN3 to design the corresponding signalings. |
| MTK |  | No | P1-P4: the benefit not clearP5: seems not RAN1 issue |
| CMCC |  | No |  |
| InterDigital | Yes |  | P1 : We support to discuss this issue to reduce signaling overhead and redudancyP2 : @ Huawei, the “change” here refers to a difference in Tx TEG association compared to the assocatgion reported in the last occasion.We don’t see a need to report TEG association at evey occasion if there is no change. To reduce redundancy in reporting, the proposal is made.P3, P4 : These are corelated proposals. These describe validty for Tx TEG asocation. Simlar to the motivation discussed for P2, the goal here is to reduce redundancy in reporting.P5: Is the aim to provide more assisatnce information?  |
| Huawei, HiSilicon2 |  |  | Reply to IDC: we would like to understand whether this case corresponds to a TEG association change. |
| Ericsson |  | P1, P3, P4, P5 P2, P5 can be discussed in RAN2 and/or RAN3 | P1: The problem is not very clear to us. It seems these proposals are some optimizations for TEG reporting overhead reduction. We don’t see them as high priority.P2: This can be discussed directly in RAN2 if it is beneficial. RAN1 does not need to discuss it.P3: Low priority. P4: The need for this is not clear to us. So, Low priority.P5: No need to discuss in RAN1. |
| LGE |  |  | Regardign the issue (P1~4): according to LS from RAN4 (R1-2200902) that it is up to UE implementation, we think that P1~P4 are not necessary to be discussed. In case of R5, we would follow majority views. |
| Intel |  | No | Low priority for discussion, current agreements are sufficient for operation |
| Nokia/NSB |  |  | P1: The issue is that the gNB does not know if the UE is measuring or reporting Rx-Tx measurements. So the gNB may be asking the UE to report something that it is already reporting directly to the LMF. This is unnecessary overhead so we support the proposal. P2-P3: agree with Huawei, this is not needed. P4: We are open to discuss this proposal but it may depend on RAN4 discussion of TEG margins in our understanding. P5: Unclear. Seems not needed.  |

### Proposal 2.2

* *For M-RTT, subject to UE capability, support the LMF to request a UE to report the UE Tx TEG association for the SRS resources for positioning together with the associated timestamp(s) within a configured time window:*
	+ *The starting time of the time window can be earlier than the time when the UE reports the UE Tx TEG association*
	+ *The end time of the time window can be later than the time when the UE reports the UE Tx TEG association*
	+ *It is up to UE’s capability and implementation on whether and how to provide the UE Tx TEG association according to the request from the LMF.*
	+ *It is up to RAN2 to define the starting and the end time*
	+ *Send an LS to RAN2 to continue the signaling design*

Comments

*Companies are invited to provide their views on whether the issue covered by the above proposal should be discussed in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | No | We are OK to discuss the MTW, and MTW can be applied to Tx TEG association reporting. |
| CATT | Yes | Support the configured time window for UE to report the UE Tx TEG association. |
| vivo | No | The motivation of using a window for SRS-TEG report needs to be clarified.We prefer to discuss SRS-TEG report in aspect 2.4 |
| Fraunhofer |  | Agree with vivo on the time window cofigutation. Support associating a UE Tx TEG with the associated timestamp, |
| OPPO | No | Periodic reporting has indicated windows implicitly.  |
| ZTE |  | Open to further discuss. But we don’t see the need to define staring time and end time.From our point of view,the mechanism for M-RTT could be similar to the following agreement for UL-TDOA.. For M-RTT, we think the association information should be provided together with measurement report. There is no need to configure another report for the association information.**Agreement*** For UL-TDOA, supporting the following for the serving gNB to request a UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning, subject to UE capability of supporting UE Tx TEG:
	+ Based on a configured periodicity, a UE may report the UE Tx TEG association for the SRS resources for positioning that have already been transmitted during the configured period
		- It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)
		- It is up to RAN4 to decide when the Tx TEG association is changed
	+ The values of the configurable periodicities are up to RAN2
	+ Note: Tx TEG association information reporting by single request/response mode is assumed already supported with the previous agreement.
* Send an LS to RAN2/RAN4 (cc: RAN3)
	+ to RAN2, including the following RAN1’s agreement related to the reporting of the UE Tx TEG, for RAN2 to work on the signaling

to RAN4 for checking the agreement and work on how to decide when the Tx TEG association is changed |
| MTK | No | Don't support.. same view as vivo for the motivation of having a window |
| CMCC |  | Confused about the motivation to introduce a time window to report the association information for multi-RTT? What is the relationship between the time window here with the measurement time window? |
| InterDigital | No | We prefer to discuss MTW.  |
| Ericsson |  | Open to discuss and conclude this issue in RAN1 this meeting. |
| LGE | No  | We are also confused about the proposal. If does the proposal imply the MTW?, we prefer to discuss the proposal after some clarifications are discussed. |
| Intel | No | Do not see the issue reflected in the proposal |
| Nokia/NSB | No |  |

## Reporting of UE Tx TEGs

Background

|  |
| --- |
| Agreement:Make the following modification of the previous agreement:For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE ~~may~~ should support, up to UE capability, either one or both of the following options:* Option 1: Reporting of UE RxTx TEG ID ~~is supported by the UE~~
	+ FFS: Further details on how the UE RxTx TEG IDs are related/associated to UE Tx TEG IDs and/or UE Rx TEG IDs and to the UE Rx-Tx measurements.
* Option 2: Reporting of ~~UE RxTx TEG ID is not supported by the UE; reporting of~~ UE Rx TEG ID and UE Tx TEG ID ~~is supported~~.
* In either option, a UE Tx TEG ID is associated with (downselection needed)
	+ Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the UE Rx-Tx measurement
	+ Alt. 2: the Tx timing of the UE Rx-Tx measurement
	+ Alt. 3: one or more UL SRS resources for positioning
* Note: An UE Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement
* FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).
* FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements

Agreement:* If a Tx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE should also report the association of the Tx TEG ID to the UL SRS resource(s)
	+ FFS: how the association of the Tx TEG ID to the UL SRS resource(s) is determined by UE.
	+ FFS: details of the signalling

Agreement:If a RxTx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE may optionally also report a Tx TEG ID.  |

Submitted Proposal

* ***(vivo, R1-2201093[2]) Proposal 1:*** *For mitigating UE Rx/Tx timing errors for DL+UL positioning, up to the UE capability, the following should be supported:*
	+ *The UE provides the association information of UE Tx TEG(s) with all UL Positioning SRS resources to LMF.*
	+ *For a Rx-Tx time difference measurement for a PRS resource, the UE may report one or more pairs of {RxTx TEG, Tx TEG}, which are used to represent the mapping relationship with all Tx TEGs of all SRS resources.*
		- *wherein, the maximum number of Tx TEGs here is N, N={1,2,3,4,6,8}, subjective to UE capability.*
* ***(Ericsson , R1-2202389[16]) Proposal 4:*** *The UE can be configured by the gNB with a list of SRS resource sets and SRS resources for which UE TX TEG association reporting should be performed. In case an SRS resource set is listed rather than an SRS resource then the UE should report the UE TX TEG association for all SRS resources in the SRS resource set.*

FL comments

Based on the previous agreement, if a UE supports Option 1, UE may (or may not) report TRP Tx TEG ID with a UE Rx-Tx time difference measurement. For a UE supporting Option 2, FL shares the similar view with vivo in that it is highly desirable for UE to report UE Tx TEG(s) of all UL Positioning SRS resources to LMF. However, further discussion is needed on whether the UE can be forced to report the mapping of *all SRS respurces to TEGs.* In UE feature, it says “lf the UE does not include TxTEG-ID associated with a measurement, no assumption can be made on the [mitigation of] UE Tx timing errors for this SRS resource for positioning.” Thus, it is still up to UE implementation to decide how the UE to provide the mapping of *the SRS respurces to TEGs.*

### Question 3.3

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(vivo, R1-2201093[2]) Proposal 1*
	+ *(Ericsson , R1-2202389[16]) Proposal 4*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | We think that the baseline is that the TEG association with all the configured positioning SRS should be considered as requested by the network. Not clear why network would pick a few from all the configured positioning SRS.In addition, if UE is not able to determine the TEG association, UE may simply not include the TEG information for a particular positioning SRS. |
| CATT | Yes |  | Support to discuss the proposals and decide whether the UE can be forced to report the mapping of all SRS respurces to TEGs. |
| vivo | √ |  | Proposal 1 is to address the potential mismatch problems between UE and gNB Rx-Tx time difference measurements. For example, the UE reports Rx-Tx time difference measurements associated with a RxTx TEG ID and a Tx TEG ID, but it cannot gurantee that the SRS resources associated with the Tx TEG can be measured by the target TRP (e.g. the target TRP measures the SRS resources associated with another Tx TEG). When the LMF combines the Rx-Tx time difference measurements of both UE and TRP sides, due to mismatch of Tx TEGs, the LMF cannot determine which RxTx TEG ID can be used in subsequent ‘differential RTT’ calculations. To address this problem, for a Rx-Tx time difference measurement for a PRS resource, the UE may report one or more pairs of {RxTx TEG, Tx TEG}, which are used to represent the mapping relationship with all Tx TEGs of all SRS resources.For FL comment about “TxTEG-ID association” in the UE feature, whether we can add a condition, as follows, to address* *For mitigating UE Rx/Tx timing errors for DL+UL positioning, up to the UE capability, the following should be supported:*
	+ *The UE provides the association information of UE Tx TEG(s) with all UL Positioning SRS resources which can associate with a TxTEG-ID to LMF.*
	+ *For a Rx-Tx time difference measurement for a PRS resource, the UE may report one or more pairs of {RxTx TEG, Tx TEG}, which are used to represent the mapping relationship with all Tx TEGs of all SRS resources which can associate with a TxTEG-ID.*
		- *wherein, the maximum number of Tx TEGs here is N, N={1,2,3,4,6,8}, subjective to UE capability.*
 |
| OPPO | Yes for proposal 1 | No for proposal 4 | For Proposal 1: Another way to match the measurement results at UE and gNB is that gNB reports Rx-Tx timine difference measurement results based on different SRS resources. But we are open to discuss it in this meeting (Yes)For Proposal 4: The motivation to restricting TEG information reporting is not clear (NO) |
| ZTE |  |  | OK to clarify the proposed issue.To our understanding, this should be discussed in RAN2 on how to report the SRS association information. At least for us, we think UE should provide the association information for positioning SRS. There is no need for additional indication on which positioning SRS should be reported with association information. |
| MTK |  | No | Don't support. Similar view as Huawei |
| CMCC | Yes |  | We are open to disucss this issue, to help the LMF find the proper match of Rx-tx time difference measurements at UE and TRP sides.  |
| Ericsson | Yes |  | The mismatch problem highlighted by vivo is valid and the relevant proposal should be discussed in RAN1. Also, we share CATT’s understanding. So we support discussing these proposals. |
| Intel |  | No | Current agreements are sufficient |
| Nokia/NSB |  | No | Agree with Huawei that the UE by default will already report all the configured SRS resources when it reports the associations.  |

## Periodict Reporting of UE Tx TEG for Multi-RTT

Background

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| --- |
| **Agreement (RAN1#107e)*** For UL-TDOA, supporting the following for the serving gNB to request a UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning, subject to UE capability of supporting UE Tx TEG:
	+ Based on a configured periodicity, a UE may report the UE Tx TEG association for the SRS resources for positioning that have already been transmitted during the configured period
		- It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)
		- It is up to RAN4 to decide when the Tx TEG association is changed
	+ The values of the configurable periodicities are up to RAN2
	+ Note: Tx TEG association information reporting by single request/response mode is assumed already supported with the previous agreement.
* Send an LS to RAN2/RAN4 (cc: RAN3)
	+ to RAN2, including the following RAN1’s agreement related to the reporting of the UE Tx TEG, for RAN2 to work on the signaling
	+ to RAN4 for checking the agreement and work on how to decide when the Tx TEG association is changed
 |

|  |
| --- |
| RAN4 LS (R1-2200902)“The UE Tx TEG association between UE Tx TEG IDs and SRS resources for positioning is up to UE implementation, so it is not necessary nor practical to define the condition when the TEG association is changed.” |

Submitted Proposal

* ***(vivo, R1-2201093[2]) Proposal 2:******Support UE Tx TEG updating in Multi-RTT as the following:***
	+ For ~~UL-TDOA~~ Multi-RTT, supporting the following for the ~~serving gNB~~ LMF to request a UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning, subject to UE capability of supporting UE Tx TEG:
		- Based on a configured periodicity, a UE may report the UE Tx TEG association for the SRS resources for positioning that have already been transmitted during the configured period
			* It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)
			* ~~It is up to RAN4 to decide when the Tx TEG association is changed~~
		- The values of the configurable periodicities are up to RAN2
		- It is up to RAN2 to decide whether to include UE Tx TEG association information request/report in Rx-Tx measurement request/report or in a separate IE
		- Note: Tx TEG association information reporting by single request/response mode is assumed already supported with the previous agreement.
	+ Send an LS to RAN2~~/RAN4~~ (cc: RAN3)
	+ ~~to RAN2,~~ including the following RAN1’s agreement related to the reporting of the UE Tx TEG, for RAN2 to work on the signalling

FL: Further discussion in Proposal 3.4-1 for Multi-RTT.

* ***(Sony, R1-2201582[6])******Proposal 1:*** *Support UE to provide periodic reporting of TEG association*

FL: Periodic reporting of UE Tx TEG is supported for UL-TDOA. See Proposal 3.4-1 for Multi-RTT.

* ***(Sony, R1-2201582[6])******Proposal 2:*** *Periodic TEG association report and aperiodic TEG association report can be both supported. LMF can configure the UE on the selected reporting type.*

FL: Periodic and aperiodic reporting of UE Tx TEG is supported for UL-TDOA. See Proposal 3.4-1 for Multi-RTT.

FL comments

Periodic reporting of UE Tx TEG associationfor UL-TDOA was agreed in the previous meeting. However, Periodic reporting of UE Tx TEG associationfor Multi-RTT was not agreed. There were different views on whether there is a need to support, Periodic reporting of UE Tx TEG associationfor Multi-RTT with the consideration that the UE may report UE Tx TEG associationfor Multi-RTT together with the measurement reports of the UE Rx-Tx measurements.

### Proposal 2.4

* + *For Multi-RTT, supporting the following for the LMF to request a UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning, subject to UE capability of supporting UE Tx TEG:*
		- *Based on a configured periodicity, a UE may report the UE Tx TEG association for the SRS resources for positioning that have already been transmitted during the configured period*
			* *It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)*
		- *The values of the configurable periodicities are up to RAN2*
		- *It is up to RAN2 to decide whether to include UE Tx TEG association information request/report in Rx-Tx measurement request/report or in a separate IE*
		- *Note: Tx TEG association information reporting by single request/response mode is assumed already supported with the previous agreement.*
	+ *Send an LS to RAN2 to continue the signaling design*

Comments

*Companies are invited to provide their views on whether the above proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | RAN2 is already implementing the feature by including SRS TEG association in the Multi-RTT measurement report, and the periodicity for both report should be aligned. |
| CATT |  |  | We prefer this proposal to be low priority since UE may report UE Tx TEG association for Multi-RTT together with the measurement reports of the UE Rx-Tx measurements. |
| vivo | √ |  | In RAN1#107e, we reached the following mirror agreements of Tx TEG request/report for both UL-TDOA and Multi-RTT. However, for periodic Tx TEG report, we only reached agreement for UL-TDOA. Therefore, a mirror agreement for Multi-RTT needs to be reached. |
| OPPO |  | No | Share similar view as Huawei |
| ZTE | Yes |  | We don’t see the need to have a separate IE to report association information. LMF only cares about the association information when there is on-going measurement report. SO, we prefer to include UE Tx TEG association information in Rx-Tx measurement report. |
| MTK |  | No | Same view as Huawei/OPPO |
| Ericsson |  | No | For multi-RTT, UE Tx TEG association with SRS resources can be reported along with UE Rx-Tx measurement reports. Hence, there is no strong need to further introduce periodic UE Tx TEG association reporting for multi-RTT. |
| LGE |  |  | We are open to the proposal. But, in our understanding, reporting the UE Tx TEG association is required not only for UL-TDOA but also for multi-RTT. If there is no crucail reason to oppose the proposal, we are agree with the proposal. |
| vivo2 | Yes |  | we are OK with Tx TEG and SRS association in Rx-Tx measurement report, but we are not sure the current CR considers the issue of Tx TEG change. Without corresponding conclusions for Multi-RTT achieved, RAN2 may only consider Tx TEG change for UL-TDOA but not for Multi-RTT. For example, it may only include SRS-TEG association corresponding to one period, but we are not sure the period of SRS is the gNB measured, and then the misalignment will occur. So, we prefer the reporting can include the multiple periods' SRS-TEG association. |
| Intel |  | No | Share similar view with Huawei |
| Nokia/NSB |  | No | Same view as Huawei.  |

## Reception of the DL PRS with different UE/TRP Rx TEGs

Submitted proposals

* **(Huawei, R1-2200920[1]) Proposal 7:** *UE is not required to measure the same DL PRS resource with the exactly the same number of Rx TEGs as requested by LMF or indicated in the capability signaling*.

FL Comments

In FL’s understanding, similar to other positioning measurements, it is up to RAN4 to decide the conditions under which the UE is required (or not required) to *measure the same DL PRS resource* with the number of different Rx TEGS as requested by LMF or indicated in the capability signaling. There is no need for RAN1 to make an agreement on that.

### Question 2.5

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Huawei, R1-2200920[1]) Proposal 7*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | Let’s sayFor FG 27-1-4, UE reports 2 for a band. Then LMF requests UE to measure a PRS on a target band with 2 Rx TEGs. Should UE be mandated to report 2 TOA for the same PRS?For FG 27-1-4a, UE reports 2 for a band. Then LMF requests UE to measure a PRS on target band. Should UE be mandated to measure the target PRS simultaneously and report the TOA with 2 Rx TEGs with the same time stamps? |
| CATT |  |  | It seems that RAN4 can discuss this issue. |
| vivo |  | √ | But we share a similar view with Huawei proposal that UE is not required to measure the same DL PRS resource with exactly the same number of Rx TEGs as requested by LMF  |
| Fraunhofer |  | No | Our understanding is that RAN1 agreemenet is clear that the LMF **optionaly** requests a UE to measure DL PRS with different Rx TEGs |
| OPPO | Yes |  | We sare simiar view as Huawei, and think it is common understanding. We can make a conclusion to make it clear. |
| ZTE |  | NO | No need to discuss it in RAN1. |
| MTK | Yes |  | A conclusion seems okay (same view as OPPO and Huawei) |
| CMCC | Yes |  | We are OK to discuss this issue. In our understanding, the LMF can explicit request a UE to measure the same DL PRS resource with N different Rx TEGs based on the capability reporting, however, the LMF cannot ensure that the UE is always capable to do so.  |
| Ericsson |  |  | In our understanding, the UE is not required to measure the same PRS resource using the exact same number of Rx TEGs as requested by LMF. This is why we included ‘UE to optionally measure’ in the following agreement. The remaining issues can be discussed in RAN4.**Agreement*** Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple UE Rx-Tx time difference measurements.
	+ - N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability, and applies to all DL PRS positioning frequency layers
		- Note: If N is not explicitly included in the request, it is up to UE to determine the number of different UE Rx TEGs to measure the same DL PRS resource within its capability
	+ FFS: details of the signalling, procedures, and UE capability

The timestamps of the multiple UE Rx-Tx time difference measurements in the same measurement report can be the same or different. |
| LGE |  |  | We are generally understand the intention. But, we think RAN1 does not required to discuss the proposal. |
| Intel |  | No | Do not see the need in this proposal  |

##  UE TX/RX temporal timing error index

Submttted proposals

* ***(Ericsson , R1-2202389[16]) Proposal 11****: Support UE to maintain a UE RX temporal timing error index (TTEI). The state of the UE RX TTEI at the instance of DL PRS reception for an RSTD or UE Rx-Tx time difference measurement should be reported together with UE RX TEG association, timestamp and RSTD/UE Rx-Tx time difference measurement in the DL-TDOA/multi-RTT measurement report.*
* ***(Ericsson , R1-2202389[16]) Proposal 12:*** *Support UE to maintain a UE TX temporal timing error index (TTEI). The state of the UE TX TTEI at the instance of UL SRS transmission should be reported together with UE TX TEG association and timestamp.*

FL Comments

The timing errors of UE Rx/Tx/RxTx TEGs may changes over time for various reasons. In previous meetings, different options regarding the reporting/updating of Tx TEG association with positioning SRS/PRS resources were discussed, including the use of a temporal timing error index (TTEI) as proposed in [16]. For Tx TEG changes, RAN1 made an agreement in RAN1#107e that “It is up to RAN4 to decide when the Tx TEG association is changed” and “It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)”.

### Question 2.6

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + ***P1****: (Ericsson , R1-2202389[16]) Proposal 11*
	+ ***P2****: (Ericsson , R1-2202389[16]) Proposal 12*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | We think this is to discuss the link consistency between TEG ID and group delay, which is a useful clarification. |
| CATT | Yes |  | We can discuss the issue and TTEI in RAN1, or leave this issue to RAN2/RAN4 as our agreement in RAN1#107-e. |
| vivo |  | √ |  |
| Fraunhofer | Yes |  |  |
| OPPO |  | No | Leave it to RAN2/RAN4 sinc we have agreement |
| ZTE |  | No | It’s up RAN2/RAN4 to further discuss this issue. |
| MTK |  | NO | Up to RAN2 and RAN4 |
| InterDigital | Yes |  | We can discuss about TTEI and the information regarding TTEI to report to the network.  |
| Ericsson | Yes. |  | In the UE features agreed so far, the maximum number of TEGs is limited by UE capability:* In FG 27-1-1, the maximum number of UE Rx TEGs for DL TDOA and/or Multi-RTT is agreed to be one of {1, 2, 3, 4, 6, 8}.
* In FG 27-1-2, the maximum number of UE-TxTEG for SRS resource for positioning, which is supported and reported by UE for UL TDOA is agreed to be one of {1, 2, 3, 4, 6, 8}.
* In FG 27-1-2a, the maximum number of UE-TxTEG, which is supported and reported by UE for Multi-RTT is agreed to be one of {1, 2, 3, 4, 6, 8}.

 These maximum number of TEGs may not be enough to indicate time domain variation of group delays and the indication of consistency of TEGs over time. For instance, in FR2, a UE may be equipped with 4 UE antenna panels, and 8 TEGs may not be enough to indicate TEG consistency over time for all 4 UE antenna panels. Hence, we support to discuss temporal index in RAN1. |
| LGE |  | O | We are not sure whether the TEG changes extremely depends on temperature. Likewise, since there is not obvious reason like as simulation result, we cannot agree with the proposal. |
| Intel |  | No | Up to RAN2 |
| Nokia/NSB |  |  | We are not fully convinced of the need for the proposal but it seems worthwhile for RAN1 to discuss it and see if any further agreements or changes are needed.  |

##  UE Tx TEG sweeping

Submttted proposals

* ***(InterDigital, R1-2201824[9]) Proposal 4:*** *Support the LMF to request the TRP to fix TRP Rx TEG, configure the UE to use N different UE Tx TEGs and report respective RTOA, if the TRP and UE support more than one Rx TEGs and Tx TEGs, respectively.*

FL: The condition of more than one TRP Rx TEG may not be needed.

* ***(CMCC, R1-2201856[10]) Proposal 1****: Support UE Tx TEG sweeping as an optional UE capability:*
	+ *Introduce a new indication for UE sending N SRS pos resources by using N different UE Tx TEGs in turn*
* ***(Ericsson , R1-2202389[16]) Proposal 5****. Support UE TX TEG sweeping over SRS resources for positioning in a SRS resource set configuration.*
* ***(Ericsson , R1-2202389[16]) Proposal 6****. The UE shall report the number of UE TX TEGs as part of UE capabilities.*

FL: This seems already covered in UE feature session.

* ***(Ericsson , R1-2202389[16]) Proposal 7****. It shall be possible to configure a UE with an SRS resource with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS.*
* ***(Ericsson , R1-2202389[16]) Proposal 8****. The total number of UE beams needed to sweep all UE TX TEGs and all directions should be reported as part of UE capabilities.*

FL: It is unclear how to define the total number of UE beams for all directions.

FL Comments

The approach of configuring a UE to use different UE Tx TEGs for UL transmission of SRS positioning resources or UE TX TEG sweeping over SRS resources for positioning was proposed by multiple companies [9][10][16]. The simulation results in [16] also shows the significant performance improvement under certain conditions. Similar proposals were discussed in the previous meeting [17], but only few companies provided the comments, and some companies did not support UE TX TEG sweeping. One potential issue related to UE TX TEG sweepingmay be the overhead on the UL resource usage and also increase of the UL interferences. We would need more inputs from interested companies to above proposals to decide whether to support UE TX TEG sweeping in Rel-17, and if yes, which of the options to support.

### Proposal 2.7

* *Support UE Tx TEG sweeping, in which*
	+ *LMF configures the UE to use N different UE Tx TEGs for the transmission of the SRS resources for positioning,*
		- *FFS: N, which is subject to UE capability*
	+ *LMF requests the TRP to use the same Rx Tx TEGs to receive the SRS resources for positioning transmitted from different UE Tx TEGs*

Comments

*Companies are invited to provide their views on whether the UE TX TEG sweeping over SRS resources for positioning should be supported (or not supported) in Rel-17, and if yes, whether it is the high priority in this meeting and any additional comments on above proposal.*

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | We support the UE Tx TEG sweeping.However, we believe from UE perspective, the indication of Tx TEG sweeping should be from the gNB. |
| CATT | Yes |  | Support to discuss the UE Tx TEG sweeping. However, maybe a subset of UE Tx TEG should be sweeping for one TRP due to low SINR. |
| vivo |  | √ | It is too late to discuss it in the maintenance phase, we prefer to reuse Rel-16 SRS mechanism (e.g. beam sweeping or spatial relationship) for SRS transmitting1.Tx TEG sweeping will increase the number of Tx TEGs, resulting in unnecessary errors. 2.When the SRS is transmitted, the relationship between the SRS and the Tx TEG depends on the UE implementation, and we do not think that the LMF can control the use of the Tx TEG. |
| Fraunoher |  | No  | Share the views of vivo |
| OPPO |  | No | Simiar to Issue 2.5, it cannot force UE to use a configured number of Tx TEGs. Tx TEG is not only related to RF chains/antennas, but also related to other factors (e.g., TA). If the spatial relationship is configured, the Tx beam for SRS transmission is determined and UE cannot use a sweeping way of Tx TEGs. If no spatial relationship is not configured. If the spatial relationship is not configured, a sweeping way for SRS transmission may lead to mismatch between the UL Tx beam and PL RS.  |
| ZTE |  | No | We don’t seed the strong need. It’s up to UE to decide how to associate the TEG with SRS. In addition, we think the SRS spatial relation info has implicitly indicated the preferred panel to transmit SRS.  |
| CMCC | Yes |  | We are supportive of UE Tx TEG sweeping, as we have agreed that a UE can measure the same DL PRS resource with different Rx TEGs if the UE is with multiple Rx TEGs in order to mitigate the Rx timing error difference between different Rx TEGs, it is reasonable to support a symmetric design for UL.Regarding the proposal, we would like to further discuss whether it should be the LMF to request. UL SRS pos is by gNB to configure, why not let gNB to indicate the UE to perform the UL Tx TEG sweeping? |
| InterDigital | Yes |  | We support to discuss the feature and we support the proposal. |
| Ericsson | Yes |  | We have shown results that UE Tx TEG to SRS association reporting alone is not enough to fully mitigate timing errors. In the Figure below, the orange curve includes timing error mitigation using only UE Tx TEG to SRS association reporting. As seen in the figure, this only achives ~20cm positioning accuracy for around 80% of the time. Hence, UE Tx TEG to SRS association reporting alone is not enough to meet positioning accuracy requirements.With combination of UE Tx TEG to SRS association reporting with UE Tx TEG sweeping, the positioning requirements can be met as shown by the Red curve in the figure below.Note that UE Rx TEG sweeping in the following agreements was made to meet positioning accuracy requirements for similar reasons:**Agreement**Make the following modification on the previous agreement made in RAN#106bis-e:* Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple RSTD measurements.

What we are after is a reciprocical agreement like the following:* Subject to UE capability, support the serving gNB to request a UE to optionally transmit the SRS resource(s) of an SRS resource set for positioning with N different UE Tx TEGs, if the UE supports multiple UE Tx TEGs for UL TDOA.

**@Vivo: In Rel-16 SRS mechanism, which UE Tx TEG the SRS is transmitted from is up to UE implementation. Hence, the network has no control over if the UE transmits all SRS resources with a single UE Tx TEG or over multiple UE Tx TEGs.****@OPPO: Regarding your comment, we don’t agree that spatial relation being configured will prevent a UE from sweeping across Tx TEGs. Assume different Tx TEGs are associated wth different UE panels. Then, for a given spatial relation, the UE can determine Tx beams for each UE panel. Sweeping across Tx TEGs here essentially means each UE panel transmitting using the determined Tx beams for each of its panels.** **@CMCC: We agree with you that the serving gNB can indicate the UE to perform UL Tx sweeping.****@vivo, @Fraunhofer, @OPPO, @ZTE: Given our results above, we’d be interested if you have any different results that show that positioning accuracy requirements can be met even without UE Tx TEG sweeping proposed above for all scenarios considered in Rel-17. Otherwise, if you still have concerns on the proposal, will you be ok to conclude that rel-17 positioning accuracy requirements may not be met for UL-TDOA with only UE Tx TEG to SRS association reporting mechanism specified in Rel-17 for all scenarios consided in Rel-17?** |
| NTT DOCOMO | Yes |  | We are supportive to the UE Tx TEG sweeping. |
| LGE |  |  | We are completely agree with the intention. But, we think that the proposal would be related with PRS resource configuration and than the more time to discuss the issue is required. So, we prefer to discuss the issues in the Rel 18 than this meeting. |
| vivo2 |  | No | We do not think it is an essential issue or a symmetric design for UL. Let us further explain the difference between UL and DL. If LMF wants to know the UE Rx TEG error between different Rx TEG IDs, it only can be known by the UE measurement. But if LMF wants to know the Tx TEG error between different Tx TEG IDs, it can be known by multiple gNB(s) that is because the SRS from one UE can be measured by multiple gNB(s). That is, if a gNB can measure the LOS path(or same path) from different SRS resources with Tx TEG, the Tx TEG error between those Tx TEG IDs can be achieved. In addition, considering the different locations of gNBs, the Tx TEG error between all the Tx TEG IDs can be achieved by different gNBs |
| Intel | Yes |  | Open to discuss this proposal |
| Nokia/NSB | Yes |  | We are okay to discuss this proposal. It may have some dependency on RAN4 progress on TEG margins in our understanding.  |

## Options of multiple RSTD measurements of the same DL PRS resource

Submitted Proposals

* ***(ZTE, R1-2201193[3]) Proposal 1:*** *When multiple reference signals are used to determine the same Rx timing, support the followings,*
	+ *For DL RSTD measurement, if multiple DL PRS resources are used to determine a start of one subframe from a TP, the multiple DL PRS resources should be associated with a same UE Rx TEG ID.*
	+ *For UE Rx-Tx time difference measurement, if multiple DL PRS resources are used to determine a start of one subframe of the first arrival path of the TP, the multiple DL PRS resources should be associated with a same UE Rx TEG ID.*
	+ *For UL RTOA measurement, if multiple SRS resources are used to determine a beginning of one subframe containing SRS received at a RP, the multiple SRS resources for positioning should be associated with a same TRP Rx TEG ID.*
	+ *For gNB Rx-Tx time difference measurement, if multiple SRS resources for positioning are used to determine a start of one subframe containing SRS, the multiple SRS resources for positioning should be associated with a same TRP Rx TEG ID.*

FL: The similar proposal was discussed in the previous meeting without conclusion. Some companies supported, while some companies commented that the proposals were not needed. In FL’s view, if the Rx TEG ID is reported together with the measurement, it implies the measurement is associated with the Rx TEG ID.

* ***(Ericsson , R1-2202389[16]) Proposal 1:*** *Downselect which among the following options apply to UE feature row 27-1-4:*
	+ *UE performs multiple RSTD measurements towards the same TRP based on different repetitions of the same DL PRS resource,*
	+ *UE performs multiple RSTD measurements towards the same TRP based on different symbols of the same DL PRS resource,*
	+ *UE performs multiple RSTD measurements towards the same TRP based on different occasions of the same DL PRS resource.*

FL: These options presented above are related to UE measures the same DL PRS resources at different times. How to support the perform multiple RSTD measurements towards the same TRP may be up to UE. It seems there is no need to further define how the UE made the measurement. Further discussion is needed on whether to specify these options directions in UE feature row 27-1-4.

### Question 2.8-1

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *ZTE, R1-2201193[3]) Proposal 1*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | Agree with the FL comment. The Rx TEG is associated with the TOA measurement (RSTD/UE Rx – Tx time difference), and if the TOA is determined based on multiple PRS resources, then it implies that the same Rx TEG is associated with “the multiple PRS resources”.Likewise for gNB side. |
| CATT |  | No | This proposal seems to be not needed. |
| vivo |  | √ | Share a similar view with FL. |
| OPPO |  | No | Similar view as FL |
| ZTE | Yes |  | The current definitions in 38.215 support UE/gNB to derive the same timing by using multiple resources. Once multiple resources are used to determine the same timing, the same TEG association for the multiple resources should be satisfied. Otherwise, the timing may include not only the TOA but also the the timing error difference between TEG, where the later one is not desirable. |
| Ericsson | may be |  | It is a question of whether this should be capturted in the spec or not. Perhaps, we can have a conclusion on this. |
| LGE |  | O | We are on the same page with FL |
| Intel |  | No | Do not need to discuss |

### Question 2.8-2

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Ericsson , R1-2202389[16]) Proposal 1*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | This is totally up to UE implementation. If any of the enhancements needs to modify the RAN4 PRS measurement period requirement, the enhancement should be discussed by RAN4. |
| CATT |  | No | It seems to a UE implementation issue. |
| vivo |  | √ | Share a similar view with FL. |
| OPPO |  | No | Similar view as FL |
| ZTE |  | No | It’s up to UE to decide. No further enhancement is needed. |
| MTK |  | No | Up to UE |
| Ericsson | Yes |   | Prefer to discuss this at least as part of UE features. |
| LGE |  | O | We think this issue is up to UE. |
| Intel |  | No | Up to UE implementation |

## Timing error margins of TEGs

Submitted Proposals

* ***(Sony, R1-2201582[6]) Proposal 3:*** *Support to associate TEG ID with the timing error margin value (e.g., the smallest TEG ID represent the TEG with the smallest timing error margin.*
* ***(Sony, R1-2201582[6]) Proposal 4:*** *Define the certain margin of a TEG. This aspect can be investigated by RAN4.*
* ***(Fraunhofer, R1-2202366[14]) Proposal 1:*** *From RAN1 perspective, the timing error margin(s) will be defined by RAN4 and the definition takes the aspects Rx timing errors/Tx timing errors defined by RAN1 into account.*
	+ *Send an LS to RAN4*

FL comments

There were intensive discussion and multiple round of discussion of different proposals on how to define the *timing error margins* and *UE capability of timing error margins* w/o conclusion. Given that RAN4 is working on the issues related to *timing error margins,* the suggestion from FL is no further discussion unless RAN4 wants RAN1 to be involved in the discussion.

### Question 2.9

*Companies are invited to provide their views on whether there is a need for RAN1 to discuss (or not discuss) the timing error margins in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal) for the following proposals:*

* + *(Sony, R1-2201582[6]) Proposal 3*
	+ *(Sony, R1-2201582[6]) Proposal 4*
	+ *(Fraunhofer, R1-2202366[14]) Proposal*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | Agree with FL comments. |
| CATT |  | No | This issue should be discussed by RAN4. |
| vivo |  | √ | Up to RAN’4 discussion. |
| Fraunhofer | Yes |  | RAN1 Rx/Tx timing error definitions clarifies the UE or TRP assumptions taken to accommodate for possible implementations. RAN1 shall clarify if this will be captured in RAN4 specifications within the error margin or not.This also addresses the aspect in Q2.10 |
| OPPO |  | No | Agree with FL |
| ZTE |  |  | Wait for RAN4’s decision. |
| CMCC |  | No | Up to RAN4 to decide. |
| InterDigital |  | No | Agree with FL’s suggestion that we can wait for RAN4.  |
| Ericsson |  | No | Leave up to RAN4 |
| LGE |  | O | Agree with FL comments. |
| Intel |  | No | Up to RAN4 |
| Nokia/NSB |  | No | RAN4 is discussing.  |

## Reporting of self-calibration of a TEG

Submitted Proposals

* ***(Nokia, R1-2201634[7]) Proposal 4:*** *Allow UE to report an indicator to LMF to inform if a positioning measurement has been calibrated for a specific TEG.*

FL comments

In FL’s view, UE/TRP will have always to perform a certain levels of calibration of the Rx timing delays for the positioning measurements in order to support meeting the measurement performance defined by RAN4, and the UE will determine whether the measurements in the same Rx TEG based on the UE implementation. Thus, it seems not meaningful for UE to indicate if a positioning measurement has been calibrated for a specific TEG unless there is a specific margin or value is defined to the calibration.

### Question 2.10

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Nokia, R1-2201634[7]) Proposal 4*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | Unclear why this report from the UE is required. UE reporting TEG information would mean that the measurement satisfies the corresponding requirement. Whether calibration is done or not to meeting the requirement is transparent. |
| CATT |  | No | It seems that no need to report this indicator to LMF to inform if a positioning measurement has been calibrated for a specific TEG. |
| vivo |  | √ |  |
| OPPO |  | No | Agree with FL |
| ZTE |  |  | OK for further discussion. According to previous discussion, the margin is defined for the timing error difference between measurements. However, this proposal means UE has also to determine its absolute timing error. Does the “ calibration” means the timing error has been fully estimated and calibrated?  |
| CMCC |  | No |  |
| Ericsson |  | No | Proposed indicator seems not needed. |
| LGE |  | O | We are fully agree with FL’s view. |
| Intel |  | No | Not important issue |
| Nokia/NSB | Yes |  | What we are referring to in our proposal is calibration beyond the type of calibration done for the initial TEG definitions. For example, the UE may measure different TRP Tx TEGs and measure the difference between those measurements. Then it is possible to remove the errors between the different Tx TEGs. So the UE could indicate this level of “calibration” to the LMF.  |

## RSRP/RSRPP diversity

Submitted Proposals

* ***(Huawei, R1-2200920[1]) Proposal 8:*** *For PRS-RSRPP, the reported value for a target DL-PRS resource can be Rx branch specific.*

FL comments

In [1], there was an observation that if the reported PRS-RSRP (and potentially PRS-RSRPP) is not lower than the PRS-RSRP (and potentially PRS-RSRPP) of any individual Rx branches, some TOA measurement associated with a Rx TEG ID may not have PRS-RSRP (and potentially PRS-RSRPP) value. Thus, the proposal is to support *Rx branch specific PRS-RSRPP* in order to have TOA measurement and *PRS-RSRPP* from the same Rx branch.

### Question 2.11

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Huawei, R1-2200920[1]) Proposal 8*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | If we agreed that RSRPP reporting can be associated with TEG feature, then we should be clear that some Rx branches (associated measurement with a specific Rx TEG ID) may have lower RSRP/RSRPP measurement than other Rx branches, and will not have RSRP/RSRPP reported following the existing RSRP definition. |
| CATT | Yes |  | Support to discuss this issue. |
| vivo |  | √ | In general, we think it is a Rel-16 issue, we would like to ask the majority whether Rel-16 PRS-RSRP reporting that is associated with RSTD or Rx-Tx measurement s not lower than the PRS-RSRPof any individual branches? For us, we think yes, that is the reporting PRS-RSRP can satisfy the definition. In this case, if the Rel-17 RSRPP is the same as the RSRP branches based on the RAN4 agreement, there is no other agreement, and restriction is needed.***RAN4 Agreements:**** Same Rx branches as applied for PRS-RSRP measurement are used for path PRS-RSRP measurement
 |
| Intel |  | No | This proposal should be aligned with Rx diversity discussion in other AIs |
| Nokia/NSB |  | No | Agree with Intel |

## Performance requirements for RSTD measurements of the same DL PRS resource

Submitted Proposals

* ***(Ericsson , R1-2202389[16]) Proposal 2:*** *Inform RAN4 with an LS that RAN4 requirements should capture that, subject to UE capability, a UE configured to perform and report multiple RSTD measurements towards the same TRP, utilizing different UE RX TEGs, shall report one RSTD measurement for each UE RX TEG association for which the DL PRS is received with an appropriate configuration and with high enough SINR..*

FL comments

In FL’s view, RAN4 will work the performance requirements for all features introduced in Rel-17 ePOS. It seems no need to specifically send LS to RAN4, asking them to define the performance requirements for RSTD measurements of the same DL PRS resource.

### Question 2.12

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *• (Ericsson , R1-2202389[16]) Proposal 2*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | Open to discuss it. Is it the correct understanding for the intention of the proposal that if UE supports measuring the same TRP with multiple Rx TEGs, then if the side conditions is stasfied, UE shall report TOA measurement associated with the same number of the multiple Rx TEGs for a TRP.If we understand the proposal correctly, this proposal is to discuss the UE Rx TEG sweeping. However, we would like to note that this may have potential impact on PRS measurement period requirement. |
| CATT |  | No | This issue should be discussed by RAN4. |
| vivo |  | √ |  |
| OPPO |  |  | Agree with FL |
| ZTE |  | No | It’s in RAN4’s scope. |
| Ericsson | Yes |  | Prefer to discuss it.@Huawei: Your understanding is correct that the proposal discusses UE Rx TEG sweeping. |
| LGE |  |  | Agree with FL’s comments. |
| Intel |  | No | Up to RAN4 |

## Association of UE Tx TEGs with the MIMO SRS

Submitted Proposals

* ***(Ericsson , R1-2202389[16]) Proposal 3:*** *The UE can be configured by the gNB to send UE TX TEG association reports for all SRS types including SRS for MIMO.*

FL comments

In previous meetings, there were intensive discussions related to whether to support a UE to provide the association information of UL SRS resources for MIMO with Tx TEGs without conclusion. Given that the WI was closed from RAN1 pespective, FL would suggest “no further discussion on the association of UE Tx TEG with MIMO SRS in Rel-17”.

### Question 2.13

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *• (Ericsson , R1-2202389[16]) Proposal 3*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | This has been discussed for a couple of meetings, and we do not see possibility of progress on it. |
| CATT |  | No | From previous agreements, if SRS-MIMO is used for positioning purpose, it should be transparent to UE. |
| vivo |  | √ | Low priority for MIMO SRS. |
| OPPO |  | No | Share similar view as Huawei/CATT |
| ZTE |  | No | Low priority. It’s hard to converge in maintenance phase. |
| Ericsson |  |  | ok to conclude as proposed by FL. |
| LGE |  | O | Agree with Huawei’s view. |
| Intel |  | No | Agree with FL on “no further discussion on the association of UE Tx TEG with MIMO SRS in Rel-17” |

## Impact of TA on UE Rx-Tx time difference

Submitted Proposals

* ***(Ericsson , R1-2202389[16]) Proposal 9:*** *To mitigate transmission timing changes for multi-RTT measurements:*
	+ *Support the LMF to configure a UE (with required capabilities) with a list of SRS resource sets and SRS resources for each TRP for reporting of transmission timing compensation.*
		- *In case, an SRS resource set is listed, then that should be interpreted as including all SRS resources in the SRS resource set.*
	+ *Given a UE Rx-Tx time difference measurement reported in a multi RTT report, the UE should also report a transmission timing compensation for each SRS resource indicated for transmission timing compensation.*
		- *The transmission timing compensation is signaled together with two timestamps:*
			* *A first timestamp for the UL subframe #j closest in time to the DL subframe #i in which the DL PRS used for the UE Rx-Tx time difference measurement is received*
			* *A second timestamp for the subframe #k where the TX instance of the SRS resource occurs which is closest in time to the reception time of the DL PRS used for the UE Rx-Tx time difference measurement.*
		- *Transmission timing compensation is defined as the difference in transmission timing between the subframe #k and subframe #j.*
		- *Transmission timing is defined as the time between the transmission of UL subframe #i and the first detected path (in time) of the corresponding downlink subframe #i from the reference cell.*
		- *A transmission timing compensation in a multi-RTT report is only coupled to the two timestamps and is thus in the report not tied to a specific SRS resource or UE Rx-Tx time difference measurement.*
* ***(Ericsson , R1-2202389[16]) Proposal 10:*** *The transmission timing compensation should be reported by the UE to the LMF together with a quality estimate, giving a measure of the deviation of the transmission timing compensation from the true difference in transmission timing between UL subframe #k of UL SRS transmission and UL subframe #j closest in time to DL PRS reception.*

FL comments

Significant efforts have been spent on the impact of TA on multi-RTT in the previous meetings on the issue [17]. Based on various considerations and the resolutions of the impact of the timing adjustment on the UE Rx-Tx time difference measurement is not explicitly included in the WI objectives, the FL had suggested no further discussion of this topic in Rel-17, which was supported by majority companies. Given that the WI was closed from RAN1’s perspective, and only one company proposes to revisit the issue, and there are many other more issues need to be resolved in this meeting, the FL would suggest no further discussion on the issue in this meeting.

### Question 2.14

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(Ericsson , R1-2202389[16]) Proposal 9*
	+ *(Ericsson , R1-2202389[16]) Proposal 10*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | This has been discussed for a couple of meetings, and we do not see possibility of progress on it. |
| CATT |  | No | It seems that no need to re-open the discussion. |
| vivo |  | √ | Low priority. |
| OPPO |  | No | Agree with FL |
| ZTE |  | No | Low priority. It’s hard to converge in maintenance phase. |
| CMCC |  | No | Agree with the FL, no need to further discuss this issue. |
| Ericsson |  |  | Ok with FL’s suggestion |
| LGE |  | O | Agree with Huwei’s view. |
| Intel |  | No | Agree with FL no discussion needed |

## Multiple reference timings

Submitted Proposals

* ***(LGE, R1-2202291[13]) Proposal 2:*** *RAN1 should consider/adopt configuring multiple reference timing to UE.*

FL comments

In FL’s understanding, LMF does not know UE channel condition and does not need to use the channel condition to configure the timing referencetoUE. The main purpose of configured *reference timing* with the uncertainty range is for the UE to search the DL PRS signals. In UE side, it is up to UE implementation on whether to use the LMF configured timing reference or define another DL PRS as the timing reference when reporting the RSTD measurements. Thus, it seems no need to consider the configuration of multiple reference timings. A similar proposal was presented in previous meetings w/o a conclusion since only few companies provided the comments.

### Question 2.15

*Companies are invited to provide their views on whether the following proposal should be discussed (or not discussed) in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

* + *(LGE, R1-2202291[13]) Proposal 2*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | Although we think that multiple reference timing is helpful for PRS measurement from multiple positioning frequency layers, given the TDM nature of positioning frequency layer processing and the potential time drift at UE, we consider it being too late to introduce this feature in RAN1. |
| CATT |  | No | It seems no need to consider the configuration of multiple reference timings, it should be a UE implementation issue. |
| vivo |  | √ |  |
| OPPO |  | No | Agree with FL |
| ZTE |  | No | According to Rel-16, the reference timing is only for UE to decide the uncertainty window. While for reporting, UE can either choose the reference timing configure by LMF or select another reference timing. |
| Ericsson |  | No |  |
| LGE | O |  | For current specificiation, it only assumes one Rx TEG at UE. We partially agree with FL’s comment that is up to UE implementation on whether to use the LMF configured timing reference. But, LMF configure single reference timing even thouh there is no restriction for UE to follow it. We think it indicate how to LMF provides its preference that is based on the priori estimate of the target device location. In addition, since RAN1 considers/adopts introducing multiple TEGs at both UE and gNB, there is no reason to support/configure multiple referece timing. For concerns about lack of time, we don't think it's a problem at all since only extending the current design of configuration of reference timing to multiple is required. So, we prefer to RAN1 discuss the proposal in this meeting. |
| Intel |  | No | No discussion needed |

# Measurement enhancements for mitigating UE/gNB Tx/Rx timing errors

Background

|  |
| --- |
| Agreement (RAN1#104e)Support enabling* A UE to report one or more measurement instances (of RSTD, DL RSRP, and/or UE Rx-Tx time difference measurements) in a single measurement report to LMF for UE-assisted positioning, and
* A TRP to report one or more measurement instances (of RTOA, UL RSRP, and/or gNB Rx-Tx time difference measurements) in a single measurement report to LMF, and
* Each measurement instance is reported with its own timestamp
	+ FFS: The measurement instances are within a [configured] measurement time window
* FFS: Each UE measurement instance can be configured with N instances of the DL-PRS Resource Set
	+ FFS: N (including N=1)
* FFS: Each TRP measurement instance can be configured with M SRS measurement time occasions
	+ FFS: M (including M=1)
* FFS: details of behavior, procedures, and UE capability if any
* FFS: whether and how to consider the additional enhancement related to measurement reporting of multi-paths and quality metric
* Note 1: A measurement instance refers to one or more measurements, which can either be the same or different types, which are obtained from the same DL PRS resource(s), or the same UL SRS resource(s).
* Note 2: This enhancement has no intention to change the mapping of measurement types to Rel-16 positioning techniques and no intention to introduce new positioning techniques either.

Agreement (RAN1#106e)Consider the following options (both could be selected) until RAN1#106b-e* Option 1: Support LMF to optionally indicate the measurement time window (MTW) for a UE for the measurement instances included in a measurement report.
* Option 2: Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a measurement report.
* FFS: the details of the MTW configuration.

Any requirements can be discussed by RAN4 after decision on the options is made. |

## Measurement time window

Background

|  |
| --- |
| Agreement (RAN1#106e)Consider the following options (both could be selected) until RAN1#106b-e* Option 1: Support LMF to optionally indicate the measurement time window (MTW) for a UE for the measurement instances included in a measurement report.
* Option 2: Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a measurement report.
* FFS: the details of the MTW configuration.
* Any requirements can be discussed by RAN4 after decision on the options is made.
 |

Submitted Proposals

* ***(Huawei, R1-2200920[1]) Proposal 2:*** *The following procedures for the MTW indication from LMF is supported:*
	+ *LMF to optionally recommend the measurement time window (MTW) for a UE for the measurement instances included in a measurement report.*
		- *A new UE capability to receive the indication of MTW is defined*
	+ *LMF to optionally recommend the measurement time window for a gNB for the measurement instances included in a measurement report.*
	+ *For both cases, UE and gNB are not required to follow the recommendation.*
	+ *Send an LS to RAN2 and RAN3.*
* ***(Huawei, R1-2200920[1]) Proposal 3:*** *MTW configuration to UE/gNB should include*
	+ *MTW starting/offset SFN*
	+ *MTW length in the unit of 10msec*
	+ *MTW periodicity for the cases of periodic reporting in the unit of 10msec*
	+ *The UE/gNB expects MTW periodicity to be configured to a number close to the periodic reporting interval, which is a multiple of PRS/SRS periodicity and can divide or can be divided by 10.24s SFN period.*
	+ *Include the parameters in the higher layer parameter spread sheet.*
* *(ZTE, R1-2201193[3])* ***Proposal 2:*** *There is no need to introduce measurement time window in Rel-17 NR positioning*
* *(CATT, R1-2201361[5])* ***Proposal 1:*** *The configurable measurement time windows should be supported, in which the UE or TRP measurement instances are obtained.*
* *(CATT, R1-2201361[5])* ***Proposal 2****: Support LMF to indicate a preferred measurement starting time to the UE/TRP for the measurement instances included in a single measurement report.*
* ***(CATT, R1-2201361[5]) Proposal 3****: UE/TRP measurement time window can be configured with the following parameters by LMF:*
	+ *For UE measurement time window (via LPP signalling):*
	+ *P1: The periodicity of UE measurement time window (for periodic UE MTW).*
	+ *T1: The start time of UE measurement time window.*
	+ *L1: The length of UE measurement time window.*
	+ *For TRP measurement time window (via NRPPa signalling):*
	+ *P2: The periodicity of TRP measurement time window (for periodic TRP MTW).*
	+ *T2: The start time of TRP measurement time window.*
	+ *L2: The length of TRP measurement time window.*
* ***(InterDigital, R1-2201824[9]) Proposal 5****: Support Option 1 (“Support LMF to optionally indicate the measurement time window for a UE”) and Option 2 (“Support LMF to optionally indicate the measurement time window for a gNB”) of the measurement time window.*
* ***(CMCC, R1-2201856[10])*** *Proposal 2: Support both of the following options:*
	+ *Option 1: Support LMF to optionally indicate the measurement time window (MTW) for a UE for the measurement instances included in a measurement report.*
	+ *Option 2: Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a measurement report.*

FL Comments

Whether to introduce the measurement time windows (MTW) for UE and gNB have been discussed very intensively in the previous meetings (e.g., [17]). While majority companies were supportive, some companies did not think it is necessary to do so. For this meeting, multiple companies (e.g., [1][5][9][10]) propose again to introduce the MTW, while one company considers it is not needed to introduce MTW. Given than the WI was closed from RAN1’s perspective, FL would like first check companies’ views on the priority of the issue, and the views on the latest proposal discussion discussed in the previous meeting, and then to decide whether we should have a further discussion on this issue in this meeting.

### Proposal 3.1

* *The measurement time window (MTW) configuration for a UE/gNB should include*
	+ *MTW starting time (e.g., the offset of SFN)*
	+ *MTW length, which may be configured with one of the following options*
		- * + *Option 1: (explicitly) configured in the unit of 10msec;*
				+ *Option 2: (implicitly) decided based on the configuration of UE/gNB measurement instances for the MTW, and the number of consecutive samples (PRS/SRS instances) for each UE/gNB measurement instance*

Comments

*Companies are invited to provide their views on whether the issue covered by the above proposal should be discussed in this meeting, and if yes, please provide the additional comments (e.g., the priority, whether you support the proposal).*

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | Yes | We think MTW is helpful to align the measurement instances between UE and gNB and between gNB. |
| CATT | Yes | Support the proposal. The configurable measurement time windows should be supported to help LMF to eliminate the influence of timing errors of TRPs and UE. |
| vivo | No | 1. From the perspective of Rx/Tx error mitigating, we believe that the role of this window can be replaced by LMF implementation by configuring the position of measurement report and batch report. 2. In addition, scheduled location information is supported by other groups, which indicates that the UE is requested to obtain location measurements or location estimates valid at the scheduledLocationTime T. It can also play the role of MTW. |
| Fraunhofer | Yes | Support the proposal |
| OPPO | NO | It has been discussed several meetings and no progress was made. The same purpose can be achieved by NW implemenation |
| ZTE | No | As we have discussed in previous meetings, it can be an implementation issue. |
| MTK | No | Don't support. And no need to bring this topic again |
| CMCC | Yes | Support to configure the MTW for both UE and TRP. |
| InterDigital | Yes | We support the proposal. |
| Ericsson |  | Open to discuss and conclude this issue. |
| LGE | Yes | We are supportive of both the proposal and option #1. |
| Lenovo, Motorola Mobility | Yes | Support the need for an MTW for timing error mititgation. |
| Intel | No | Do not support the proposal  |
| Nokia/NSB | No | This is not an essential correction in our view and we don’t support it.  |

## Timestamp of measurement instance

Submitted proposals

* ***(vivo, R1-2201093[2]) Proposal 3:*** *Support to enable the UE to report PRS measurements derived from the most recent measurement instances before the measurement report.*
* ***(vivo, R1-2201093[2]) Proposal 4:*** *The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource (or the last SRS resource for the positioning purpose) that are used to determine the measurement instance.*
* **(ZTE, R1-2201193[3])** ***Proposal 3*:** *Support of a UE to report multiple measurement instances in a measurement report,*
	+ *For PRS processing sample number=1, each measurement instance should be based on a single time instance of corresponding DL PRS resource. UE can report multiple measurement instances based on different time instances of the same DL PRS resource, where different time instances of the same DL PRS resource should be associated with the same UE Rx TEG.*
	+ *For PRS processing sample number=4, each measurement value in a measurement instance can be based on a filtered/averaged results from at least four time instances of the corresponding DL PRS resource. UE should report a time stamp to indicate the time duration over which the filtering or average is performed, where the time stamp includes,*
	+ *A starting time instance corresponds to the reception time of the first instance of the DL PRS resources to obtain the reported measurement instance, and*
	+ *An ending time instance corresponds to a reception time of the last instance of the DL PRS resources to obtain the reported measurement instance.*
	+ *Note: For both PRS processing sample number=1 and PRS processing sample number=4, UE should always follow the measurement period defined in Rel-16.*

FL Comments

Whether and how to define to the timestamp of measurement instances have been discussed very intensively in the previous meetings (e.g., [17]). Various options were discussed, while majority companies were supportive for RAN1 to provide the clear definition of the timestamp of measurement, some companies did not think it is necessary to do so. For this meeting, two companies (e.g., [2][3]) propose again the definition of the timestamp of measurement instances. Given than the WI was closed from RAN1’s perspective, FL would like first check companies’ views on the priority of the issue, and the views on the latest proposal discussion discussed in the previous meeting, and then to decide whether we should have a further discussion on this issue in this meeting.

### Proposal 3.2

*The timestamp for a measurement instance in a measurement report is defined by one of the following options:*

* *Option 1: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource (or the last SRS resource for the positioning purpose) that are used to determining the measurement instance.*
	+ *FFS: Whether to report an additional timestamp corresponding to the reception time of the first instance of the DL PRS (or UL SRS) resources, if multiple instances of the DL PRS (or UL SRS) resources are used to obtain the measurement instance.*
* *Option 2: Up to UE implementation.*
* *Option 3: Up to UE implementation but within the reception time of the first and last DL-PRS resource (or the first and last SRS resource for the positioning purpose) that are used to determining the measurement instance.*

Comments

*Companies are invited to provide their views on whether the issue covered by the above proposal should be discussed in this meeting, and if yes, please provide the additional comments (e.g., the priority, which options you want to support, etc.).*

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | No | Already discussed, and it is best to up to UE implementation. |
| CATT |  | We prefer this issue to be low priority. |
| vivo | Yes | A clear definition of timestamp is especially important for measurement instance with N/M>1 PRS instances or SRS occasions. For example, the clear definition of timestamp makes the UE measurement results and the TRP measurement results with relatively uniform time domain distribution, which allows the LMF to better match the measurements from UE and TRP into calculation. |
| OPPO | Yes | A clear definition of timestamp is beneficial. |
| ZTE | Yes |  |
| CMCC | Yes |  |
| LGE |  | we are supportive the option #2. |
| Intel | Yes |  |
| Nokia/NSB | No | This is not an essential correction in our view and we don’t support it.  |

## Timestamp of measurement instance

Submitted proposals

* **(ZTE, R1-2201193[3])** ***Proposal 4*:** *Further discuss the association between measurement instances and UE measurement report, at least consider one of the following alternatives,*
	+ *Alt.1: For each indicated DL PRS resource in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource.*
	+ *Alt.2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.*
	+ *Alt.3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.*
	+ *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
	+ *Alt.5: Multiple measurement instances are directly associated with a measurement report.*
* ***(Qualcomm, R1-2202140[12])Proposal 4:*** *With regards to the association between measurement instances and UE measurement report, at least support the following option:*
	+ *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
		- *That is, a UE should be able to report, in a single NR-XXX-ProvideLocationInformation, multiple NR-XXX-SignalMeasurementInformation elements for UE assisted positioning, and NR-XXX-LocationInformation for UE-based positioning.*

FL Comments

The proposal of the association between measurement instances and UE measurement report was discussed in the previous meeting w/o conclusion. Some companies considered that the issue should be discussed and decided in RAN1, but some other companies commented the issue should be discussed RAN2. Given than the WI was closed from RAN1’s perspective, FL would like first check companies’ views on the priority of the issue, and the views on the latest proposal discussion discussed in the previous meeting, and then to decide whether we should have a further discussion on this issue in this meeting.

### Proposal 3.3

* *The association between measurement instances and UE measurements should be defined with at least one of the following alternatives,*
	+ *Alt.1: For each indicated DL PRS resource in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource.*
	+ *Alt.2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.*
	+ *Alt.3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.*
	+ *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
	+ *Alt.5: Multiple measurement instances are directly associated with a measurement report.*

Comments

*Companies are invited to provide their views on whether the issue covered by the above proposal should be discussed in this meeting, and if yes, please provide the additional comments (e.g., the priority, which alternative you want to support, etc.).*

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | Yes | The alternatives are too vague.From our side, to support this functionality, we think the explanation used by Qualcomm should be considered.* + *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
		- *That is, a UE should be able to report, in a single NR-XXX-ProvideLocationInformation, multiple NR-XXX-SignalMeasurementInformation elements for UE assisted positioning, and NR-XXX-LocationInformation for UE-based positioning.*
 |
| CATT | Yes | We are OK to discuss this issue, and we prefer Alt.4, or we are also fine to leave this issue to RAN2. |
| vivo |  | We would like to confirm with the majority whether the measured TRPs in different measurement instances are different? In our view, the assistance date is the same for a measurement report, so the TRP priority is the same in the different measurement instances within a measurement report. Therefore, we would like to know whether the measured TRPs are the same in multiple instances if Alt.4 is supported.  |
| Fraunhofer |  | We think this issue is better addressed in RAN2  |
| OPPO | Yes | Support to discuss this issue |
| ZTE | Yes | We should further down-select one of the alternatives. |
| Nokia/NSB |  | Okay for RAN2 to handle it.  |

# RAN2/SA2 Reply LSs on Positioning Reference Unit (PRUs)

Background

|  |
| --- |
| Agreement: (RAN1#105e)Send an LS to RAN2/RAN3 (cc SA2), including the following content:* RAN1 has evaluated the use of positioning reference units (PRUs) with known locations for positioning and observes improvements in using PRUs for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly requests RAN2/RAN3 (cc SA2) to determine if and what specification enhancements are adopted for PRUs for positioning.
* Notes:
	+ The term “positioning reference unit (PRU)” is only used as a terminology in this discussion. PRU does not necessarily mean an introduction of a new network node.
	+ 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
	+ PRU may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the PRU is known, the information may also be requested by the LMF.

[R1-2106265](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2106265.doc) [DRAFT] LS on Positioning Reference Units (PRUs) for enhancing positioning performance Final LS endorsed in [R1-2106326](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2106326.doc) (Email endorsement) |

SA2’s response to RAN1 LS [R1-2200862]

|  |
| --- |
| SA2 discussed the PRU and agreed to include the objective of how to support the ***PRU in Rel-18*** eLCS\_Ph3 Study Item, considering SA2 Rel-17 is already frozen and more time is needed to study how to support the PRU in SA2.SA2 also noticed that RAN2 is under discussion of how *to support PRUs in Rel-17* and is considering solutions which may or may not have impacts to SA2. SA2 does not have enough time in Rel-17 to comment on such solutions at the present time but expects that a solution or solutions preferable to SA2 should be possible in Release 18. |

RAN2’s response to RAN1 LS [R1-2200857]

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| --- |
| RAN2 discussed support of PRUs as described in the RAN1 LS R2-2106920 (R1-2106326, S2-2105263). Based on the information provided by RAN1, RAN2's current understanding is that a PRU is a device with a priori known location (to some degree of accuracy at least) and which performs location measurements at this known location. In addition, the PRU can transmit SRS to enable TRPs to measure and report UL positioning measurements from PRUs at known location. The PRU or TRP measurements can then be compared by a location server with the measurements expected to determine "correction information" for other nearby target devices. The location measurements for other target devices may then be corrected based on the previously determined "correction information". Further, RAN2 discussed the modelling of PRUs and agreed that the PRU can be considered (at least) as a UE (from LMF perspective). However, since the PRU location measurements are needed by an LMF itself different views exist in RAN2 on how this can be enabled in the current LCS architecture.Some companies in RAN2 believe that PRU support has no impact on SA2 and CT specifications and think that the MT-LR procedures as currently specified in TS 23.273 can also be instigated by an LMF (e.g., an LMF may initiate a location request to a GMLC) or existing MO LR procedures as specified in TS 23.273 can be instigated by a PRU for enabling an LMF to obtain PRU location measurements or transmit UL-SRS.Other companies in RAN2 believe that an LMF needs to be enabled to instigate location procedures for a PRU (e.g., LPP, NRPPa procedures) without receiving a location request for the PRU from an AMF (i.e., in the absence of an MT-LR or MO-LR for the PRU). These companies also believe that this effectively means that the LMF should act as an "LCS Client" for PRUs. However, since the LCS procedures and overall architecture are in the realm of SA2, RAN2 would like to confirm with SA2 whether PRU support as described by RAN1 can be provided with the current LCS framework as specified by SA2 (e.g., TS 23.273) or whether any changes would be required.In addition, RAN2 discussed whether the LMF determined "correction information" obtained from PRU measurements needs to be provided to target UEs for UE-based mode of operation. As mentioned by RAN1 in the LS, a PRU may provide "antenna orientation information" to an LMF and RAN2 would like to ask RAN1 to provide further details of the "PRU antenna orientation information".2. Actions:To RAN1 group.ACTION: RAN2 kindly asks RAN1 whether the LMF determined "correction information" obtained from PRU measurements need to be ***provided to target UEs for UE-based mode of operation***, and if so, kindly asks RAN1 to ***provide further details on the specific "correction information"*** which need to be provided to target UEs.RAN2 also kindly asks RAN1 to provide further details on the "***PRU antenna orientation information***" which should be provided to an LMF. |

*Submitted Proposals*

* ***(Sony, R1-2201582[6]) Proposal 5:*** *Support to provide UE capability information to LMF, which can assist LMF to select the capable UE to become PRU.*
* ***(Sony, R1-2201582[6]) Proposal 6:*** *PRU with known location support the following reporting: Location uncertainty information, stationary status, positioning measurement and/or estimated Tx/Rx Timing error report.*
* ***(Nokia, R1-2201634[7]) Proposal 1:*** *Prioritize UE-assisted PRU in Rel-17 and send an LS to RAN2 informing them of this decision.*
* ***(Nokia, R1-2201634[7]) Proposal 2****: Include in the reply LS to RAN2 that the PRU antenna orientation is the 3D angle in the global coordinate system at which the PRU antenna is location*
* ***(Intel, R1-2201697[8])******Proposal 1:*** *For UE-based DL-TDOA positioning, support one of the following options for assistance information reporting from the LMF to the target UE to facilitate TRP TX timing errors mitigation:*
	+ *Option 1:*
		- *Support the LMF providing the DL RSTD measurement and the associated TX TEGs obtained with the Positioning Reference Unit (PRU) to the target UE*
		- *Support the LMF providing the PRU coordinates to the target UE*
	+ *Option 2:*
		- *Support the LMF providing the TRP TX timing errors difference (between the target and reference TRP) and the associated TX TEGs to the target UE*
* ***(Intel, R1-2201697[8])******Proposal 2:*** *Support PRU antenna orientation information reporting in GCS from PRU to the LMF reusing the LCS-GCS-Translation-Parameter-r16 defined in Rel.16*
	+ *where the PRU antenna array boresight direction in LCS is aligned with the x axis, and*
	+ *y and z axes in LCS are aligned with the row and column dimensions of the antenna array, respectively*
* ***(Intel, R1-2201697[8])******Proposal 3:*** *Introduce the following UE capability/feature groups for PRU support:*
	+ *FG x1: Support of the PRU functionality*
		- *UE may be requested by the LMF to provide its own known location coordinate information to the LMF to facilitate mitigation of UE/gNB TX/RX timing delay mitigation*
	+ *FG x2: Support of the PRU with antenna orientation information reporting*
		- *UE may be requested by the LMF to provide antenna orientation information*
	+ *FG x1 is a pre-requisite of the FG x2*
* ***(InterDigital, R1-2201824[9]) Proposal 5****: Support Option 1 (“Support LMF to optionally indicate the measurement time window for a UE”) and Option 2 (“Support LMF to optionally indicate the measurement time window for a gNB”) of the measurement time window.*
* ***(InterDigital, R1-2201824[9]) Proposal 6****: Integrity metrics associated with location information of the PRU is used to verify “known location” of the UE.*
* ***(InterDigital, R1-2201824[9]) Proposal 7****: Time validity conditions for PRU should be specified.*
* ***(Samsung, R1-2202014[11]) Proposal 1****: The "correction information" could at least include the time difference and the angle difference for PRU or between PRU and target UE, and each of them should be associated with two or more cell ID or reference signal ID for location measurement.*
* ***(Samsung, R1-2202014[11]) Proposal 2****: Correction state indicator should be configured to trigger the target UEs to receive "correction information".*
* ***(Samsung, R1-2202014[11]) Proposal 3****: The "correction information" can be requested by target UEs or provided by LMF directly according to the correction state indicator.*
* ***(Lenovo, R1-2202370[15])Proposal 1:*** *LMF may use current capability signalling procedures to differentiate and identify PRU and normal UEs.*
* ***(Lenovo, R1-2202370[15])Proposal 2:*** *LMF can manage and process PRU reference measurements in a similar manner to normal UE measurements.*
* ***(Lenovo, R1-2202370[15])Proposal 3****: RAN1 to confirm that PRU UE basic operations may be supported in Rel-17 with existing LPP procedures based on RAN2 and SA2 input.*
* ***(Lenovo, R1-2202370[15])Proposal 4:*** *RAN1 to confirm that the PRU UE can report its known available location information to the LMF via:*
	+ *LPP signalling;*
	+ *RRC signalling (e.g. using CommonLocationInfo message) via gNB.*
	+ *Offline/pre-configured location calibration*
	+ *Note: It is up to RAN2 decide, which messages may be used to transfer the known location information.*
* ***(Lenovo, R1-2202370[15])Proposal 5:*** *RAN1 to support provision of double differential correction information for UEs performing UE-based positioning.*
* ***(Lenovo, R1-2202370[15])Proposal 6:*** *RAN1 to at least support the following differential correction information provided to the UE:*
	+ *Pseudorange error corrections of associated TRPs including DL-PRS resource information of the measured TRPs;*
	+ *Pseudorange error correction validity time;*
	+ *Source type of the double differential correction information (e.g., PRU UE).*
* *(vivo, R1-2201046) And at least RSTD correction information should be included for UE-based DL TDOA.*
* *(ZTE, R1-2201205) RAN1 thinks LMF can obtain time/synchronization difference between a TEG i of a first TRP and TEG j of a second TRP based on the PRU/TRP measurements and the PRU location. Hence, the correct information refers to the time/synchronization difference between a TEG i of a first TRP and TEG j of a second TRP where a first TRP can be the same as the second TRP. It is like to extend NR-RTD-Info-r16 from TRP basis to TEG basis.*
* *(OPPO, R1-2201246) correction information” can be Tx timing error for PRS resource(s) / PRS resource set(s) to facilitate UE to compensate the timing-based measurement result.*
* *(CATT) Proposal 1: The support of providing "correction information" obtained from PRU measurements from LMF to target UEs for UE-based mode of operation will be considered in a future release, but not in Rel-17.*
* *(***InterDigital***, R1-2201822) Proposal 1: Correction information can be provided by the LMF to the target UE for UE-based positioning*
* *(***InterDigital***, R1-2201822) Proposal 2: As correction information, estimated timing offset associated with TRP Tx TEG is provided by the LMF to the target UE for UE-based positioning*
* *(CMCC, R1-2201838) Proposal 1: Support LMF to provide correction information of timing errors to a target UE using UE-based positioning.*
* *(CMCC, R1-2201838) Proposal 2: The correction information should include the positioning method or positioning measurement used at the LMF to obtain the timing errors, and the specific timing error values*
* *(Qualcomm, R1-2202108) no new assistance data, or correction information has been identified in this release beyond the assistance data enhancements that has already been agreed.*
* *(LGE, R1-2202296) it would be a details about the value of estimated Tx/Rx/TxRx TEGs at gNB obtained by PRU measurements.*
* *(Ericsson, R1-2202323)* *During Rel-17 enhanced positioning normative phase, RAN1 agreed that there is no RAN1 specification impact with respect to PRUs. As such, details of “correction information” were not discussed nor agreed during Rel-17 enhanced positioning normative phase. From RAN1 perspective, such detailed discussion needs to be deferred to a future release.*
* *(Huawei, R1-2202454)* *Proposal 1: RAN1 confirm that PRU functionality as a UE can be specified in RAN in Rel-17 time frame.*
* *(Huawei, R1-2202454) Proposal 2: RAN1 to reply to RAN2 with the question of correction information for UE-based mode:*
	+ *It is RAN1 understanding that the correction information for UE-based DL-TDOA can be provided via NR-RTD-Info in Rel-16 without change of specification, and that the correction information for UE-based DL-AoD can be provided via the Rel-17 TRP beam/antenna information already agreed.*
* ***(vivo, R1-2201046)*** ***the boresight direction information of PRU, and the contents are similar to (the boresight direction of a beam in AoD positioning(ie. DL-PRS-BeamInfoElement-r16))***
* *(ZTE, R1-2201205) a boresight direction where a PRU is used for receiving/transmitting reference signals, which can be expressed by azimuth angle information and/or elevation angle information.*
* *(OPPO, R1-2201246) For the type of PRU regarded as UE, the PRU antenna orientation information cannot be obtained.*
* *(CATT, R1-2201315)* *Proposal 2: If a PRU is a TRP, the TRP may provide its antenna orientation information, i.e., LCS to GCS Translation information, for the transmission of SRS resources for positioning to the LMF, which is similar to the case when TRP provides the antenna orientation information for the transmission of PRS resources to the LMF as supported in Rel-16. If a PRU is a UE, there is no need to support the UE to provide its antenna orientation information to the LMF in Rel-17.*
* *(***InterDigital***, R1-2201822)* Proposal 3: If requested by the network, the PRU can provide antenna orientation information where the antenna orientation information can include boresight angles of Tx and/or Rx panels
* *(Qualcomm, R1-2202108) RAN1 has not identified in this release, any further details on the "PRU antenna orientation information" which should be provided to an LMF*
* *(LGE, R1-2202296) Tx/Rx/TxRx TEGs (e.g. association information) and it may also include the coordination of antenna when the antennas are distributed.*
* *(Ericsson, R1-2202323)* PRU can be considered as a UE (from LMF perspective). As the UE’s orientation is likely to change, it doesn’t seem beneficial for a PRU UE to report “PRU antenna orientation information” to the LMF. Furthermore, details of “PRU antenna orientation information” were not discussed nor agreed during Rel-17 enhanced positioning normative phase.
* (Huawei, R1-2202454) Proposal 3: RAN1 to reply to RAN2 with the question of antenna orientation information:
	+ It is RAN1 understanding that a single LCS-GCS translation per UE is sufficient to convey the antenna orientation of a PRU.

FL comments

SA2 Reply LS has made clear that from SA2 Rel-17 is already frozen, and thus any PRU features that has impact on SA2 will be considered in Rel-18, but not in Rel-17. Thus, for Rel-17, RAN may only consider the support of the PRU features that do not have the impact on SA2, e.g., MO-LR.

In RAN2 replay LS asks RAN1 to provide the response on the following question,

* Q1: whether the LMF determined "correction information" obtained from PRU measurements need to be provided to target UEs for UE-based mode of operation, and if so, kindly asks RAN1 to provide further details on the specific "correction information" which need to be provided to target UEs.
* Q2: RAN2 also kindly asks RAN1 to provide further details on the "PRU antenna orientation information" which should be provided to an LMF.

For the 1st question of providing "correction information" obtained from PRU measurements from LMF to target UEs for UE-based mode of operation, many companies propose providing the timing related correction information, e.g., estimated TRP TX timing errors difference (Intel, Samsung, OPPO, InterDigital, CMCC, LGE, Huawei), differential correction (Lenovo), RSTD correction (vivo), TRP time/synchronization difference (ZTE). Some companies also propose providing the angle related correction information (Samsung, Huawei).

However, there are also multiple companies propose either prioritize UE-assisted PRU in Rel-17 (Nokia), or consider the support of providing "correction information" obtained from PRU measurements from LMF to target UEs for UE-based mode of operation in a future release, but not in Rel-17 (CATT, Qualcomm, Ericsson), mainly because RAN1 has so far not made the agreement on the correction information for UE-based positioning, and the WI was closed from RAN1’s perspective. In addition, Rel-16 already supports LMF to provide the RTD (real time difference) to UE. Thus, when LMF estimates the time synchronization errors between a reference TRP and a list of neighbour TRPs based on the information from PRU, the LMF can sent the *NR-RTD-Info* to UE to provide time synchronization information between a reference TRP and a list of neighbour TRPs.

For the 2nd question of “PRU antenna orientation information", most of companies consider the PRU antenna orientation information is the LCS-GCS transformation information of the PRU antenna (Nokia, Intel, CATT, InterDigital, LGE, Huawei) or the boresight direction of the signals (vivo, ZTE). However, some companies have pointed out that when a PRU is a UE, PRU antenna orientation information may not be available (OPPO, CATT, Ericsson). One company (Qualcomm) also proposes no further details on the "PRU antenna orientation information" should be provided to an LMF in Rel-17.

Based on the proposals from the companies, RAN1 will need to first discuss *whether the LMF determined new "correction information" obtained from PRU measurements need to be provided to target UEs for UE-based mode of operation* and whether and which "PRU antenna orientation information" can be provided to an LMF.

### Question 4-1

*Companies are invited to provide their views on whether RAN1 needs to define new "correction information" to be determined by the LMF from PRU measurements and provide the "correction information" for UE-based positioning in Rel-17.*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | This can be done by the existing RTD info. |
| CATT |  | No | Given that the ePos WI was closed from RAN1’s perspective, the support of providing "correction information" obtained from PRU measurements from LMF to target UEs for UE-based mode of operation will be considered in a future release, but not in Rel-17. |
| vivo | √ |  | We think the enhancement should be applicable for both UE-based and UE-assist modes, not just one of them |
| OPPO | Yes |  | It would be helfull for UE-based positioning. This is not to introduce a new feature, but just to finish the details for the supported feature (PRU), which can be done in the maintanence stage.  |
| ZTE |  | No | The NR-RTD-Info can already include the synchronization information between TRPs, which can serve as the “ correction information”. |
| CMCC | Yes |  | This feature should be applicable for both UE-assisted and UE-based positioning. |
| InterDigital | Yes |  | We support to discuss the details. Measurements returned by the PRU can be used by the LMF to derive correction information. We believe the correction information is associated with TEG such that the UE can use the provided corection information for enhancing accuracy during UE-based positioning. |
| Ericsson |  | No | It should be noted that RAN1 so far has not discussed nor agreed any details related to “correction in formation” in Rel-17. Since ePos rel-17 WI is closed and we are in maintenance phase, we should not discuss enhancements for “correction information” now in maintenance phase. So, we suggest that any enhancements related to “correction information” is not supported in Rel-17. |
| LGE | O |  | We think providng “correction information” is the motivation of introducing the PRU. So, it should be considered and it also needs to be provided for UE-assisted too.We are also supportive of PRU. But, we think that the dicssuion on PRU totally needs to be postponed in accordance with the absence of SA2 (based on LS (S2-2109104, from SA2 to RAN2). Consdidering that SA2 has finished R-17 and this issue cannot be dealt in SA2, it seems appropriate reply LS for RAN2 about our consideration and RAN1 needs to discuss the issue in further release than Rel-17. |
| Lenovo, Motorola Mobility | Yes |  | We prefer to consider PRU functionality to benefit both UE-assisted and UE-based positioning methods. Provision of correction information was sent by RAN2 at the latter stages of the WI and still remains an open issue. Since RAN1 triggered the issue of PRU with other WGs, it is up to RAN1 to close this isse by providing the requested information. |
| Intel | Yes |  | The “correction information” should be supported for UE-based positioning |
| Nokia/NSB |  | No | While we agree that correction information can be helpful for UE-based positioning we are okay to prioritize UE-assited for Rel-17.  |

### Question 4-2

*If you consider RAN1 needs to define new "correction information" to be determined by the LMF from PRU measurements for UE-based positioning, please indicates which of the following can be the "correction information":*

* *TRP Tx timing error*
* *TRP Tx timing error difference between reference TRP and neighboring TRPs*
* *Correction of TOA measurement*
* *Correction of RSTD measurement between reference TRP and neighboring TRPs*
* *TRP synchronization information (in addition to the existing NR-RTD-Info)*
* *Differenial correction information*
* *…*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  | No | Resource specific RTD was discussed, but not agreed. |
| CATT |  | No | Given that the ePos WI was closed from RAN1’s perspective, the support of providing "correction information" obtained from PRU measurements from LMF to target UEs for UE-based mode of operation will be considered in a future release, but not in Rel-17. |
| vivo | √ |  | Bullet 4 is preferred. Based on TS37.355, the RTK correct information has been supported and includes the *CarrierPhaseCorrectionDifference*. With the introduction of PRU, which not only corrects for synchronization, TEG errors but also RSTD measurement errors. |
| OPPO | Yes |  | Bullet 2 and 4 can be considered |
| ZTe |  | No | The NR-RTD-Info can already include the synchronization information between TRPs, which can serve as the “ correction information”. |
| CMCC | Yes |  | 2nd or 4th bullets should be supported. |
| InterDigital | Yes |  | Bullet #1-#4 can be discussed. |
| Ericsson |  | No | It should be noted that RAN1 so far has not discussed nor agreed any details related to “correction in formation” in Rel-17. Since ePos rel-17 WI is closed and we are in maintenance phase, we should not discuss enhancements for “correction information” now in maintenance phase. So, we suggest that any enhancements related to “correction information” is not supported in Rel-17. |
| LGE |  |  | We are also supportive of PRU. But, we think that the dicssuion on PRU totally needs to be postponed in accordance with the absence of SA2 (based on LS (S2-2109104, from SA2 to RAN2). Consdidering that SA2 has finished R-17 and this issue cannot be dealt in SA2, it seems appropriate reply LS for RAN2 about our consideration and RAN1 needs to discuss the issue in further release than Rel-17. |
| Lenovo, Motorola Mobility | Yes |  | We also consider the RSTD measurements to be part of the differential correction information. The pseudo-reange errors computed by the LMF need to also be accounted for by the UE. |
| Intel | Yes |  | Bullet #2 and bullet #4 For bullet #4 PRU coordinate needs to be reported to UE |
| Nokia/NSB |  | No | While we agree that correction information can be helpful for UE-based positioning we are okay to prioritize UE-assited for Rel-17.  |

### Question 4-3

*Companies are invited to provide their views on following on whether PRU needs to provide “PRU antenna orientation information” to LMF when the PRU is a TRP, and if yes, provide your views on which of following defines the “PRU antenna orientation information”:*

* *Option 1: The translation information of a Local Coordinate System (LCS) of the PRU antenna to a Global Coordinate System (GCS) as defined in TR 38.901, including the angles α (bearing angle), β (downtilt angle) and γ (slant angle) (see e.g.,* LCS-GCS-TranslationParameter-r16 in 38.355)
* *Option 2: The boresight of direction information of the transmitted/received signals, including the azimuth and elevation angles in LCS or in GCS (see e.g., DL-PRS-BeamInfoElement in TS 37.355)*
* *Option 1 and Option 2 (LCS)*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  |  | We are fine not to support antenna orientation information, and we do not support PRU being a TRP. |
| CATT | Yes |  | We support Option1. |
| vivo |  |  | Based on the RAN2 agreement, PRU as UE is supported, we would like to confirm whether PRU as TRP has been supported? If it is not, we prefer not to support PRU being a TRP in Rel-17.Agreements:Proposal 1 (modified): For purposes of RAN2 discussion, the PRU functionality as described in the RAN1 LS can be considered as UE with known location (to some degree of accuracy) at least (16/17).PRU modelled as a gNB can be discussed in RAN3 (no RAN2 action). |
| OPPO |  |  | If PRU is a TRP, it would be ok. However, RAN2 has agreed that PRU is regarded as UE.  |
| ZTE |  |  | Prefer to treat PRU as a UE agreed by RAN2. |
| InterDigital |  |  | Our understanding is that PRU is a UE, as agreed in RAN2#115e. We should not spend time to disucss this proposal. |
| Ericsson |  | No | @vivo/ZTE: In our understanding, PRU as UE is not supported in RAN2 either. The above agreement you quote only says consider for discussion purposes, and does not say it is supported. The latest agreement from RAN2 is as follows:Agreement:RAN2 will not discuss PRUs further without further guidance from RAN1 (LS or feature list).Given RAN1 has not discussed details of above “PRU antenna orientation information” in Rel-17. Since ePos rel-17 WI is closed and we are in maintenance phase, we should not discuss enhancements for “antenna orientation information” now in maintenance phase. So, we suggest that any enhancements related to “antenna orientation information” is not supported in Rel-17. |
| LGE |  |  | We prefer to that RAN1 firstly needs to discuss the PRU as UE not a TRP.We are also supportive of PRU. But, we think that the dicssuion on PRU totally needs to be postponed in accordance with the absence of SA2 (based on LS (S2-2109104, from SA2 to RAN2). Consdidering that SA2 has finished R-17 and this issue cannot be dealt in SA2, it seems appropriate reply LS for RAN2 about our consideration and RAN1 needs to discuss the issue in further release than Rel-17. |
| Lenovo, Motorola Mobility |  |  | No strong view, but in line with the other companies, the PRU as a UE should be first priority.@Ericsson, RAN2 had already supported PRU as a UE via the following agreements:Agreements:Proposal 1 (modified): For purposes of RAN2 discussion, the PRU functionality as described in the RAN1 LS can be considered as UE with known location (to some degree of accuracy) at least (16/17).PRU modelled as a gNB can be discussed in RAN3 (no RAN2 action).Agreement:RAN2 confirm that the PRU considered as a UE supports the normal LPP procedures for assistance data transfer and location information transferThe latest agreements by RAN2 are a trigger to RAN1 to provide feedback. |
| Intel | Yes |  | In general we are supporting of Option 1, but we think that TRP as PRU is not decided by SA/RAN3 |
| Nokia/NSB | Yes |  | We agree with Intel. For UE as PRU it should be option 1. RAN1 should prioritize sending an LS back to RAN2 which clarifies this point and that PRU (at least UE type) is beneficial and feasible.  |

### Question 4-4

*Companies are invited to provide their views on following on whether PRU needs to provide “PRU antenna orientation information” to LMF when the PRU is a UE, and if yes, provide your views on which of following defines the “PRU antenna orientation information”:*

* *Option 1: The translation information of a Local Coordinate System (LCS) of the PRU antenna to a Global Coordinate System (GCS) as defined in TR 38.901, including the angles α (bearing angle), β (downtilt angle) and γ (slant angle) (see e.g.,* LCS-GCS-TranslationParameter-r16 in 38.355)
* *Option 2: The boresight of direction information of the transmitted/received signals, including the azimuth and elevation angles in LCS or in GCS (see e.g., DL-PRS-BeamInfoElement in TS 37.355)*
* *Option 1 and Option 2 (LCS)*

Comments

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon |  |  | We are fine not to support antenna orientation information. |
| CATT |  |  | When the PRU is a UE, we prefer not to support the “PRU antenna orientation information”. |
| vivo |  |  | If a PRU is a UE, it may be difficult to obtain the antenna orientation information as the UE moves or flips. But if antenna orientation information can be reported by some UEs (e.g. fixed UEs), so, only the boresight information of PRU in GCS is supported, otherwise, not supported. |
| OPPO |  |  | RAN2 has agreed that PRU is regarded as UE. We cannot get such kind information for a UE |
| ZTE |  |  | OK for further discuss the use cases for this. |
| InterDigital | Yes |  | We don’t understand the usecases where a PRU which serves as a reference point moves or rotates unpredictably. Our understanding is that these PRUs are nearly static such that the network can use them for calibration purpose. PRU can be a refernece point set up by a surveyor. It is possible to obtain antenna orientation information for a such usecase. We are ok with the options mentioned by the FL as the starting point.  |
| Ericsson |  | No | If PRU is considered a UE, the UE orientation will change time to time. Hence, it is hard to obtain orientation information. We do not support ‘PRU antenna orientation information’. |
| LGE |  |  | We are also supportive of PRU. But, we think that the dicssuion on PRU totally needs to be postponed in accordance with the absence of SA2 (based on LS (S2-2109104, from SA2 to RAN2). Consdidering that SA2 has finished R-17 and this issue cannot be dealt in SA2, it seems appropriate reply LS for RAN2 about our consideration and RAN1 needs to discuss the issue in further release than Rel-17. |
| Lenovo, Motorola Mobility |  |  | No strong view, but also ok to further discuss the feasibility and need for providing antenna orientation information. |
| Intel | Yes |  | Option 1, known antenna orientation of static PRU can be used for calibration |
| Nokia/NSB | Yes |  | We agree with Intel. For UE as PRU it should be option 1. RAN1 should prioritize sending an LS back to RAN2 which clarifies this point and that PRU (at least UE type) is beneficial and feasible.  |

FL Comments

From the feebbacks of Question 4-1, 7 companies (*vivo, OPPO, CMCC, IDC, LGE, Lenovo, Intel*) support defining new "correction information", while 4 companies (*Huawei, CATT, ZTE, Ericsson, Nokia*) does not support it. One company (LGE) considers the PRU discussion needs to be postponed according the SA2 LS.

From the feebbacks of Question 4-2, among the companies that support the new “correction information”, most of them (*vivo, OPPO, CMCC, IDC, LGE, Lenovo, Intel*) support “correction of RSTD measurement between reference TRP and neighboring TRPs”, some of them (*OPPO, CMCC, IDC)* support “TRP Tx timing error difference between reference TRP and neighboring TRPs”.

In FL’s view, there is a need to have a discussion on the common understanding of the *NR-RTD-Info,* which is already supported in Rel-16 before we further discuss whether to support new “correction information”. In FL’s understanding, the *NR-RTD-Info* to provide time synchronization information between a reference TRP and a list of neighbour TRPs, which should be interprested as the “TRP Tx timing difference between reference TRP and neighboring TRPs” at the transmitting antenna, but not the timing difference between the internal clocks of the reference TRP and neighboring TRPs.

For the reporting of the *PRU antenna orientation information,* it seems most companies do not support providing the information, given that TRP as PRU is not suppprted.

### Proposal 4-1

Provide the following responses to RAN2’s LS on PRU:

*About “whether the LMF determined ‘correction information’ obtained from PRU measurements needs to be provided to target UEs for UE-based mode of operation”, provide one of the following options as the response:*

* *Option 1: In Rel-17, there is no need to support the LMF to provide new "correction information" obtained from PRU measurements to target UEs for UE-based mode of operation*
* *Option 2: In Rel-17, support the LMF to provide the following new "correction information" obtained from PRU measurements to target UEs for UE-based mode of operation:*
	+ *Correction of RSTD measurement between reference TRP and neighboring TRPs*
	+ *TRP Tx timing error difference between reference TRP and neighboring TRPs*

*About “the details of the "PRU antenna orientation information", provide one of the following options as the response:*

* *Option 1: When a PRU is a UE, there is no need to support PRU to provide the antenna orientation information to LMF in Rel-17.*
* *Option 2: The PRU antenna orientation information is defined as follows:*
	+ *The translation information of a Local Coordinate System (LCS) of the PRU antenna to a Global Coordinate System (GCS) as defined in TR 38.901, including the angles α (bearing angle), β (downtilt angle) and γ (slant angle) (see e.g., LCS-GCS-TranslationParameter-r16 in 38.355)*

# RAN4 LS on SRS for multi-RTT positioning

Background

|  |
| --- |
| RAN4 LS (R1-2200900):*RAN4 discussed whether Rel-15 SRS is applicable for multi-RTT positioning, i.e. whether it can be used in UE Rx-Tx time difference and gNB Rx-Tx time difference measurements.* *The UE Rx-Tx time difference measurement requirements in clause 9.9.4, TS 38.133 and gNB Rx-Tx time difference accuracy requirements in clause 10.1.25, TS 38.133 are applicable provided that the UE is configured with SRS.* *RAN4 has observed that some legacy gNB may not support Rel-16 positioning SRS. Furthermore, same gNB may be configured to perform gNB Rx-Tx time difference measurement and UL RTOA for the same UE.* *RAN4 kindly requests RAN1 to confirm whether Rel-15 SRS is applicable for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement, and if so, from which release.*  |

|  |
| --- |
| Agreement(RAN1#99):Support reuse of Rel-15 SRS resource set for NR UL RTOA, AoA and gNB RSRP measurements for positioning in NR.* Note: There is no impact to specifications managed by RAN1
* Note: There is no impact to specifications managed by RAN4 for UE requirements
* Note: No new UE behaviour is expected

Agreement (RAN1#98):* gNB Rx-Tx time difference is defined with respect to the subframe timing associated with the UE
* Multiple SRS resources for positioning purposes can be used to determine the received UL subframe timing of the first arrival path of the UE.
* FFS: The resource ID(s) or resource set ID(s) used for determining the timing of the UE and possibly the Rx beam used at the gNB in the gNB Rx-Tx time difference measurements can be requested for reporting in the measurement report.
 |

|  |
| --- |
| TS 38.214 Section 5.1.6.2The UE may be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference measurements corresponding to a single configured SRS resource or resource set for positioning. Each measurement corresponds to a single received DL PRS resource or resource set which can be in different positioning frequency layers. |

|  |
| --- |
| Agreement (RAN1 #106-e):Reporting of one gNB Rx-Tx time difference and multiple UL-AOAs measurements for the first arrival path per SRS resource for positioning in a single gNB report to LMF is supported * The above measurements are associated with SRS resource ID which is also reported to LMF
* FFS: Reporting of RSRP for the first arrival path

Agreement:NR supports gNB reporting of the first arrival path UL-AOA/ZOA measurement per SRS for positioning resource and SRS for MIMO resourceNote: The use of SRS for MIMO resource is transparent to the UEAgreement:* For the first arrival path measurements ~~on SRS for positioning resource,~~
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one-gNB Rx-Tx time difference}
	+ FFS additional option: gNB can report to LMF the following set of measurements {multiple SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA, one-gNB Rx-Tx time difference}
	+ All gNB measurements above are associated with SRS resource ID and timestamp, which are also reported to LMF
* For the first arrival path measurements on SRS for MIMO resource,
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ FFS: gNB can report to LMF the following set of measurements {multiple SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ All gNB measurements above are associated with SRS resource ID and timestamp, which are also reported to LMF
	+ Note: The operation of SRS for MIMO is transparent to the UE
 |

**PDC agreements for URLLC:**

|  |
| --- |
| AgreementFor RTT-based PDC, existing definitions of UE Rx – Tx time difference (i.e. section 5.1.30 in TS 38.215) and gNB Rx – Tx time difference (i.e. section 5.2.3 in TS 38.215) are reused, with updates at least to reflect the single pair of TRS/PRS and SRS configured for RTT-based PDC. AgreementFor RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signalling. |

TS 38.215 V17.0.0 [6]

|  |  |
| --- | --- |
| **Definition** | The gNB Rx – Tx time difference is defined as TgNB-RX –TgNB-TXWhere:TgNB-RX is the Transmission and Reception Point (TRP) [18] received timing of uplink subframe #*i* containing SRS associated with UE, defined by the first detected path in time.TgNB-TX is the TRP transmit timing of downlink subframe #*j* that is closest in time to the subframe #*i* received from the UE.Multiple SRS resources can be used to determine the start of one subframe containing SRS.The reference point for TgNB-RX shall be:- for type 1-C base station TS 38.104 [9]: the Rx antenna connector,- for type 1-O or 2-O base station TS 38.104 [9]: the Rx antenna (i.e. the centre location of the radiating region of the Rx antenna),- for type 1-H base station TS 38.104 [9]: the Rx Transceiver Array Boundary connector.The reference point for TgNB-TX shall be:- for type 1-C base station TS 38.104 [9]: the Tx antenna connector,- for type 1-O or 2-O base station TS 38.104 [9]: the Tx antenna (i.e. the centre location of the radiating region of the Tx antenna),- for type 1-H base station TS 38.104 [9]: the Tx Transceiver Array Boundary connector. |

*Submitted Proposals*

* ***(Huawei, R1-2201010, R1-2202457):***
	+ *The use of MIMO SRS by the UE for UE Rx - Tx time difference measurement is not specified in Rel-16.*
	+ *The use of MIMO SRS by the UE for UE Rx - Tx time difference measurement is already supported in Rel-17.*
	+ *The use of MIMO SRS by the gNB for gNB Rx - Tx time difference measurement is up to gNB implementation.*
* ***(vivo, R1-2201053):***
	+ *RAN1 would like to confirm, in release 17 and previous releases, RAN1 has not supported the use of Rel-15 SRS for UE Rx-Tx time difference measurement.*
	+ *The use of SRS for MIMO resource is transparent to the UE*
	+ *RAN1 also concluded that Tx TEG enhancement is only for Rel-16 SRS and not applicable for Rel-16 SRS for UL TDOA positioning and Multi-RTT Positioning.*
	+ *RAN1 has finished Rel-17 work on NR\_pos\_enh, therefore, it may not be possible to study this topic, at leat in this release.*
* ***(ZTE, R1-2201210)***
	+ *From RAN1 perspective, only SRS configured for positioning (introduced from Rel-16) is applicable for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement. Hence, Rel-15 SRS is not applicable for multi-RTT positioning.*
* ***(OPPO, R1-2201248)***
	+ *According to RAN1 agreement made in RAN1#99, Rel-15 SRS is NOT applicable for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement.*
* ***(CATT, R1-2201309, R1-2201310)***
	+ *Rel-15 SRS is not applicable for both UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement.*
* ***(Qualcomm, R1-2202104)***
	+ *Rel-15 SRS is not applicable for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement in neither NR Rel-16 release, nor NR Rel-17 release.*
* ***(Ericsson, R1-2202400)***
	+ *Support reuse of Rel-15 SRS resource set for gNB Rx-Tx and UE Rx-Tx measurements for rel16 NR positioning.*

*FL Comments*

Based on the contributions from the companies (Huawei, vivo, ZTE, OPPO, CATT, Qualcomm), it seems we have the following common understanding:

* *The use of MIMO SRS for UE/gNB Rx - Tx time difference measurements is not specified in Rel-16.*
* *The use of MIMO SRS for UE/gNB Rx - Tx time difference measurement for the purpose of positioning is not specified in Rel-17.*
* *MIMO SRS can be used for gNB Rx - Tx time difference measurement for RTT-based PDC in Rel-17.*

Then, it seems what we need is to discuss whether MIMO SRS can be used for both UE and gNB Rx-Tx time difference measurements for the purpose of positioning in Rel-17.

Another issue we may want to consider is that for *RTT-based PDC* the SRS is used to obtain the gNB Rx-Tx time difference from the serving cell only. For multi-RTT positioning, there is a need for the nighboring cells to measure the UE SRS in order to obtain the gNB Rx-Tx time differences from multiple TRPs.

By the way, it is unclear to me why RAN4 LS ask RAN1 to conform whether Rel-15 SRS is applicable for UE Rx-Tx time difference. In my understanding, UE Rx-Tx time difference is obtained by measuring the DL signals (e.g., PRS), but not the UL SRS signals.

### Question 5-1

*Companies are invited to provide their views on the following questions:*

*Q1: Do you agree that the use of Rel-15 SRS for Multi-RTT is not specified in Rel-16?*

*Q2: Do you agree that the use of Rel-15 SRS for Multi-RTT is not specified in Rel-17 for the purpose of positioning?*

*Q3: Do you agree that the use of Rel-15 SRS for Multi-RTT is already specified in Rel-17 for the purposes other than positioning?*

*Q4: Do you support the reuse of Rel-15 SRS for Multi-RTT for the purpose of positioning in Rel-17?*

Comments

|  |  |
| --- | --- |
| **Company** | **comments** |
| Huawei, HiSilicon | Q1: Multi-RTT should be changed to UE Rx – Tx time difference measurement, and Yes.Q2: Multi-RTT should be changed to UE Rx – Tx time difference measurement, and Yes.Q3: Multi-RTT should be changed to UE Rx – Tx time difference measurement, and Yes.Q4: Multi-RTT should be changed to UE Rx – Tx time difference measurement, and Yes. For UE already supporting RTT-based PDC, phy performs action based on indication from higher layers, regardless of whether the indication comes from RRC or NAS/LPP, and we can hardly find justification that UE already supporting RTT based PDC, cannot support use of MIMO SRS for UE Rx – Tx time difference measurement reported in NAS/LPP.With regards to the use of MIMO SRS for gNB Rx – Tx time difference measurement, we believe it is up to gNB implementation, regardless of whether UE supports it. |
| CATT | Q1: Yes.Q2: Yes.Q3: Yes.Q4: No. |
| vivo | Q1: Yes.Q2: Yes. Q3: No. The use of Rel-15 SRS was agreed in gNB Rx-Tx measurements for RTT-based PDC, which is applicable for single-RTT not multi-RTT. It cannot be inferred from RTT-based PDC agreement that R15 SRS is applicable for Multi-RTT positioning.Q4: No. From the perspective of positioning, all relevant conclusions of R16/17 show that the use of R15 is transparent to the UE. Considering that RAN1 has finished Rel-17 work on NR\_pos\_enh, therefore, the same principle should be maintained at least in this release. |
| OPPO | Q1: YesQ2: YesQ3: NoQ4: No |
| ZTE | Q1: YesQ2: YesQ3: As mention by some companies, Rel-15 SRS can be used to determine gNB Rx-Tx time difference for serving gNB in URLLC agenda. The intention is not for positioning purpose. So the gNB Rx-Tx time difference cannot be provided to LMF via NRPPa.Q4: We prefer not to introduce this new feature at maintenance phase.  |
| CMCC | Q1: Yes;Q2: Yes;Q3: No;Q4: No |
| Ericsson | Q1: YesQ2: YesQ3: YesQ4: Yes |
| Intel | Q1: YesQ2: Yes;Q3: No;Q4: No; |
| Nokia/NSB | Q1: YesQ2: YesQ3: Maybe, other WIs may use it. Q4: No, too late in the release for this type of agreement.  |

FL Comments

Based on the feedbacks, it is clear that we have the consensus the use of Rel-15 SRS for UE/gNB Rx-Tx time difference measurements are not supported for the purpose of the positioning in the specs. The use of Rel-15 SRS for gNB Rx-Tx time difference measurements is defined for determining the gNB Rx-Tx time difference for serving gNB for URLLC, but it is not for positioning purpose. The issue is whether we want to support the use of Rel-15 SRS for UE/gNB Rx-Tx time difference measurements for positioning purpose in Rel-17. Based on the response from the companies, 2 companies support the reuse of Rel-15 SRS for UE/gNB Rx-Tx time difference measurements for positioning purpose in Rel-17 assuming for the serving cell only, while 5 companies do not support it.

### Proposal 5-1

Provide the following responses to RAN4’s LS on Rel-15 SR for UE/gNB Rx-Tx time difference measurement:

* *The use of Rel-15 SRS for UE Rx-Tx time difference measurement and/or gNB Rx-Tx time difference measurement for the purpose of positioning is currently not supported.*
* *RAN1 has discussed the use of Rel-15 SRS for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement for the purpose of positioning in Rel-17, but has not made the decision to support it.*

# TPs

##  Multiple measurement instances

Background

|  |
| --- |
| Agreement (RAN1#104e)Support enabling* A UE to report one or more measurement instances (of RSTD, DL RSRP, and/or UE Rx-Tx time difference measurements) in a single measurement report to LMF for UE-assisted positioning, and
* A TRP to report one or more measurement instances (of RTOA, UL RSRP, and/or gNB Rx-Tx time difference measurements) in a single measurement report to LMF measurements) in a single measurement report to LMF, and
* Each measurement instance is reported with its own timestamp
 |

Submitted Proposals

* ***(OPPO, R1-2201239[4]) Proposal 1:*** *Adopt the following TP (TP1) to avoid the potential ambiguity on whether a report can contain different types of measurement results. (The modifications are highlighted by YELLOW).*

|  |
| --- |
| TP1 (based on Draft CR R1-2112953)The UE may be configured to report one or more measurement instances, each with its own timestamp, on DL RSTD~~,~~ and optionally DL PRS-RSRP~~, and/or UE Rx-Tx time difference~~ measurements, in a single measurement report. The UE may be configured to report one or more measurement instances, each with its own timestamp, on UE Rx-Tx time difference measurements, in a single measurement report. |

* ***(OPPO, R1-2201239[4]) Proposal 2:*** *In order to avoid additional definition of the association information and align RAN1 and RAN2 spec, adopt the following the change for draft CR.*
	+ *the association information of DL RSTD measurement(s) with UE Rx TEG(s) via higher layer parameter [ueRxTEG-ID] when the UE reports the DL RSTD measurement(s). -> the ~~association information of~~ DL RSTD measurement(s) with associated UE Rx TEG(s) via higher layer parameter [ueRxTEG-ID] ~~when the UE reports the DL RSTD measurement(s)~~.*
	+ *the association information of UE Rx-Tx time difference measurement(s) with UE RxTx TEG(s) via higher layer parameter [ueRxTxTEG-ID] -> the ~~association information of~~ UE Rx-Tx time difference measurement(s) with associated UE RxTx TEG(s) via higher layer parameter [ueRxTxTEG-ID].*
	+ *the association information of UE Rx-Tx time difference measurement(s) with the UE Rx TEG(s) and UE Tx TEG(s) via the higher layer parameters of [ueRxTEG-ID], and [ueTxTEG-ID] -> the ~~association information of~~ UE Rx-Tx time difference measurement(s) with ~~the~~ associated UE Rx TEG(s) and associated UE Tx TEG(s) via the higher layer parameters of [ueRxTEG-ID], and [ueTxTEG-ID]*
* ***(OPPO, R1-2201239[4]) Proposal 3:*** *In order to avoid additional definition of the association information and align RAN1 and RAN2 spec, adopt the following the change for draft CR*
	+ *where the DL RSTD can be DL RSTD measurement in NR-DL-TDOA-AdditionalMeasurementElement -> where the DL RSTD can be DL RSTD measurement in NR-DL-TDOA-MeasElement and/or NR-DL-TDOA-AdditionalMeasurementElement*
* ***(OPPO, R1-2201239[4]) Proposal 4:*** *Move the definition of “UE Tx TEG” to Section 5.1.6.5 of TS 38.214*
* ***(OPPO, R1-2201239[4]) Proposal 5****: Adopt the following TP (TP2) for the draft CR. (The modifications are highlighted by YELLOW)*

### Question 5.1-1

*Companies are invited to provide their views on the following proposal:*

* ***(OPPO, R1-2201239[4]) Proposal 1***

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | No | Not required, as long as there is no conflict between 214 and LPP. |
| CATT | No | It seems that the TP is not needed. |
| vivo |  | We agree to separate different positioning methods into different paragraphs to resolve ambiguity.In addition to the CR above, a single paragraph for PRS-RSRP measurement in DL-AOD should also be added. |
| OPPO | Yes | Reply to HW/CATT: The current spec may lead to the misunderstanding that UE can report both DL RSTD and UE Rx-Tx time difference measurements in a single report. The proposal TP is to avoid such kind of potential ambiguity |
| ZTE |  | This proposal can be further discussed after we have a conclusion on proposal 3.3. |
| Ericsson |  | Ok to further discuss TP.  |

### Question 5.1-2

*Companies are invited to provide their views on the following proposal:*

* ***(OPPO, R1-2201239[4]) Proposal 2***

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | Yes | OK, but do not see a big problem of using association information though. |
| CATT | Yes | Support. |
| vivo | No |  |
| OPPO | Yes | It is better aligned with RAN2 siganling |
| ZTE | Yes |  |
| Ericsson | No | This is not a critical change. No need to discuss. |
| LGE | Yes |  |

### Question 5.1-3

*Companies are invited to provide their views on the following proposal:*

* ***(OPPO, R1-2201239[4]) Proposal 3***

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | Yes | OK. |
| CATT | Yes | Support. |
| vivo |  | OK |
| OPPO | Yes |  |
| ZTE | Yes |  |
| Ericsson |  | Ok |
| LGE | Yes |  |

### Question 5.1-4

*Companies are invited to provide their views on the following proposal:*

* ***(OPPO, R1-2201239[4]) Proposal 4***

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | No |  |
| CATT | No |  |
| vivo | No |  |
| OPPO | Yes | If this proposal is not adopt, UE Tx TEG will be used before it is defined. If TEG is defined in other spec, this proposal is not needed |
| ZTE | No |  |
| Ericsson | No |  |
| LGE | No |  |

### Question 5.1-5

*Companies are invited to provide their views on the following proposal:*

* ***(OPPO, R1-2201239[4]) Proposal 5***

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no** | **Additional comments**  |
| Huawei, HiSilicon | No | Do not support the Tx TEG part. The TP was not written in a way it should have been with changes on changes, and was not based on the latest version of specification. |
| CATT | No |  |
| vivo | No |  |
| OPPO |  | We will provide the corresponding TP next time based on a clear version of the spec. |
| Ericsson |  | Agree with earlier comments that TP should be provided on the latest rel-17 specifications. May be it is not urgent to treat this TP in this meeting. |
| LGE | No |  |

## Definitions of UE/TRP Rx/Tx timing errors and Timing Error Groups

Submitted Proposals

* ***(Fraunhofer, R1-2202366[14]) Proposal 2:*** *To avoid duplication, ueRxTxTEG and ueRxTEG definitions are removed from TS38.214 if captured in LPP****.***

FL comments

The above proposal may be discussed after *ueRxTxTEG and ueRxTEG definitions* are captured in LPP in RAN2. It has no impact on high-layer. Thus, FL suggests no further discussion of above proposal in this meeting.

### Question 5.2-1

*Companies are invited to provide their views on the following proposal in the following table*

* + *(Fraunhofer, R1-2202366[14]) Proposal 2*

|  |  |  |  |
| --- | --- | --- | --- |
| **Company** | **yes** | **NO** | **Additional comments** |
| Huawei, HiSilicon | Yes |  | It is good to avoid duplication. RAN1 could decide whether to keep in only RAN1 specification or RAN2 specification. |
| CATT |  | No | We prefer to keep the ueRxTxTEG and ueRxTEG definitions in both 38.214 and LPP specs. |
| Fraunhofer | Yes |  |  |
| OPPO |  |  | TEG should be defined only in one spec to avoid duplication. We have a slight preference to keep it only in RAN1 spec |
| Ericsson |  |  | Not critical for this meeting. we can revisit this once LPP specs are stabilized. |

# RRC Parameters

##  RAN2 LS (R2-2201776)

Submitted Proposals

* ***(CATT, R1-2201361[5]) Proposal 4:*** *The following two duplicated parameters should be deleted in the RAN1 parameter table*
	+ *numOfUERxTEG-PerPRSResource*
	+ *numOfTRPRxTEG-PerPRSResource\_RTOA*
* ***(CATT, R1-2201361[5]) Proposal 5****: The value range of maxNumOfUE-RxTEG should be 32, rather than as 8.*
* ***(CATT, R1-2201361[5]) Proposal 6****: There is no need to include the positioning SRS resource set ID in ueTxTEG and trpRxTEG association report.*
* ***(CATT, R1-2201361[5]) Proposal 7****: There is no need to introduce a triplet of UE {RxTx TEG ID, Rx TEG ID, Tx TEG ID} for ueRxTxTEG-ID-group or a triplet of TRP {RxTx TEG ID, Rx TEG ID, Tx TEG ID} for trpRxTxTEG-ID-group.*
* ***(Intel, R1-2201697[8])******Proposal 4****: Prepare reply to LS for RAN WG2 on the duplicated parameters issue (R1-2200878) clarifying the following:*
	+ *The parameters MeasPRSwithDiffRxTEGs\_Request\_RSTD and numOfUERxTEG-PerPRSResource do not duplicate each other, and both need to be captured in the higher layer parameter list*
	+ *The parameter MeasPRSwithDiffRxTEGs\_Request\_RSTD defines the total maximum number of different UE RxTEGs that can be measured for the same DL PRS*
	+ *The parameter numOfUERxTEG-PerPRSResource defines the maximum number of different UE RxTEGs that can be measured simultaneously in time for the same DL PRS resource*
	+ *Enhance the description of the corresponding parameters in the higher layer parameters list in R1-2112976 clarifying the difference*
* ***(Intel, R1-2201697[8])******Proposal 5****: Discuss in RAN WG1 the following modifications for the parameters MeasPosSRSwithDiffRxTEGs\_Request and numOfTRPRxTEG-PerPRSResource\_RTOA:*
	+ *Rename the parameter "MeasPosSRSwithDiffRxTEGs\_Request" to "MeasPosSRSwithDiffRxTEGs\_Request\_RTOA"*
	+ *Clarify that this parameter defines the total maximum number of different TRP RxTEGs that can be measured for the same UL SRS*
	+ *Rename the parameter "numOfTRPRxTEG-PerPRSResource\_RTOA" to "numOfTRPRxTEG-PerSRSResource"*
	+ *Clarify that this parameter defines the maximum number of different TRP RxTEGs that can be measured simultaneously in time for the same UL SRS resource*
	+ *Enhance the description of the corresponding parameters in the higher layer parameters list in R1-2112976 clarifying the difference*
	+ *Send the reply to LS for RAN WG2 on the duplicated parameters issue (R1-2200878) clarifying the changes above*
* ***(Intel, R1-2201697[8]) Proposal 6****: Clarify the correct number for the maxNumOfUE-RxTEG parameter, i.e. [8] or [32] should be used*
* ***(Qualcomm, R1-2202140[12]) Observation 1****: According to the previous agreement, a UE may support reporting both {Rx TEG ID, Tx TEG ID} and {RxTx TEG ID}.*
* ***(Qualcomm, R1-2202140[12]) Observation 2****: There is no need to include the SRS-PosResourceSetId in the Tx TEG SRS association.*
* ***(Qualcomm, R1-2202140[12]) Proposal 2:*** *Proposal 2: An M-RTT report is across all the bands that the UE has been configured with DL-PRS and SRS. The Tx TEG SRS Association report should include the option of optionally reporting an association of the SRS resource IDs to an SRS Frequency (NR ARFCN: The carrier frequency of SRS Transmission Bandwiwdth) to avoid any ambiguities if the same SRS resource ID is being used across multiple CCs.*
* ***(Qualcomm, R1-2202140[12]) Proposal 3:*** *With regards to the Tx TEG SRS Association inside an M-RTT report, support a maximum of 1024 Tx TEG SRS associations (up to 8 Tx TEG per band \* Up to 4 bands \* Up to 32 timestamps).*

FL comments

Above proposals related to RAN2 LS (R2-2201776) on RRC parameters will be discussed in Section 8.5.

# Proposals for GTW Session

##  First GTW Session

### Proposal 4-1

Provide the following responses to RAN2’s LS on PRU:

*About “whether the LMF determined ‘correction information’ obtained from PRU measurements needs to be provided to target UEs for UE-based mode of operation”, provide one of the following options as the response:*

* *Option 1: In Rel-17, there is no need to support the LMF to provide new "correction information" obtained from PRU measurements to target UEs for UE-based mode of operation*
* *Option 2: In Rel-17, support the LMF to provide the following new "correction information" obtained from PRU measurements to target UEs for UE-based mode of operation:*
	+ *Correction of RSTD measurement between reference TRP and neighboring TRPs*
	+ *TRP Tx timing error difference between reference TRP and neighboring TRPs*

*About “the details of the "PRU antenna orientation information", provide one of the following options as the response:*

* *Option 1: When a PRU is a UE, there is no need to support PRU to provide the antenna orientation information to LMF in Rel-17.*
* *Option 2: The PRU antenna orientation information is defined as follows:*
	+ *The translation information of a Local Coordinate System (LCS) of the PRU antenna to a Global Coordinate System (GCS) as defined in TR 38.901, including the angles α (bearing angle), β (downtilt angle) and γ (slant angle) (see e.g., LCS-GCS-TranslationParameter-r16 in 38.355)*

### Proposal 5-1

Provide the following responses to RAN4’s LS on Rel-15 SR for UE/gNB Rx-Tx time difference measurement:

* *The use of Rel-15 SRS for UE Rx-Tx time difference measurement and/or gNB Rx-Tx time difference measurement for the purpose of positioning is currently not supported.*
* *RAN1 has discussed the use of Rel-15 SRS for UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement for the purpose of positioning in Rel-17, but has not made the decision to support it.*

## Second GTW Session

TBD

# References

1. [R1-2200920](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2200920.doc) Maintenance of Rx/Tx timing error, Huawei, HiSilicon
2. [R1-2201093](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201093.doc) Maintenance on enhancements for RX/TX timing delay mitigating vivo
3. [R1-2201193](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201193.doc) Remaining issues on timing delay mitigation for NR positioning ZTE
4. [R1-2201239](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201239.doc) Enhancement of timing-based positioning by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays OPPO
5. [R1-2201361](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201361.doc) Remaining issues on mitigating UE and gNB Rx/Tx timing errors CATT
6. [R1-2201582](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201582.doc) Remaining Issues on Mitigating Rx/Tx Timing Delays Sony
7. [R1-2201634](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201634.doc) Maintenance of mitigating UE and gNB Rx/Tx timing errors Nokia, Nokia Shanghai Bell
8. [R1-2201697](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201697.doc) Maintenance for mitigation UE Rx/Tx and/or gNB Rx/Tx timing delays Intel Corporation
9. [R1-2201824](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201824.doc) Discussion on accuracy improvements by mitigating timing delays InterDigital, Inc.
10. [R1-2201856](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2201856.doc) Remaining issues on UE/gNB Rx/Tx timing errors mitigation CMCC
11. [R1-2202014](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202014.doc) Discussion on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Samsung
12. [R1-2202140](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202140.doc) Maintenance for Timing Error Mitigations for improved Accuracy Qualcomm Incorporated
13. [R1-2202291](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202291.doc) Discussion on accuracy improvement by mitigating UE Rx/Tx and gNB Rx/Tx timing delays LG Electronics
14. [R1-2202366](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202366.doc) Maintenance for Rx/Tx timing delays mitigation Fraunhofer IIS, Fraunhofer HHI
15. [R1-2202370](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202370.doc) Tx/Rx timing error mitigation maintenance issues, Lenovo, Motorola Mobility
16. [R1-2202389](file:////Users/renda000/Downloads/2022_02_RAN1_108e/Docs/R1-2202389.doc) Techniques mitigating Rx/Tx timing delays Ericsson
17. R1-2112513, FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, Moderator (CATT)
18. R1-2200862, Response LS on Positioning Reference Units (PRUs) for enhancing positioning performance, SA2, CATT
19. R1-2200857, Response LS on Positioning Reference Units (PRUs) for enhancing positioning performance, RAN2, Qualcomm, CATT
20. R1-2201046 Draft reply LS on Positioning Reference Units (PRUs) for enhancing positioning performance vivo
21. R1-2201205 Draft reply LS to RAN2 on Positioning Reference Units (PRUs) ZTE
22. R1-2201246 Discussion on "response LS on Positioning Reference Units (PRUs) for enhancing positioning performance" OPPO
23. [R1-2201315](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201315.zip) Discussion on PRU for enhancing positioning performance CATT
24. [R1-2201316](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201316.zip) Draft reply LS on the PRU for enhancing positioning performance CATT
25. [R1-2201822](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201822.zip) Draft reply LS on Positioning Reference Units (PRUs) for enhancing positioning performance InterDigital, Inc.
26. [R1-2201838](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2201838.zip) Discussion on RAN2 LS on Positioning Reference Units (PRUs) for enhancing positioning performance CMCC
27. [R1-2202108](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202108.zip) Draft Reply to RAN2 LS on Positioning Reference Units (PRUs) for enhancing positioning performance Qualcomm Incorporated
28. [R1-2202296](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202296.zip) Draft Reply LS on Positioning Reference Units (PRUs) for enhancing positioning LG Electronics
29. [R1-2202323](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202323.zip) Draft reply to LS on Positioning Reference Units (PRUs) for enhancing positioning performance Ericsson
30. [R1-2202454](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_108-e%5CDocs%5CR1-2202454.zip) Discussion on the functionality of PRU Huawei, HiSilicon
31. R1-2200878 Response LS on the reporting of the Tx TEG association information RAN2, CATT
32. R1-2200900 LS on SRS for multi-RTT positioning RAN4, Huawei
33. R1-2201010 Draft reply LS on SRS for multi-RTT positioning Huawei
34. R1-2201053 Draft reply LS on SRS for multi-RTT positioning vivo
35. R1-2201210 Draft reply LS on SRS for multi-RTT positioning ZTE
36. R1-2201248 Discussion on "LS on SRS for multi-RTT positioning" OPPO
37. R1-2201309 Discussion on SRS for multi-RTT positioning CATT
38. R1-2201310 Draft reply LS on SRS for multi-RTT positioning CATT
39. R1-2202104 Draft Reply to RAN4 LS on SRS for multi-RTT positioning Qualcomm Incorporated
40. R1-2202457 Discussion on use of MIMO-SRS for Multi-RTT positioning Huawei, HiSilicon
41. R1-2202400 views on LS on SRS for multi-RTT positioning Ericsson
42. R1-2200899 Reply LS on lower Rx beam sweeping factor for latency improvement RAN4, CATT
43. R1-2200902 Reply LS on reporting of the Tx TEG association information RAN4, Huawei