3GPP TSG RAN WG1 Meeting #107e R1-2112511

**e-meeting, November 11th – 19th, 2021**

**Source: Moderator (CATT)**

**Title: FL Summary #2 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:

[107-e-NR-ePos-01] Email discussion/approval on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays with checkpoints for agreements on November 15 and 19 – Ren Da (CATT)

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 document covers the following aspects related to potential enhancements related to the accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays based on the contributions [1-18]:

|  |
| --- |
| 1. Definitions of UE/TRP Rx/Tx timing errors and Timing Error Groups 2. Methods for mitigating UE/TRP Tx/Rx timing errors 3. Reference devices for mitigating UE/gNB Tx/Rx timing errors 4. Measurement enhancements for mitigating UE/gNB Tx/Rx timing errors 5. Additional proposals |

**Notes:**

* The following highlights will be used in this summary:
  + “Pink highlights” are used for proposals with high priority
  + “Yellow highlights” are used for proposals with medium priority
  + “No highlights” are used for proposals with low 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/medium/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.

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

## Association of the UE Tx TEG and UE Tx beam direction

Submitted Proposals

* ***(Nokia, R1- 2111364[6]) Proposal 1:*** *The UE TX TEG reporting to be extended with an angular validity region and direction reference for which the TEG certain margin remains valid*

FL comments

In [6], it was observed that dynamic UE antenna array phase center offsets (PCOs) may be a sizable contributor to TOA/TOD errors, and PCOs can be seen also as timing delays that are dependent on the formfactor of the device, antenna panel used as well as the beam configuration and the particular AoA/AoD. If a reference gNB direction is known by the UE, the UE may evaluate a validity region around this reference gNB direction within which a certain PCO accuracy target is still met and this validity region is dependent on the relative direction of the reference gNB within the radiated coverage area of the used beam configuration.

A similar proposal was discussed in previous meetings, but only few companies provided the comments during the email discussion. We would need more inputs from interested companies to see if we can make any progress on this issue in this meeting.

### Proposal 2.1

* *The UE TEG reporting to be extended with an angular validity region and direction reference for which the TEG certain margin remains valid.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| **Nokia/NSB** | Support. As we show with detailed evaluations in our paper the TEG can be invalid if the angular validity region is not taken into account. If RAN1 wants to tackle this issue in Rel-17 we feel this is a very important component to the TEG concept. |
| **Huawei, HiSilicon** | Our understanding is that this not only involves potential timing error, but also involves UE location error. If we understand it correctly, UE location would be considered different under different “PCO”. |
| **ZTE** | Similar to ARP in UL measurement, we don’t see it should be involved in timing error. |
| **FL** | In the 1st round discussion, one 3 companies provided inputs and two of them do not support the proposal. Suggest closing the discussion if the proposal cannot get more support. |

## Clarification of Rx/Tx/RxTx TEG definitions

*Background*

|  |
| --- |
| Agreement: (RAN1#104e)  The following definitions are used for discussion of internal timing errors (*these terms are not agreed to be included in the specifications):*   * **Tx timing error**: From a signal transmission perspective, there will be a time delay from the time when the digital signal is generated at the baseband to the time when the RF signal is transmitted from the Tx antenna. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Tx time delay for the transmission of the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Tx time delay after the calibration, or the uncalibrated Tx time delay is defined as *Tx timing error*. * **Rx timing error**: From a signal reception perspective, there will be a time delay from the time when the RF signal arrives at the Rx antenna to the time when the signal is digitized and time-stamped at the baseband. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Rx time delay before it reports the measurements that are obtained from the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Rx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Rx time delay after the calibration, or the uncalibrated Rx time delay is defined as Rx timing error. * **UE Tx ‘timing error group’ (UE Tx TEG):** A UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing errors within a certain margin. * **TRP Tx ‘timing error group’ (TRP Tx TEG):** A TRP Tx TEG is associated with the transmissions of one or more DL PRS resources, which have the Tx timing errors within a certain margin. * **UE Rx ‘timing error group’ (UE Rx TEG):** A UE Rx TEG is associated with one or more DL measurements, which have the Rx timing errors within a certain margin. * **TRP Rx ‘timing error group’ (TRP Rx TEG):** A TRP Rx TEG is associated with one or more UL measurements, which have the Rx timing errors within a margin. * **UE RxTx ‘timing error group’ (UE RxTx TEG):** A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin. * **TRP RxTx ‘timing error group’ (TRP RxTx TEG):** A TRP RxTx TEG is associated with one or more gNB Rx-Tx time difference measurements and one or more DL PRS resources, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin. |

Submitted proposals

* ***(Ericsson, R1-2112339[18]) Proposal 28:*** *RAN1 to clarify the definition of timing error groups as given by the text:*

***---------------------------------------------- start text proposal ---------------------------------------------***

* + **UE Tx ‘timing error group’ (UE Tx TEG):** A UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing errors within a certain margin , i.e. the difference in UE TX timing error between two UL SRS resources associated to the same UE Tx TEG is smaller than the margin .
  + **TRP Tx ‘timing error group’ (TRP Tx TEG):** A TRP Tx TEG is associated with the transmissions of one or more DL PRS resources, which have the Tx timing errors within a certain margin , i.e. the difference in TRP TX timing error between two DL PRS resources associated to the same TRP Tx TEG is smaller than the margin .
  + **UE Rx ‘timing error group’ (UE Rx TEG):** A UE Rx TEG is associated with one or more DL measurements, which have the Rx timing errors within a certain margin , i.e. the difference in UE Rx timing error between two DL measurements associated to the same UE Rx TEG is smaller than the margin .
  + **TRP Rx ‘timing error group’ (TRP Rx TEG):** A TRP Rx TEG is associated with one or more UL measurements, which have the Rx timing errors within a margin , i.e. the difference in TRP Rx timing error between two UL measurements associated to the same TRP Rx TEG is smaller than the margin .
  + **UE RxTx ‘timing error group’ (UE RxTx TEG):** A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin , i.e. the difference in UE RxTx timing error between two UE Rx-Tx time difference measurements and two corresponding UL SRS resources associated to the same UE RxTx TEG is smaller than the margin .
  + **TRP RxTx ‘timing error group’ (TRP RxTx TEG):** A TRP RxTx TEG is associated with one or more gNB Rx-Tx time difference measurements and one or more DL PRS resources, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin , i.e. the difference in TRP RxTx timing error between two gNB Rx-Tx time difference measurements and two corresponding DL PRS resources associated to the same TRP RxTx TEG is smaller than the margin .

FL comments

For Rx/Tx/RxTx TEG definitions made in RAN1#104e, the Rx/Tx/RxTx ***timing errors*** in a TEG are defined to be within a margin. In RAN4’s reply LS ([R1-2108707](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108707.doc)), however, it is said “*TEG framework enables association information without limiting implementation to ensure that* ***the timing error difference******between measurements/transmissions associated to the same TEG******are within a certain margin***”. That is, RAN4 has a slightly different view on Tx/RxTx TEG definitions. Obviously, if Rx/Tx/RxTx timing errors in a TEG are within the margin *M (RAN1’s definition)*, the timing error difference between any two timing errors is also within the margin *2M (RAN4’s definition).* On the other hand, if the timing error difference between any two timing errors is within the margin *2M,* the Rx/Tx/RxTx timing errors in a TEG may not necessarily be within the margin *M.* The definitions given by RAN4 may make the UE/TRP to determine the TEGss easier in the implementation, because the UE/TRP only need to make sure the relative timing error difference in a TEG is within the margin, but no need to know the absolute timing errors in a TEG are within the margin. It seems *RAN1 needs to modify the definitions of* the Rx/Tx/RxTx TEG definitions with the consideration of RAN4’s inputs, as suggested in [2][18].

Another issue that needs to be discussed is that when RAN1 agreed on Rx/Tx/RxTx TEG definitions in RAN1#104e, the main intention at that time was to have the common ground for the discussions on how to mitigating the Rx/Tx/RxTx timing errors, but it is unclear whether the definitions agreed at that time are adequate to be included in the specification. Now we are near the close of the WI, it is time for us to consider finalizing these definitions for the specifications.

However, the issue was discussed in the previous meetings without conclusion. In addition, during the discussion of the draft CR for TS 38.214, there was a proposal to capture the definition in the TS 38.214, but some companies did not consider it is necessary. Based on the feedbacks in previous email discussions, FL considers it is low priority to further discuss the TEG definitions in this meeting.

Proposal 2.2

*Replace the definitions of timing error groups agreed in RAN1#104e with the following modified definitions and adopt them in the specifications:*

* + ***Tx timing error:*** *From a signal transmission perspective, there will be a time delay from the time when the digital signal is generated at the baseband to the time when the RF signal is transmitted from the Tx antenna. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Tx time delay for the transmission of the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Tx time delay after the calibration, or the uncalibrated Tx time delay is defined as Tx timing error.*
  + ***Rx timing error:*** *From a signal reception perspective, there will be a time delay from the time when the RF signal arrives at the Rx antenna to the time when the signal is digitized and time-stamped at the baseband. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Rx time delay before it reports the measurements that are obtained from the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Rx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Rx time delay after the calibration, or the uncalibrated Rx time delay is defined as Rx timing error.*
  + ***UE Tx ‘timing error group’ (UE Tx TEG):*** *A UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose~~, which have the Tx timing errors within a certain margin~~. The difference in UE TX timing error between two UL SRS resources associated with the same UE Tx TEG is within a certain margin.*
  + ***TRP Tx ‘timing error group’ (TRP Tx TEG):*** *A TRP Tx TEG is associated with the transmissions of one or more DL PRS resources~~, which have the Tx timing errors within a certain margin~~ The difference in TRP TX timing error between two DL PRS resources associated with the same TRP Tx TEG is within a certain margin.*
  + ***UE Rx ‘timing error group’ (UE Rx TEG):*** *A UE Rx TEG is associated with one or more DL measurements~~, which have the Rx timing errors within a certain margin~~ The differences in UE Rx timing errors between any two DL measurements associated with the same UE Rx TEG is within the same margin.*
  + ***TRP Rx ‘timing error group’ (TRP Rx TEG):*** *A TRP Rx TEG is associated with one or more UL measurements~~, which have the Rx timing errors within a margin~~. The differences in UE Rx timing errors between any two DL measurements associated with the same UE Rx TEG are within the same margin.*
  + ***UE RxTx ‘timing error group’ (UE RxTx TEG):*** *A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose~~, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin.~~ The differences in UE RxTx timing errors between any two UE Rx-Tx time difference measurements associated with the same UE RxTx TEG are within the same margin.*
  + ***TRP RxTx ‘timing error group’ (TRP RxTx TEG):*** *A TRP RxTx TEG is associated with one or more gNB Rx-Tx time difference measurements and one or more DL PRS resources~~, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin~~ The differences in TRP RxTx timing errors between any two gNB Rx-Tx time difference measurements associated with the same TRP RxTx TEG are within the same margin.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | For UE RxTx TEG, the association information is unclear based on the following agreement, especially whether UE RxTx TEG can be directly associated with one or more UL SRS resources.  For us, without modification of the UE Rx-Tx time difference measurement definition， RxTx TEG ID or UE Rx-Tx measurement can not be associated with UL SRS resources directly.  Agreement: (RAN1#106-e)  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   * + ***UE RxTx ‘timing error group’ (UE RxTx TEG):*** *A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose~~, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin.~~ The differences in UE RxTx timing errors between any two UE Rx-Tx time difference measurements associated with the same UE RxTx TEG are within the same margin.* |
| Nokia/NSB | Okay with the update to UE/TRP Tx TEG. What is the moitivation to change from within a certain margin to within the same margin in the other definitions?  FL: Not intentionally use two terms. We can replace “within the same margin” with “within a certain margin” as in the previous agreement, although to me “within the same margin” is better. |
| Ericsson | Support.  This should have **high priority** since other proposals rely on this one. Notably the margin will need to be defined somewhere. It may be reported by the UE either semi-dynamically or as a UE capability,  All simulations to show gains have been based on the TEG margins limiting the *difference* in timing error between measurements based on the same TEG, as clarified by the proposal. This is also what RAN4 has replied. There are no results at all showing any gain when the margin limits the timing error itself, and we have seen no arguments for that either.  FL: Based on the feedback, the suggestion is to try resolve the issue through email discussion. |
| Qualcomm | We agree that it is about timing error differences. RAN4 also has the same understanding. I think also Ran1 is aligned. It may make sense to update the text if there is confusion. |
| Huawei, HiSilicon | We prefer to keep the current in the draft CR on this.  [The UE may be configured, subject to UE capability, to report UE TEGs (Timing Error Group), where the TEGs are:  *- ueRxTEG* is associated with one or more DL measurements, which have the Rx timing error difference within a certain margin.  *- ueRxTxTEG* is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose, which have the ‘Rx timing errors+Tx timing errors’ difference within a certain margin.]  *- ueTxTEG* which is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing error difference within a certain margin.]  Is the proposal intended to change above text? We don’t see a strong need.  FL: I think the draft CR has capture quite will for UE Rx/Tx/RxTx TEGs. But, it would be better to: a) have an alignment of the CR with the agreement; and b) the draft CR does not include the definitions for TRP side.  If there is a strong request, we would like to change UE RxTx TEG definition by replacing *The differences in UE RxTx timing errors* by *The differences in UE Rx timing errors plus UE Tx timing errors*  FL: The suggestion looks fine to me. |
| OPPO | The proposal intends to refine/modify the spec wording. It can be discussed in the maintanence of R17 spec.  FL: The proposal has been presented for a few meeting. If there is no special concern, it would be better if we can make the agreement through email discussion in this meeting instead of waiting for R17 maintenance. |
| ZTE | Agree with Huawei. Draft CR has already reflected the changes.  FL: See the reponse to Huawei’s comments. |
| vivo 2 | We suggested modifying as follows since ueRxTxTEG can be associated with UE Rx-Tx time difference measurements, but there is no clear relationship with SRS  *- ueRxTxTEG* is associated with one or more UE Rx-Tx time difference measurements, ~~and one or more UL SRS resources for the positioning purpose,~~ which have the ‘Rx timing errors+Tx timing errors’ difference within a certain margin.  FL: The suggestion looks fine to me. Although a UE Rx-Tx time difference measurement may be associated with UL SRS resources, one *ueRxTxTEG* will include the UE Rx-Tx time difference measurements that have the ‘Rx timing errors+Tx timing errors’ difference within a certain margin. It seems no need to mention *UL SRS resources for the positioning.* |

### (Round 2) Proposal 2.2

*Replace the definitions of timing error groups agreed in RAN1#104e with the following modified definitions and adopt them in the specifications:*

* + ***Tx timing error:*** *From a signal transmission perspective, there will be a time delay from the time when the digital signal is generated at the baseband to the time when the RF signal is transmitted from the Tx antenna. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Tx time delay for the transmission of the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Tx time delay after the calibration, or the uncalibrated Tx time delay is defined as Tx timing error.*
  + ***Rx timing error:*** *From a signal reception perspective, there will be a time delay from the time when the RF signal arrives at the Rx antenna to the time when the signal is digitized and time-stamped at the baseband. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Rx time delay before it reports the measurements that are obtained from the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Rx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Rx time delay after the calibration, or the uncalibrated Rx time delay is defined as Rx timing error.*
  + ***UE Tx ‘timing error group’ (UE Tx TEG):*** *A UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose~~, which have the Tx timing errors within a certain margin~~. The differences in UE TX timing errors between two UL SRS resources associated with the same UE Tx TEG are within a certain margin.*
  + ***TRP Tx ‘timing error group’ (TRP Tx TEG):*** *A TRP Tx TEG is associated with the transmissions of one or more DL PRS resources~~, which have the Tx timing errors within a certain margin~~ The differences in TRP TX timing errors between two DL PRS resources associated with the same TRP Tx TEG is within a certain margin.*
  + ***UE Rx ‘timing error group’ (UE Rx TEG):*** *A UE Rx TEG is associated with one or more DL measurements~~, which have the Rx timing errors within a certain margin~~ The differences in UE Rx timing errors between two DL measurements associated with the same UE Rx TEG are within a certain margin.*
  + ***TRP Rx ‘timing error group’ (TRP Rx TEG):*** *A TRP Rx TEG is associated with one or more UL measurements~~, which have the Rx timing errors within a margin~~. The differences in UE Rx timing errors between two DL measurements associated with the same UE Rx TEG are within a certain margin.*
  + ***UE RxTx ‘timing error group’ (UE RxTx TEG):*** *A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements~~, and one or more UL SRS resources for the positioning purpose, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin.~~ The differences of “Rx timing errors + Tx timing errors” between any two UE Rx-Tx time difference measurements associated with the same UE RxTx TEG are within a certain margin.*
  + ***TRP RxTx ‘timing error group’ (TRP RxTx TEG):*** *A TRP RxTx TEG is associated with one or more gNB Rx-Tx time difference measurements ~~and one or more DL PRS resources, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin~~. The differences in TRP “Rx timing errors + Tx timing errors” between two gNB Rx-Tx time difference measurements associated with the same TRP RxTx TEG are within a certain margin.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Support.  We think the above change in FL proposal can match the Reply LS from RAN4 about the definition of TEG. |
|  |  |
|  |  |
|  |  |

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

## Association of DL PRS resources with Tx TEG for UE-based DL TDOA

Background

|  |
| --- |
| Agreement: (RAN1#104bis-e)   * Support the following for mitigating TRP Tx timing errors and/or UE Rx timing errors for DL TDOA   + Support a UE to provide the association information of RSTD measurements with UE Rx TEG(s) to the LMF when the UE reports the RSTD measurements to the LMF if the UE has multiple TEGs   + Support a TRP providing the association information of DL PRS resources with Tx TEGs to the LMF if the TRP has multiple TEGs   + Support the LMF to provide the association information of DL PRS resources with Tx TEGs to a UE for UE-based positioning if the TRP has multiple TEGs   + FFS: the details of the signaling, procedures, and UE capability * Send an LS to RAN4 to check if there is any issue to support the above enhancements |

Submitted Proposal

* ***(Apple, R1- 2111874[12]) Proposal 1:*** *The association information of DL PRS resources with Tx TEGs is indicated to UE by LMF through LPP message and/or broadcast in PosSIB.*

FL comments

A similar proposal was discussed in the previous meeting as shown in [20], but only few companies provided the responses with different views. Since that RAN1 has made the decision to support the LMF to provide the association information of DL PRS resources with Tx TEGs to a UE for UE-based positioning if the TRP has multiple TEGs, FL would suggest it can be up to RAN2 to decide how the information is provided to the UE in higher layer signalling, and there is no need to have the further discussion in RAN1. Interested companies are encouraged to provide their opinions on the suggestion.

### Proposal 3.1 (for conclusion)

* *It is up to RAN2 to decide how the association information of DL PRS resources with Tx TEGs is indicated to UE by LMF.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We are okay with the FL proposal |
| Nokia/NSB | Okay |
| Ericsson | Support FL proposal |
| Qualcomm | Not sure why such a simple thing needs to be send to RAN2. We prefer to just directly discuss that any UE-based AD should be applicable to both unicast and broadcast.  FL: I am not sure if we need to send LS to RAN2 on this. It is normally up to RAN2 to work on the broadcast assistance information as in Rel-16. I assume RAN1 could further discuss it and then send LS to RAN2 on RAN1’s decision/recommendation, but it sems unnecessary. |
| OPPO | We support QC’s suggestion. RAN1 can have an agreement and then leave the detailed signalling design to RAN2.  FL: See the response to Qualcomm’s comments. |
| ZTE | At least we should provide some guidance to RAN2. For example, whether the association should be static or dynamic.  FL: See the response to Qualcomm’s comments. |
| CATT | Support. It is RAN2’s responsibility to design the detailed signaling of the association information of DL PRS resources with Tx TEGs. |
| **FL** | In the 1st round discussion, 4 companies support to let RAN2 to decide how the association information of DL PRS resources with Tx TEGs is indicated to UE by LMF, while 3 companies suggest RAN1 to made the decision to support both unicast and broadcast, and let RAN2 to work on the details. Let us wait for see the comments from other companies. Although I think this issue can be handled easily in RAN2, if there is a majority support for tRAN1 to made the decision to support both unicast and broadcast, we can revise the proposal to do so. Otherwise, I think this issue is commonly handled by RAN2 w/o the need of RAN1 LS. |

## Association information of SRS resources and UE Tx TEGs

Background

The following conclusion was made in RAN1#104e and RAN1#104bis-e, related to the option(s) for mitigating UE Tx and TRP Rx timing errors for UL TDOA.

|  |
| --- |
| Agreement (RAN1#104bis-e):  Support the following for mitigating UE Tx timing errors and/or TRP Rx timing errors for UL TDOA   * Support a TRP to provide the association information of RTOA measurements with TRP Rx TEG(s) to the LMF when the TRP reports the RTOA measurements to the LMF if the TRP has multiple Rx TEGs * Support a UE to provide under capability the association information of UL SRS resources for positioning with Tx TEGs to the LMF if the UE has multiple Tx TEGs   + FFS: Whether to support a UE to provide the association information of UL SRS resources for MIMO with Tx TEGs to the LMF if the UE has multiple Tx TEGs   + FFS: Whether the association information is sent directly from UE to LMF, or is first provided to gNB and then forwarded to LMF; * FFS: the details of the Signaling, procedures, and UE capability   Working assumption: (RAN1#106bis-e):   * For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.   + The serving gNB should forward the association information provided by the UE to the LMF.     - FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs   + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB. * For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.   + FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs   + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF. * FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used. |

Submitted Proposals and FL comments

* ***(Huawei, R1-2110850[1]) Proposal 5****: The reporting of SRS-TEG association is under network control, and*
  + *For DL-TDOA + UL-TDOA, at least SRS-TEG association reporting following UL-TDOA is supported.*
  + *For UL-TDOA + Multi-RTT, SRS-TEG association reporting could follow either UL-TDOA or Multi-RTT*
* ***(ZTE, R1-2110956[2]) Proposal 1****: Neighbor gNBs don’t need to know association information of UL SRS resources for positioning with Tx TEGs.*
* ***(ZTE, R1-2110956[2])*** *Proposal 2: For mitigating UE Tx timing errors when UL-TDOA and DL-TDOA are jointly configured, support at least one of the following options.*
  + *Option 1: Serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs. Then, the serving gNB should forward the association information provided by the UE to the LMF*
  + *Option 2: Support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs.*
* ***(vivo, R1-2111013[3]) Proposal 4:*** *For mitigating UE Tx timing errors for jointly configured positioning methods (Multi-RTT, UL-TDOA and/or DL-TDOA), regarding UE Tx TEG information report via LPP or RRC+NRPPa, support the following:*
  + *As long as Multi-RTT is included, UE should report Tx TEG information via LPP.*
  + *When UL-TDOA and DL-TDOA are jointly configured, UE should report Tx TEG information via RRC+NRPPa.*
* ***(vivo, R1-2111013[3]) Proposal 5:*** *Support LMF to forward the UE Tx TEG information associated with SRS resource(s) provided by the UE to the neighboring gNBs.*
* ***(CATT, R1-2111256[4]) Proposal*** *1: Confirm the working assumption of UE providing the association information of UL SRS resources for positioning with Tx TEGs in RAN1#106bis-e.*
  + *Send an LS to RAN2 and RAN3 for further higher-layer signaling design.*
* ***(CATT, R1-2111256[4]) Proposal*** *2: No need to support the serving gNB to forward the association information of UL SRS resources for positioning with Tx TEGs provided by the UE to the neighboring gNBs.*
* ***(CATT, R1-2111256[4])******Proposal*** *3: No need to support LMF to forward the association information of UL SRS resources for positioning with Tx TEGs provided by the UE to the serving and neighboring gNBs.*
* ***(OPPO, R1-2111289[5]) Proposal 3****: Confirm the working assumption of UE to provide the association information of UL SRS resources for positioning with Tx TEGs for UL-TDOA and Multi-RTT.*
* ***(OPPO, R1-2111289[5]) Proposal 4****: For UL-TODA, NOT support the serving gNB to forward the association information to the neighboring gNBs.*
* ***(OPPO, R1-2111289[5]) Proposal 5****: For Multi-RTT, NOT support LMF to forward the association information to the serving and neighboring gNBs*
* ***(Nokia, R1- 2111364[6]) Proposal 9:*** *Confirm the working assumption on UE Tx TEG association reporting.*
* ***(Nokia, R1- 2111364[6]) Proposal 10:*** *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).*
* ***(CMCC, R1-2111609[9]) Proposal 1:*** *Confirm the following working assumption:*
  + *For mitigating UE Tx timing errors for UL TDOA, subject to UE's capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.*
    - *The serving gNB should forward the association information provided by the UE to the LMF.*
      * *FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs*
    - *UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.*
  + *For mitigating UE Tx timing errors for Multi-RTT, subject to UE's capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.*
    - * *FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs*
    - *UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.*
* ***(CMCC, R1-2111609[9]) Proposal 2:*** *When hybrid positioning including Multi-RTT, UL-TDOA and/or DL-TDOA is used, it is up to LMF to indicate how to provide the association information of UL SRS resources for positioning with Tx TEGs.*
* ***(LGE, R1-211973[13]) Proposal 1:*** *Multi-RTT, RAN1 should support that both LMF and gNB can request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly.*
* ***(LGE, R1-211973[13]) Proposal 2:*** *For Multi-RTT, RAN1 should not support proving the association information for neighbor TRP.*
* ***(LGE, R1-211973[13]) Proposal 9:*** *For mitigating TRP Tx/Rx timing errors for DL+UL positioning, select option #2 (i.e., Reporting of a TRP Rx TEG ID and a TRP Tx TEG ID.)*
* ***(MTK, R1-2112071[14]) Proposal 4-1****: When M-RTT is jointly configured with other positioning methods, LPP could be used for SRS-TEG delivery*
* ***(MTK, R1-2112071[14]) Proposal 4-2****: When UL-TDOA and DL-TDOA are jointly configured, RRC+ NRPPa could be used for SRS-TEG delivery*
* ***(NTT DOCOMO, R1-2112108[15]) Proposal 2:*** *The working assumption made at RAN1#106b-e meeting regarding the association information of SRS resources with UE Tx TEGs should be confirmed.*
* ***(Qualcomm, R1-2112217[16])Proposal 4:*** *Do not support the LMF or serving gNB to forward the Tx-TEGs to SRS association to the gNBs*
* ***(Qualcomm, R1-2112217[16])Proposal 5:*** *With regards to the TxTEGs-to-SRS association for a UE supporting both TDOA and Multi-RTT, the UE will report the association in the RRC (LPP) message depending on whether the request was received in RRC (LPP) respectively. No additional specification support would be needed.*
* ***(Ericsson, R1-2112339[18]) Proposal 4:*** *The UE should report it's UE TX TEG capability to the gNB.*
* ***(Ericsson, R1-2112339[18]) Proposal 5:*** *Do not support the serving gNB to forward the UE TX TEG association information to the neighbouring gNBs.*
* ***(Ericsson, R1-2112339[18]) Proposal 15:*** *For multi-RTT positioning the UE TX TEG association to UL SRS resources should be included in the multi-RTT report.*

FL comments

Multiple companies (e.g., CATT, OPPO, Nokia, CMCC, NTT DOCOMO), propose to confirm the working assumption of UE providing the association information of UL SRS resources for positioning with Tx TEGs in RAN1#106bis-e, while it seems no company proposes to challenging the working assumption. In addition, one company (LGE) proposes for Multi-RTT, RAN1 should also support gNB can request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs.

Proposal 3.2a (H)

*Confirm the following working assumption made in RAN1#106bis-e*

* For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
  + The serving gNB should forward the association information provided by the UE to the LMF.
    - FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs
  + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
  + FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs
  + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Okay |
| Ericsson | Support |
| CATT | Support. |
| Nokia/NSB | Support. |
| Qualcomm | OK |
| Huawei, HiSilicon | OK. |
| CMCC | Support |
| OPPO | Support |
| Intel | Support the proposal |
| ZTE | Support |
| NTT DOCOMO | Support |
| LGE | As we mentioned our preference in our contribution, if the working assumption is agreed, there is no reason to disagree that gNB also can request UE to provide the association information in Multi-RTT since additional signaling (RRC+NRPPa) is already designed and existed for UL TDOA . Considering it, we prefer to add that gNB also can request the association information in case of Multi-RTT. If there aren't any companies who agree with our view, we are okay with current FL’s proposal.  FL: There were a long discussion on whether gNB also can request the association information in case of Multi-RTT. The WA was a compromise made in the previous meeting. FL would suggest not opening the discussion again. |

FL comments

About the two FFSs on whether to support the serving gNB or LMF to forward the association information of UL SRS resources for positioning with Tx TEGs to the neighboring gNBs, one company (vivo) proposes to support LMF to forward the *SRS-TEG association* to the neighboring gNBs, no company proposes to support the serving gNB to forward the *SRS-TEG association* to the neighboring gNBs, and multiple companies (e.g., ZTE, CATT, OPPO, LGE, Qualcomm, Ericsson) proposes not to support serving gNB or LMF to forward the *SRS-TEG association* to the neighboring gNBs.

About the “FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used”, multiple companies (e.g., Huawei, ZTE, CMCC, Qualcomm) proposes that the UE will report SRS-TEG association is under network control. In addition, for supporting UL-TDOA+DL-TDOA, some companies (e.g., Huawei, vivo, MTK) propose the reporting of SRS-TEG association via RRC+NRPPa needs at least to be supported. For Multi-RTT+other positioning, the reporting of SRS-TEG association via LPP needs to be supported. One company (Nokia) proposes to 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) in case the UE receives the request from both LMF and serving gNB.

It seems the common view is that reporting *SRS-TEG association via RRC/NRPPa* needs to be supported, at least, for the combinations of UL TDOA+DL-TDOA, and reporting *SRS-TEG association via LPP* needs to be supported for the combinations of Multi-RTT with others (including UL TDOA).

Proposal 3.2b (H)

*Modify the previous working assumption made in RAN1#106bis-e as follows:*

* For mitigating UE Tx timing errors for UL TDOA, including when UL TDOA is used together with DL-TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
  + The serving gNB should forward the association information provided by the UE to the LMF.
    - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, including when Multi-RTT is used together with DL TDOA and/or UL TDOA, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
  + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We wonder the yellow highlighted wording is needed because “if the UE supports multiple UE Tx TEGs” seems clear enough and it is difficult to judge whether the UE supports multiple Tx TEGs for Multi-RTT” if only RxTx TEG is reported for Multi-RTT   * For mitigating UE Tx timing errors for UL TDOA, including when UL TDOA is used together with DL-TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA. * For mitigating UE Tx timing errors for Multi-RTT, including when Multi-RTT is used together with DL TDOA and/or UL TDOA, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.   FL: The yellow highlighted wordings seem redundant, but it would be better to keep them. It may be clearer if “subject to UE’s capability” and “if the UE supports multiple UE Tx TEGs for UL TDOA” are combined as “subject to UE’s capability to support multiple UE Tx TEGs for UL TDOA”, i.e., the UE supports sending Tx TEG information via RRC/NRPPa. |
| Ericsson | This proposal doesn’t leave the SRS TEG association reporting over RRC/LPP when multiple/hybrid positioning methods are used. If Multi-RTT is used, LPP is mandated by the proposal. As noted by FL multiple companies (e.g. Ericsson, Huawei, ZTE, CMCC, Qualcomm) want this to be under network control. We therefore propose the following change of the WA 3.2a:   * For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.   + The serving gNB should forward the association information provided by the UE to the LMF.     - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~   + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB. * For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.   + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~   + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF. * For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if a request to do so is received from the gNB and the the UE should provide the association information of UL SRS resources for positioning with Tx TEGs to the LMF if a request to do so is received from the LMF. ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~   FL: This can be another option. It basically means when both UL-TDOA and Multi-RTT are used, it gives the LMF the freedom to request the Tx TEGs either via RRC/NRPPa or via LPP. |
| CATT | Support. |
| Nokia/NSB | We support removing the FFS on forwarding to neighboring cells.   For the last FFS point on hybrid techniques, in our understanding it is still quite open how the UE will update the TEG association for Tx TEGs to the LMF (e.g., periodic, etc). At least to us it is not clear that the UE will not receive both a request from the gNB and from LMF. For example, in case of batch reporting where the RTOA measurements are transparent to the UE. The UE doesn’t know if it should reply to both. We feel the UE should be able to inform LMF/gNB which way it will report the associations and which way it will continue to update the TEG association.  FL: It would be simpler that the UE simply makes the response based on the request from the network, assume the network will avoid the unnecessary request by the implementation. |
| Qualcomm | We don’t think that there is a need to discusss something more. The UE will just report according to a request it will receive. No more specification work is needed.  FL: It would be better to have the clarity since the question was brought up. |
| MTK | We support FL proposal |
| Huawei, HiSilicon | Same understanding as Ericsson, and only remove the entire FFS bullets.  If there is a strong request, we suggest to add the following Note.   * Note: The above methods also apply to the hybrid positioning that uses UL-TDOA or Multi-RTT positioning method, respectively |
| CMCC | We are supportive that when hybrid positioning (incl. multi-RTT, UL- and/or DL- TDOA) is configured, the UE should report the association information based on from which it gets the request. |
| OPPO | Support FL proposal |
| Intel | Do not see the reasons for changing the original proposal  FL: Which part? I assume we need to at least to resolve the “FFS” |
| ZTE | Support FL proposal if the yellow parts suggested by Ericsson are removed.  FL: yellow parts suggested by vivo? |
| Sony |  |
| LGE | We are supportive of Ericsson’s revision and same view in 3.2a |

### (Closed) Proposal 3.2b (H)

*Modify the previous working assumption made in RAN1#106bis-e as follows by one of the following alternatives:*

Alt. 1:

* For mitigating UE Tx timing errors for UL TDOA, including when UL TDOA is used together with DL-TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
  + The serving gNB should forward the association information provided by the UE to the LMF.
    - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, including when Multi-RTT is used together with DL TDOA and/or UL TDOA, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
  + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~

Alt. 2:

* For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
  + The serving gNB should forward the association information provided by the UE to the LMF.
    - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
  + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs:
  + to the serving gNB if a request to do so is received from the gNB
  + to the LMF if a request to do so is received from the LMF.
* ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We support Alt 2. One small suggestion below. We should clarify that the gNB is the serving gNB.   * For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs:   + to the serving gNB if a request to do so is received from the serving gNB   + to the LMF if a request to do so is received from the LMF. |
| Qualcomm | Alt. 2 |
|  |  |
|  |  |

**Agreement**

Confirm and modify the working assumption with the following modifications:

* For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
  + The serving gNB should forward the association information provided by the UE to the LMF.
    - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
  + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~
  + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* Note: For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT, or UL-TDOA and DL-TDOA are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs, subject to UE capability (in the bullets above):
  + to the serving gNB if a request to provide the association information is received from the gNB
  + to the LMF if a request to provide the association information is received from the LMF.
* ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~

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

Background

|  |
| --- |
| Agreement: (RAN#106bis-e)  Make the following modification on the previous agreement made in RAN#106e:   * 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.   + - N=[2, 3, 4, 6, 8] (FFS: other values), where the maximum value of N depends on UE capability   + The TRP can be either a “RSTD” reference TRP or a neighbour TRP   + FFS: details of the signalling, procedures, and UE capability   + The timestamps of the multiple RSTD measurements in the same measurement report can be the same or different.   + Note: All RSTD measurements are relative to a single reference timing * Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP Rx TEGs and report the corresponding multiple RTOA measurements.   + M = [2, 3, 4, 6, 8] (FFS: other values)   + FFS: details of the signalling, procedures   + The timestamps of the multiple RTOA measurements in the same measurement report can be the same or different. |

Submitted proposals

* ***(vivo, R1-2111013[3]) Proposal 2:*** *Regarding UE capability of measuring the same PRS resource with N Rx TEGs, support the following*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability per band.*

FL: Further discussion in Proposal 3.3-1.

* ***(Intel, R1-2111495[8])Proposal 3****: Support the LMF to request a UE to optionally measure the same DL PRS Resource of a TRP with N different UE RX TEG IDs and report the corresponding multiple RSTD measurements*
  + *Support the maximum number of N values equal to 8*
  + *For the multiple measurements performed within a single transmission period, the following measurement format can be used:*
    - *{RSTD, UE RX TEG ID for reference TRP, UE RX TEG ID for neighbor TRP} for the nth measurement, where n = 1, 2, ‚…, N*

FL: The proposal seems already supported.

* ***(Intel, R1-2111495[8])Proposal 4****: Support the LMF to request a TRP to optionally measure the same UL SRS Resource for positioning of a UE with M different TRP RX TEG IDs and report the multiple corresponding RTOA measurements*
  + *Support the maximum number of M values equal to 8*
  + *For the multiple measurements performed within a single transmission period, the following measurement format can be used:*
    - *{RTOA, TRP RX TEG ID} for the mth measurement, where m = 1, 2, ‚..,, M*

FL: The proposal seems already supported.

* ***(Qualcomm, R1-2112217[16])Proposal 6:*** *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 or M different UE RxTx TEGs and report the corresponding multiple UE Rx-Tx measurements.*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability*
  + *M=[2, 3, 4, 6, 8], where the maximum value of M depends on UE capability*
  + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different.*

FL: The proposal seems a straightforward extension of the agreement made for DL RSTD. Further discussion in Proposal 3.3-2.

* ***(Qualcomm, R1-2112217[16])Proposal 7:*** *Support the LMF to request a TRP to optionally measure the same SRS resource with M different gNB Rx-Tx measurements and report the corresponding multiple gNB Rx-Tx measurements to the LMF*
  + *M = [2, 3, 4, 6, 8]*
  + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*

FL: The proposal seems a straightforward extension of the agreement made for UL RTOA. Further discussion in Proposal 3.3-2.

* ***(Ericsson, R1-2112339[18]) Proposal******1:*** *Support a UE to perform multiple RSTD measurements towards the same TRP based on (1) different repetitions of the same DL PRS resource, (2) different symbols of the same DL PRS resource, (3) different occasions of the same DL PRS resource, and (4) simultaneous reception of the same DL PRS, and to report these measurements to the LMF.*

FL: 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.

* *(****Ericsson, R1-2112339[18]) Proposal*** *2: Support configuration of UE to perform multiple RSTD measurements towards the same TRP, utilizing different UE RX TEGs, e.g. by including an indicator in the NR-DL-TDOA-RequestLocationInformation IE.*

FL: The proposal seems already supported. The corresponding parameter “numOfUERxTEG-PerPRSResource” is included in R1-2110680. It will be up to RAN2 to decide the parameter will be included in which IE.

* *(****Ericsson, R1-2112339[18]) Proposal*** *3: 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: We may assume we will send all of the agreements to RAN4 in this meeting.

* ***(Ericsson, R1-2112339[18]) Proposal 20****: Introduce the possibility to configure the UE to perform multi UE-RX-TEG - UE RX-TX time difference measurements, i.e. one UE RX-TX time difference measurement for each UE RX TEG and TRP.*

FL: The proposal seems a straightforward extension of the agreement made for UL RTOA. Further discussion in Proposal 3.3-2.

### Proposal 3.3a (H)

*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.*
  + - *N=[2, 3, 4, 6, 8] ~~(FFS: other values),~~ where the maximum value of N depends on UE capability per band*
  + *The TRP can be either a “RSTD” reference TRP or a neighbour TRP*
  + *FFS: details of the signalling, procedures, and UE capability*
  + *The timestamps of the multiple RSTD measurements in the same measurement report can be the same or different.*
  + *Note: All RSTD measurements are relative to a single reference timing*
* *Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP Rx TEGs and report the corresponding multiple RTOA measurements.*
  + *M = [2, 3, 4, 6, 8] ~~(FFS: other values)~~ per band*
  + *FFS: details of the signalling, procedures*
  + *The timestamps of the multiple RTOA measurements in the same measurement report can be the same or different.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We agree with the FL proposal, and the maximum number of UE Rx TEGs per band should be 8 in proposal 3.5a |
| Ericsson | Support.  Regarding the DL PRS configurations needed to enable multi-TEG RSTD reporting, we think this needs to be discussed and decided by RAN1. This could, however, be done under a new separate proposal. |
| CATT | Support. |
| Nokia/NSB | Okay |
| Qualcomm | OK |
| InterDigital | Support |
| Huawei, HiSilicon | One question for clarification on removing (FFS: other values).  Is it clearly understood that if there is no such request, network expects N=1, which means that UE SHALL NOT report the multiple RSTD measurement for the same DL PRS resource with multilple different Rx TEGs?  FL: My understanding similar to others, that UE will follow Rel-16’s behaviour. However, if UE reports the multiple RSTD measurements for the same DL PRS, I assume it does not mean the measurement report is invalid. Then, it will then be up to the LMF on whether to use or ignore extra measurements. |
| OPPO | Support. Regarding Huawei’s question, our understanding is that if N is not indicated by LMF, UE will do the measurement following R16 way, i.e., it is up to UE implementation how to use the Rx antennas/pannels. We are open to add the value of “1” to address Huawei’s concern.  FL: I assume the similar reasoning may also apply to the case when UE supports more the N Rx TEGs. It is up to UE implementation how to use which N Rx antennas/panels. |
| Intel | Support the proposal |
| ZTE | Support. We think N=1 is a default UE behavior if UE supports the feature of TEG. So we don’t need to mention it explicitly. |
| NTT DOCOMO | Support |
| LGE | We are generally fine with FL’s proposal. However, we have a one concern about time stamp (“*The timestamps of the multiple RSTD measurements in the same measurement report can be the same or different.”* Here*,* we want to know the intention that the time stamp can be different in the third sub-bullet. In our understanding, the original intention of the proposal is to let LMF know the difference between Rx TEGs. We cannot understand the motivation that the timestamp can be different. If there are no strongest proponents, we prefer to remove it.  FL: Yes, the original intention of the proposal is to let LMF know the difference between Rx TEGs. It would be best if the measurements are obtained at the same time. But, one measurement report can have multiple measurements obtained at different times. Thus, the measurements from the same DL PRS resource may be measured in different times and thus have different timestamps. Please also see the discussion in previous meeting [19]. |
| Ericsson | We have the same understanding as FL in his reply to LGE question. We prefer to keep ‘same or different’ for the timestamps part. Note that this is already an agreement, and we should not change the agreement now. |
| Huawei, HiSilicon2 | Reply to FL:  We have concern on the comment that if N is not included, UE should follow Rel-16 behaviour.  In fact, we think there are two different signalings: one is to request UE to provide TEG information, while the other is to request to measure the same PRS with N TEGs.  To address this, we prefer to add the following Note   * + *Note: if N (or M) is not explicitly included it is up to UE (or TRP) to determine the number of Rx TEGs for the same PRS/SRS.*   Another question for clarification is that if we say the maximum value of N depends on UE capability per band, we would like to understand the following implications   * Should different N be set to frequency layers on different bands? Or alternatively, should a single N be present per request, or multiple Ns be present while each N corresponds to a frequency layer? We would only support a single N value per request. * If it is a single N per request. How should we interpret the sentence that the maximum value of N depends on UE capability? Should it be smaller than the **maximum** or **minimum** across the capability reported on the concerned bands? * For M per band, is the intention of have band indicator in associated with M in the measurement request? Why do we need per band here? |
| Qualcomm | Support. Even though we understand the questions that HW/HiSi is asking, but to us these are secondary details, and we need to main feature agreed. To answer the questions from our side:   * Yes we think its 2 different requests: One to start reporting TEGs, the other to do measurements with multiple TEGs. If the latter request is not there, clearly it is up to the UE what to do. * We are fine with Single request, and not per PFL; but we can accept to be per PFL; it is more general and forward compatible. * From our side, even if LMF requests for more than what the UE can do, this would not change the UE behavior. * OK to remove the “per band” for the gNB. |
| Huawei, HiSilicon | To Qualcomm: We want to emphasize that this is the last meeting of the open WI, and prefer not to leave FFS.  We are Ok with the following modification.   * *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.*   + *N=[2, 3, 4, 6, 8] is common to all positioning frequency layers*   + *Note: if N is not explicitly included it is up to UE to determine the number of Rx TEGs for the same PRS*   + *The TRP can be either a “RSTD” reference TRP or a neighbour TRP*   + *The timestamps of the multiple RSTD measurements in the same measurement report can be the same or different.*   + *Note: All RSTD measurements are relative to a single reference timing* * *Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP Rx TEGs and report the corresponding multiple RTOA measurements.*   + *M = [2, 3, 4, 6, 8]  is common to all SRS resources in a measurement request*   + *Note: if M is not explicitly included it is up to TRP to determine the number of Rx TEGs for the same SRS.*   + *The timestamps of the multiple RTOA measurements in the same measurement report can be the same or different.* |

Proposal 3.3b (H)

* *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, or M different UE RxTx TEGs, and report the corresponding multiple UE Rx-Tx measurements.*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability per band*
  + *M=[2, 3, 4, 6, 8], where the maximum value of M depends on UE capability per band*
  + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different*
  + *FFS: details of the signalling, procedures, and UE capability*
* *Support the LMF to request a TRP to optionally measure the same SRS resource with M different gNB Rx-Tx measurements and report the corresponding multiple gNB Rx-Tx measurements to the LMF*
  + *M = [2, 3, 4, 6, 8] per band*
  + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*
  + *FFS: details of the signalling, procedures*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Firstly, further clarification is needed. For M different UE RxTx TEGs, does it need to associate with the same Tx TEG? Or there is no restriction, it can associate the same or different Tx TEGs? At least based on current Rx-Tx time difference measurement, we don’t find the case where multiple UE Rx-Tx measurements corresponding to the same PRS resource can associate with different Tx TEGs.  Secondly, we wonder why the UE side includes “*N different UE Rx TEGs, or M different UE RxTx TEGs*”, while the TRP side only includes “*M different* gNB Rx TEGs”.  Then, some typos, e.g.change “gNB Rx-Tx measurements” to “gNB Rx TEGs” as follows  *Support the LMF to request a TRP to optionally measure the same SRS resource with M different gNB RxTx TEGs, ~~gNB Rx-Tx measurements~~ and report the corresponding multiple gNB Rx-Tx measurements to the LMF*   * + *M = [2, 3, 4, 6, 8] per band*   + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*   + *FFS: details of the signalling, procedures* |
| Ericsson | Support.  For the RxTx TEG part it’s unclear for us how that’s supposed to work. We are still fine to agree the proposal as it is (with minor typos corrected). Alternativel the Rx part could be agreed separately as   * *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, ~~or M different UE RxTx TEGs,~~ and report the corresponding multiple UE Rx-Tx measurements.*   + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability per band*   + *~~M=[2, 3, 4, 6, 8], where the maximum value of M depends on UE capability per band~~*   + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different*   + *FFS: details of the signalling, procedures, and UE capability* * *Support the LMF to request a TRP to optionally measure the same SRS resource with M different gNB Rx TEGs ~~Rx-Tx measurements~~ and report the corresponding multiple gNB Rx-Tx measurements to the LMF*   + *M = [2, 3, 4, 6, 8] per band*   + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*   + *FFS: details of the signalling, procedures* |
| CATT | Support. |
| Nokia/NSB | Okay in principle. |
| Qualcomm | RxTx TEG should stay in the proposal.  To E//: Which aspect is unclear? The UE measures PRS with multiple antennas, and reports a separate RxTxTEG. Note, that not all UEs will report RxTEG for RTT. Again, multiple RxTxTEGs can be because of multiple Rx, and not because of having multiple Tx. |
| InterDigital | Support |
| Huawei, HiSilicon | Same comments the previous one.  We also support Ericsson’s version, with the clarication on number with absence of the request answered. |
| OPPO | We have the same question as vivo’s 2nd one. If it is clarified, we would be ok with the proposal. |
| ZTE | We prefer Ericsson’s update. When we’re talking about measurement for UE Rx-Tx difference, which only involves PRS reception. |
| NTT DOCOMO | Support |
| LGE | Same view in 3.3a |

FL Comments

It seems that most companies are fine with “*different UE/TRP Rx TEGs*”, but have more questions or the case with “*different UE/TRP RxTx TEGs*”*.*

To my understanding, the case of “*different UE/TRP Rx TEGs”* applies to the case when the UE/TRP supports the option of reporting {Rx TEG ID, Tx TEG ID} together with *Rx-Tx measurements*, while the case of “*different UE/TRP RxTx TEGs”* applies to the case when the UE/TRP supports the option to report RxTx TEG ID with the *UE/TRP Rx-Tx measurements.* For example, if LMF requests the UE to measure the same *DL PRS resource* with *different UE RxTx TEGs,* the LMF may obtain the timing differences between these *different UE RxTx TEGs* from the reported measurements.

Maybe we could discuss the two cases separately since it may requires different UE capabilities.

### (Round 2) Proposal 3.3b-1 (H)

* *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 measurements.*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability per band*
  + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different*
  + *FFS: details of the signalling, procedures, and UE capability*
* *Support the LMF to request a TRP to optionally measure the same SRS resource with M different TRP Rx TEGs and report the corresponding multiple gNB Rx-Tx measurements to the LMF*
  + *M = [2, 3, 4, 6, 8] per band*
  + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*
  + *FFS: details of the signalling, procedures*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Support. |
| ZTE | Support |
| Huawei, HiSilicon | Same comments as the previous one (3.3a)  1. How to handle the case when N is not included, but TEG information report is requested? (We do not think Rel-16 behaviour is the case here).  2. Single or multiple N per request?  3. How to interpret UE capability per band to determine single N.  4. Why is M per band. |
| Qualcomm | Support. Even though we understand the questions that HW/HiSi is asking, but to us these are secondary details, and we need to main feature agreed. To answer the questions from our side:   * Yes we think its 2 different requests: One to start reporting TEGs, the other to do measurements with multiple TEGs. If the latter request is not there, clearly it is up to the UE what to do. * We are fine with Single request, and not per PFL; but we can accept to be per PFL; it is more general and forward compatible. * From our side, even if LMF requests for more than what the UE can do, this would not change the UE behavior. * OK to remove the “per band” for the gNB. |
| vivo | Support, and remove the FFS bullet |
| Ericsson | Support. As suggested by others, we are ok to remove ‘per band’ for the gNB part. |
| OPPO | Support. |

### (Round 2) Proposal 3.3b-2 (H)

* *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 RxTx TEGs, and report the corresponding multiple UE Rx-Tx measurements.*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability per band*
  + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different*
  + *FFS: details of the signalling, procedures, and UE capability*
* *Support the LMF to request a TRP to optionally measure the same SRS resource with M different TRP RxTx TEGs and report the corresponding multiple gNB Rx-Tx measurements to the LMF*
  + *M = [2, 3, 4, 6, 8] per band*
  + *The timestamps of the multiple gNB Rx-Tx measurements in the same measurement report can be the same or different.*
  + *FFS: details of the signalling, procedures*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Support.  We think “UE/TRP RxTx TEGs” case can be used for UE/TRP reporting RxTx TEG ID with the UE/TRP Rx-Tx measurements. |
| ZTE | This proposal confuses us. The main bullet only mentions the association DL PRS to TEG. However, the RxTx TEGs may involve both DL measurement and UL transmission. As we have agreed, UE can report {Rx TEG ID, Tx TEG ID} to a UE Rx-Tx measurement, we prefer only to agree this case. For example,   * *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 measurements.* |
| Qualcomm | Support  To ZTE: We think it is important to agree for both UE implementations for RTT. We don’t see how the “Tx” is related here. The UE will be measuring with multiple antennas/panels the PRS, and derive different RxTxTEGs, |
| vivo | Do the N and M here have any relationship with the proposal 3.3a and 3.3b-1?  In addition, for M different UE RxTx TEGs, does it need to associate with the same Tx TEG? Or there is no restriction, it can associate the same or different Tx TEGs, and why the candidate value N is same as the N in proposal 3.3b-1?  We prefer to discuss it after the association relationship of UE RxTx TEGs is clear. At least based on current Rx-Tx time difference measurement, we don’t find the case where multiple UE Rx-Tx measurements corresponding to the same PRS resource can associate with different Tx TEGs. |
| OPPO | In our understanding, there would be some difference between the cases of RxTx TEGs and Rx TEGs. For example, a UE reporting to support 4 Rx TEGs, it is able to measure the same PRS resource via 4 Rx TEGs. Let’s consider a UE with 2 Rx panels and 2 Tx panels. It may report 4 RxTx TEGs. However, it only has 2 different panels for the same PRS reception. Thus, what’s the benefit for LMF to configure UE measure the same DL PRS resource of a TRP with 4 RxTx TEGs? Would isn’t it sufficient to use 2 RxTx TEG for the same DL PRS resource? |
| Qualcomm2 | To OPPO: But that is why the “N” is the same as the RxTEG, and it is not more. It still goes up to 8.  To vivo: we can say that, If the UE reports both RxTxTEG-ID and TxTEG-ID with an Rx-Tx measurement, the same TxTEG is expected to be reported. |

## Reporting/updating of Rx/Tx/RxTx TEGs

Background

Proposals regarding the reporting/updating of Tx TEG association with positioning SRS/PRS resources were discussed in previous meetings w/o conclusion. The latest FL proposal discussed in RAN1#106bis-e meetings is shown as below:

|  |
| --- |
| (Round 2) Proposal 3.5 (H)  * *Consider to support one or both of the following options for UE to provide the updates of the association information between UE Tx TEG IDs and positioning SRS resources for UL TDOA*    + *Option 1: the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, based on a configured periodicity or a validity timer*     - *FFS: the values of the configurable periodicities or a validity timer*   + *Option 2: the gNB to request a UE to report the updates of the association information between UE Tx TEG IDs and positioning PRS resources whenever the UE determines the previous association information is no longer valid*     - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid* * *Consider to support one or both of the one of the following options for UE to provide the updates of the association information between UE Tx TEG IDs and positioning SRS resources for Multi-RTT:*   + *Option 1: the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, based on a configured periodicity or a validity timer*     - *FFS: the values of the configurable periodicities or a validity timer*   + *Option 2: the LMF to request a UE to report the updates of the association information between UE Tx TEG IDs and positioning PRS resources whenever the UE determines the previous association information is no longer valid*     - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid* * *Consider to support one or both of the following options for TRP to provide the updates of the association information between TRP Tx TEG IDs and positioning PRS resources:*   + *Option 1: the LMF to request a TRP to report the association information between TRP Tx TEG IDs and positioning PRS resources, based on a configured periodicity or a validity timer*     - *FFS: the values of the configurable periodicities or a validity timer*   + *Option 2: the LMF to request a TRP to report the updates of the association information between TRP Tx TEG IDs and positioning PRS resources whenever the TRP determines the previous association information is no longer valid*     - *Note: It is up to the TRP to determine when and whether the previous association information is no longer valid* |

Submttted proposals

* ***(Huawei, R1-2110850[1]) Proposal 6****: Support Tx TEG association with positioning SRS resource reported as part of non-TRP associated information, and Tx TEG association with UE Rx - Tx time difference measurement reported as part of TRP associated information.* 
  + *Note that the same Tx TEG ID is used to link the measurement Tx time and the corresponding positioning SRS resource(s).*
* ***(Huawei, R1-2110850[1]) Proposal 7****: Adopt the signaling structure for NR-Multi-RTT-SignalMeasurementInformation IE to include both non-TRP associated information and TRP associated information, where Tx TEG ID is used to link the measurement timing to the SRS resource.*
* ***(ZTE, R1-2110956[2]) Proposal*** *3: At least in a report for TEG-SRS association, SRS transmissions in different time occasions associated with the same TEG ID should be assumed to experience timing errors within the same margin.*
* ***(ZTE, R1-2110956[2]) Proposal 4****: Support UE to provide the association information of a UL SRS resource for positioning with Tx TEGs in different time occasions of the same SRS resource, where each time occasion should be indicated by a time stamp.*

Further discussion in Proposal 3.5-1.

* ***(vivo, R1-2111013[3]) Proposal 3****: Support the LMF/serving gNB to request a UE to provide the report of the association information between UE Tx TEG IDs and positioning SRS resources whenever the UE determines the previous association information is no longer valid.*
  + *For adjacent 2 triggered reports, it can be assumed that Tx TEG information associated SRS transmission is relatively stable from the last SRS instance before the previous report to the penultimate SRS instance before the next report.*
  + *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
* ***(OPPO, R1-2111289[5]) Proposal 2:*** *Regarding to the updating/reporting of the association of Tx TEG IDs and positioning SRS/PRS resources, support Option 2, i.e.,* 
  + *For UL TDOA:* 
    - *Option 2: the gNB to request a UE to report the updates of the association information between UE Tx TEG IDs and positioning PRS resources whenever the UE determines the previous association information is no longer valid*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
  + *For multi-RTT*
    - *Option 2: the LMF to request a UE to report the updates of the association information between UE Tx TEG IDs and positioning PRS resources whenever the UE determines the previous association information is no longer valid*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
* ***(Nokia, R1- 2111364[6]) Proposal 5:*** *Do not support any event driven and/or periodic reporting of Rx TEG and RxTx TEG association reporting outside of the measurement reports.*

FL: It seems so far no company proposes event driven and/or periodic reporting of Rx TEG and RxTx TEG association reporting outside of the measurement reports.

* ***(Nokia, R1- 2111364[6]) Proposal 6:*** *The Tx TEG associations should be sent after the transmission of the resources for particular measurements.*
* ***(Nokia, R1- 2111364[6]) Proposal 7:*** *Support a UE to provide the association information of UE Rx-Tx time difference measurement with UE RxTx TEGs to the LMF when the UE reports the UE Rx-Tx time difference measurements.*

FL: This seems to be already agreed.

* ***(Nokia, R1- 2111364[6]) Proposal 8:*** *Support a UE to provide the association information of UE Rx-Tx time difference measurements with UE Rx TEGs and UE Tx TEGs when the UE reports the UE Rx-Tx time difference measurements.*
* ***(Sony, R1-2111397[7]) Proposal 1:*** *Support UE/TRP to report time validity information associated with each TEG report to LMF.*
* ***(InterDigital, R1-2111797[11]) Proposal 2:******Support both Option 1*** *(“LMF to request a UE/TRP to report the association information between UE/TRP Tx TEG IDs and positioning SRS/PRS resources, based on a configured periodicity or a validity timer”)* ***and Option 2*** *(“LMF to request a UE/TRP to report the updates of the association information between UE/TRP Tx TEG IDs and positioning SRS/PRS resources whenever the UE/TRP determines the previous association information is no longer valid”) for UE/TRP to provide the updates of the association information between UE/TRP Tx TEG IDs and positioning SRS/PRS resources.*
* ***(InterDigital, R1-2111797[11]) Proposal 3****: Support validity time for TEG, i.e., within the validity time, the UE/gNB may not report the TEG association information.*
* ***(Apple, R1- 2111874[12]) Proposal 2:*** *Support Option 2, i.e., the LMF to request a UE (TRP) to report the updates of the association information between UE Tx TEG IDs (TRP Tx/Rx TEG IDs) and positioning SRS (PRS) resources whenever the UE (TRP) determines the previous association information is no longer valid.*
* ***(Qualcomm, R1-2112217[16])Proposal 2:*** *For TxTEG association to SRS (PRS) resources reporting, support the UE (TRP) to report the updates of the association information whenever the UE (TRP) determines the previous association information is no longer valid.*
  + *A timestamp should be included in the TxTEG to SRS (PRS) association reporting.*
* ***(Qualcomm, R1-2112217[16])Proposal 3:*** *For mitigating UE Tx/Rx timing errors for DL+UL positioning, the TxTEG-to-SRS association can be included in a separate report from the UE Rx-Tx measurement report.*
* ***Qualcomm, R1-2112217[16])Proposal 8:*** *With regards to the Rx, RxTx TEG Information reporting, support including a flag in the measurement report for each TEG-ID which is flipped (e.g. NDI-like a bit) to notify the LMF that RSTD/Rx-Tx measurements on a report with a flipped bit, do not have timing error differences within a margin with the RSTD/Rx-Tx measurements with a previous report, even if the same Rx/RxTx TEG ID is being used.*
* ***(Ericsson, R1-2112339[18]) Proposal 8:*** *Support the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, based on a configured periodicity.*
* ***(Ericsson, R1-2112339[18]) Proposal 9:*** *Support the gNB to configure the UE with a UE TX TEG reporting time window (RTW). The UE should report the UE TX TEG association for all TX instances of the SRS resources within the RTW in one measurement report. Both periodic measurement reporting and aperiodic measurement reporting should be supported. In case of periodic measurement reporting the RTW should be periodic.*
* ***(Ericsson, R1-2112339[18]) Proposal 16:*** *The SRSs for which UE TX TEG association should be reported by the UE in the multi-RTT report should be configurable by the LMF in terms of a list of SRS resource sets and SRS resources. 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.*
* ***(Ericsson, R1-2112339[18]) Proposal 17:*** *Support LMF to configure a UE TX TEG reporting time window (RTW) for UE TX TEG association reporting within the multi-RTT measurement report. The UE should include the UE TX TEG association for all SRS TX instances within the configured RTW. FFS whether the RTW can be the same as the MTW also being discussed by RAN1.*
* ***(Ericsson, R1-2112339[18]) Proposal 21****: 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. The timing error difference between two measurements based on the same UE RX TEG should be smaller than the margin if the difference in reported UE RX TTEI is smaller than a fixed value of N index steps. The UE RX TTEI difference between two subsequent UE RX TTEIs reported to the LMF should not be larger than N. FFS: [N=7], [Size of TTEI = 8].*
* ***(Ericsson, R1-2112339[18]) Proposal 22****: 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. The timing error difference between two UL SRS transmissions based on the same UE TX TEG should be smaller than the margin if the difference in reported UE TX TTEI is smaller than a fixed value of N index steps. The UE TX TTEI difference between two subsequent UE TX TTEIs reported to the LMF should not be larger than N. FFS: [N=7], [Size of TTEI =8].*

FL Comments

The timing errors of UE Rx/Tx/RxTx TEGs may changes over time for various reasons as discussed by multiple companies (e.g., [2][3][5][6][7][11][12][16][18]). Different options regarding the reporting/updating of Tx TEG association with positioning SRS/PRS resources were discussed in previous meetings w/o the conclusion.

For the reporting of the Tx TEG information, multiple companies ([3][5][11][12][16]) supports Option 2, in which the gNB/LMF requests the UE/TRP to report the updates of the Tx TEG association information when the previous association information is no longer valid. two companies ([11][18]) support Option 1, in which the gNB/LMF requests the UE/TRP to report the updates of the Tx TEG association information at a configured periodicity; and two companies ([7][11]) propose using the validity timer to control the reporting of theTx TEG association. In comparison, Option 2 may have the benefits of minimizing the traffic load, since Tx TEG association information is updated only when it is needed, while other methods allow the gNB/LMF have more control on when the Tx TEG association is provided. One company [6] proposes that Tx TEG association Tx TEG associations is sent after the transmission of the resources for particular measurements, which could also be an option, although it could result in some unnecessary transmission of the Tx TEG information. A possible way forward is to support all of these options to give the flexibility to the network on which of the options to use based on its requirements.

For Tx TEG information reported in different time occasions, one company [2] proposes that “the same TEG ID should be assumed to experience timing errors within the same margin” and two companies ([2][16][18]) propose including the timestamp in the reporting of Tx TEG association.

Two companies propose that the SRS - TxTEG association information can be included in a separate report from the UE Rx-Tx measurement report, while UE TxTEG IDs are included in the UE Rx-Tx measurement report.

For Rx TEG reporting, one company [16] proposes to use a flag to change of the Rx/RxTx TEG Information, i.e., the *same Rx/RxTx TEG ID* in the two sequential reports does not mean the same Rx/RxTx TEG if the a flag is flipped.

One company [18] proposes to support the gNB/LMF to configure the UE with a UE TX TEG reporting time window (RTW) for the reporting of the UE TX TEG association for all TX instances of the SRS resources within the RTW in one measurement report.

One company [18] proposes the SRSs for which UE TX TEG association should be reported by the UE in the multi-RTT report should be configurable by the LMF.

One company [18] proposes to support UE to maintain a UE RX/Tx temporal timing error index (TTEI), which can be used to indicate the timing error difference between two reports of the same UE RX/TX TEGs.

Proposal 3.4 (H)

* *For UL TDOA, consider supporting the following options for the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:* 
  + *Option 1:, based on a configured periodicity or a validity timer*
    - *FFS: the values of the configurable periodicities or a validity timer*
  + *Option 2: whenever the UE determines the previous UE Tx TEG association information is no longer valid*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
  + *Option 3: whenever the UE has completed one transmission occasion of SRS for positioning*
* *For Multi-RTT, consider supporting the following options for the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*
  + *Option 1:, based on a configured periodicity or a validity timer*
    - *FFS: the values of the configurable periodicities or a validity timer*
  + *Option 2: whenever the UE determines the previous UE Tx TEG association information is no longer valid*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
  + *Option 3: whenever the UE has completed one transmission occasion of SRS for positioning*
* *For DL-TDOA, consider supporting the following options for the LMF to request a TRP to provide the association information between TRP Tx TEG IDs and positioning PRS resources:*
  + *Option 1: based on a configured periodicity or a validity timer*
    - *FFS: the values of the configurable periodicities or a validity timer*
  + *Option 2: whenever the TRP determines the previous TRP Tx TEG association information is no longer valid*
    - *Note: It is up to the TRP to determine when and whether the previous association information is no longer valid*
  + *Option 3: whenever the TRP has completed the transmission of one DL PRS instance*
* *FFS: the details of the signalling, procedures*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We are supportive of option 2  1. We would like to confirm the difference for trigger reporting based on validity timer and periodicity  FL: I don’t see my difference between “reporting based on validity timer” and “periodic reporting. For the former, UE provides the reports whenever the timer expires, and then restart the timer; and the latter UE provides in a configured periodicity. I assume only one of them need to be supported.  2. The “,” after “option 1: “ should be moved  FL: Okay. |
| Ericsson | We are supportive of option1, but we think one could also consider combinations of option 1 and 2.  **Multi-RTT case**  If the UE reports UE Rx-Tx periodically in multi-RTT reports to the LMF, then the LMF will need the UE Tx TEG association info at the same time. To send UE TX TEG associationinfo inbetween the periodic multi-RTT reports every time a UE TX TEG association changes would waste resources. Note that this can mean that the UE has to start a separate UL transmission just for this purpose so the overhead is very significant. All UE TX TEG associations/changes during the period between multi-RTT reports should be collected and reported in the multi-RTT report itself or at least at the same time. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent.  FL: It seems which option is better may depending on the configured SRS transmission period, the UE Rx-Tx measurement reporting interval, and how long the UE Tx TEG can be valid. For example, assume the transmission periodicity of UL SRS and UE Rx-Tx measurement reporting periodicity are both 64ms, but the Tx TEG association is valid for 640ms, then Option 2 may have advantage to reduce the traffic load. On the other hand, if transmission periodicity of UL SRS is 64ms, and the Tx TEG association is also valid only for 64ms, but the UE Rx-Tx measurement reporting periodicity is 640ms, then there is no need to provide update Tx TEG association every 64ms, but the provide the package with optimized signalling every 640ms.  **UL TDOA case**  Similarly the gNB reports the RTOA periodically to the LMF, then the gNB will need the UE Tx TEG association info at the same time. To send UE TX TEG associationinfo inbetween the periodic RTOA reports every time a UE TX TEG association changes would waste resources. Note that this means that the UE sometimes has to start a separate UL transmission just for this purpose so the overhead is very significant. All UE TX TEG associations/changes during the period between RTOA reports should be collected and reported in one report. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent.  FL: Assume TRP provides the RTOA with the SRS transmission periodicity (no. sample=1). Then, in this case, Option 2 seems to be optimal. UE will only provide TX TEG association changes when it is necessary, instead of every SRS transmission period.  **DL TDOA case**  If the UE reports RSTDs periodically in UL-TDOA reports to the LMF, then the LMF will need the TRP Tx TEG association info at the same time. To send TRP TX TEG associationinfo inbetween the periodic DL-TDOA reports every time a gNB TX TEG association changes would waste resources. All TRP TX TEG associations/changes during the period between multi-RTT reports should be collected and reported in one report. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same DL PRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same DL PRS resource need not be sent.  Thus we make the following compromise proposal based on periodic reporting with signaling optimizations to avoid reporting of TEG associations that didn’t change:   * *For UL TDOA, support the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*    + *based on a configured periodicity and SFN offset*     - *FFS: the values of the configurable periodicities and offsets*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value* * *For Multi-RTT, support the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*   + *based on a configured periodicity and SFN offset*     - *FFS: the values of the configurable periodicities and offsets*     - *FFS: whether the TX TEG IDs are reported as a part of the multi-RTT report and thus with the same periodicity and offset*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value* * *For DL-TDOA, support the LMF to request a TRP to provide the association information between TRP Tx TEG IDs and positioning PRS resources:*   + *based on a configured periodicity and offset*     - *FFS: the values of the configurable periodicities and offsets*   + *The TRP TX TEG association is reported for each DL PRS instance during the configured period*     - *Signaling is optimized by using the last reported TRP TX TEG association for the same DL PRS resource as default value* |
| CATT | Support the proposal, and we prefer the Option 2 for all of the three main bullets, i.e., event-triggered reporting of update of the association information in order to reduce the overhead and latency. |
| Nokia/NSB | We support a modified option 3 where the UE/TRP should report the Tx TEG associations after a TRP/UE (respectively) reports a measurement report with corresponding Rx TEGs. This should be the baseline of the feature. It is possible that a modified option 1 can also meet this criteria in which case we could accept that potentially.  FL: I assume Option 3 can be a special case for Option 1 when the Tx TEG reporting periodicity is configured to be the same as the PRS/SRS transmission periodicity, for periodic reporting. |
| Qualcomm | Option 2 is the minimal and natural way to consider. |
| InterDigital | We support Option 1 and Option 2. We don’t support Option 3.  We don’t see the benefit of Option 3, which may result in large signalling overhead.  Option 3 can be obtained by combining Option 1 and Option 2. |
| MTK | Option 2 for all. This is event trigger behaviour which is pretty feasible |
| Huawei, HiSilicon | We do not consider this proposal essential for multi-RTT, since we believe that information in each report should be processed individually. Note that LPP periodical report is at least 1 sec.  FL: For longer measurement reporting intervals, the benefits to consider the signalling optimization could smaller. But, I assume RAN2 could introduce the reporting interval to be smaller 1s, since RAN2 has agreed RAN1’s request to support a finer granularity for location response time.   |  | | --- | | ***periodicalReporting***  This IE indicates that periodic reporting is requested and comprises the following subfields:  - ***reportingAmount*** indicates the number of periodic location information reports requested. Enumerated values correspond to 1, 2, 4, 8, 16, 32, 64, or infinite/indefinite number of reports. If the *reportingAmount* is '*infinite/indefinite'*, the target device shou-ld continue periodic reporting until an LPP *Abort* message is received. The value '*ra1*' shall not be used by a sender.  - ***reportingInterval*** indicates the interval between location information reports and the response time requirement for the first location information report. Enumerated values ri0-25, ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64 correspond to reporting intervals of 1, 2, 4, 8, 10, 16, 20, 32, and 64 seconds, respectively. Measurement reports containing no measurements or no location estimate are required when a *reportingInterval* expires before a target device is able to obtain new measurements or obtain a new location estimate. The value '*noPeriodicalReporting*' shall not be used by a sender. |   For TRP side, we do not think TRP changing TEG-PRS association is typical.  FL: If it is so, the Option 2 may be the better choice, which only requirs the gNB to send the updated Tx TEG when it is necessary.  For UL-TDOA, we would like to understand whether this report is reflecting the association in the past or the association in the near future.  FL: I assume there is timestamp in each Tx TEG that indicates the starting time from which the Tx TEG is valid. After a Tx TEG is received, it will be valid until it is replaced by the next Tx TEG report. |
| CMCC | It is a bit unclear to us that how does the periodicity or the validity timer in Option 1 be decided, and it seems that Option 2 is feasible. |
| OPPO | We support Option 2.  Regarding Option 1, we failed to understand the claim “allow the gNB/LMF have more control on when the Tx TEG association is provided”. Not sure what the value is for the repeated reports of the same information.  For Option 3, the signalling overhead is too large. |
| Samsung | Option 2 is preferred. |
| Intel | Why update of TRP Tx TEG ID for Mutli-RTT is not included into the proposal?  FL: The proposal is related to the reporting of the Tx TEG association information. The Tx TEG association information between TRP Tx TEG IDs and positioning PRS resources is coverd in the 3rd main bullet. |
| ZTE | For DL-TDOA(UE side for Rx TEG) and Multi-RTT(UE side), we don’t see the need to support separate report for the association.  FL: The proposal does not cover the reporting of DL-TDOA(UE side for Rx TEG). For Multi-RTT(UE side), if UE reports the UE Tx TEG ID with the Rx-Tx measurement, then we may consider whether we need to consider if having separate report for the association will have any special advantage.  So, basically, we should firstly discuss whether the TEG association should be reported aside for measurement report. We agree with Ericsson on the following statement,  *UE TX TEG associations/changes during the period between multi-RTT reports should be collected and reported in the multi-RTT report itself or at least at the same time.*  In addition, UE can only know TEG association after UE finishes the transmission/reception. Therefore, what we need to discuss is whether UE can buffer the TEG association/change between two measurement reports.  For UL-TDOA, we think it’s reasonable to have periodical report since the TEG association is provided by RRC first. Option 2 requires a lot of report overhead.  FL: Again, this really depends on reporting intervals and stability of the Tx TEG.  As we said, UE may buffer the TEG association/change between two measurement reports, so UE doesn’t need to report the TEG association in any time when the association is changed.   * *For UL TDOA, consider supporting the following options for the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*    + *based on a configured periodicity*     - *FFS: the values of the configurable periodicities*   + ***Support UE to provide the association information of a UL SRS resource for positioning with Tx TEGs in different time occasions of the same SRS resource, where each time occasion should be indicated by a time stamp*** * *For Multi-RTT, consider supporting the following options for the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources in* ***a location measurement report****, subject to UE capability:*   + *based on a configured periodicity*     - *FFS: the values of the configurable periodicities*   + ***Support UE to provide the association information of a UL SRS resource for positioning with Tx TEGs in different time occasions of the same SRS resource, where each time occasion should be indicated by a time stamp***   FL: I assume there is a need to include the timestamps in multiple Tx TEGs at different times are included in one report., especially for large reporting interval. |
| NTT DOCOMO | We support Option 1 and/or Option 2. |
| Sony | We support Option 1. |
| LGE | We are supportive of option 2. |
| **FL** | Based on the feedbacks, it might be better to support both option 1 and 2 (assume Option 3 is a special case for Option 1), since each option may have its advantages. Then, it is up to the network to configure which option is used for the optimization of the resource optimization. |

### (Round 2) Proposal 3.4 (H)

* *For UL TDOA, consider supporting the following options for the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:* 
  + *Option 1:, based on a configured periodicity [or a validity timer]*
    - *FFS: the values of the configurable periodicities [or a validity timer]*
    - *The UE TX TEG association is reported for each SRS instance during the configured period*
      * *A timestamp should be provided for the UE TX TEG for each SRS instance*
      * *If one same SRS resource is associated with different Tx TEGs in different time occasions, each time occasion should be indicated by a time stamp*
  + *Option 2: whenever the UE determines the previous UE Tx TEG association information is no longer valid*
    - *A timestamp should be provided that indicates the starting time for the valid of the UE Tx TEG association*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
* *For Multi-RTT, consider supporting the following options for the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*
  + *Option 1:, based on a configured periodicity [or a validity timer]*
    - *FFS: the values of the configurable periodicities [or a validity timer]*
    - *The UE TX TEG association is reported for each SRS instance during the configured period*
      * *A timestamp should be provided for the UE TX TEG for each SRS instance*
      * *If one same SRS resource is associated with different Tx TEGs in different time occasions, each time occasion should be indicated by a time stamp*
  + *Option 2: whenever the UE determines the previous UE Tx TEG association information is no longer valid*
    - *A timestamp should be provided that indicates the starting time for the valid of the UE Tx TEG association*
    - *Note: It is up to the UE to determine when and whether the previous association information is no longer valid*
* *For DL-TDOA, consider supporting the following options for the LMF to request a TRP to provide the association information between TRP Tx TEG IDs and positioning PRS resources:*
  + *Option 1:, based on a configured periodicity [or a validity timer]*
    - *FFS: the values of the configurable periodicities [or a validity timer]*
    - *The UE TX TEG association is reported for each SRS instance during the configured period*
      * *A timestamp should be provided for the TRP TX TEG for each SRS instance*
      * *If one same SRS resource is associated with different Tx TEGs in different time occasions, each time occasion should be indicated by a time stamp*
  + *Option 2: whenever the TRP determines the previous TRP Tx TEG association information is no longer valid*
    - *A timestamp should be provided that indicates the starting time for the valid of the UE Tx TEG association*
    - *Note: It is up to the TRP to determine when and whether the previous association information is no longer valid*
* *FFS: the details of the signalling, procedures*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | To FL, response time is the one-shot measurement. Changing the granularity of response time does not mean the periodical reporting period needs to be reduced. We do not think multi-RTT is useful.  For TRP side, we do not need to have “for DL-TDOA” since this is only about PRS transmission change, and in NRPPa, there is no DL-TDOA/Multi-RTT/DL-AOD differentiation when it comes to PRS configuration. If we go with Option 2, we may need LS to RAN3, since there is no class 2 NRPPa procedure procedure for TRP information exchange. |
| vivo | OK with FL’s proposal for progress. |
| OPPO | Not support. It is not a constructive way to support duplicated mechanisms. One solution is sufficient. |
| CATT | Support the proposal, and we prefer the Option 2 for all of the three main bullets, i.e., event-triggered reporting of update of the association information in order to reduce the overhead and latency. |
| Sony | Support the FL’s latest version, and our preference is option 1 (timer/periodicity based TEG update). |

## Parameters related to the maximum numbers of TEGs and UE capabilities

Background

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Agreement:  Support the following parameters and values related to the accuracy enhancement for mitigating UE Rx/Tx and/or gNB Rx/Tx timing errors:   |  |  |  |  | | --- | --- | --- | --- | | **Parameter Description** | **Values in specifications (e.g., TS 37.355, TS 38.455)** | **Values that can be signaled as part of UE Capability** | **Comments** | | The maximum number of UE RxTEGs [for UE-assisted DL TDOA and/or Multi-RTT] | [32] | [1, 2,4,6,8,12,16,24,32]  FFS: per UE/band /FL/FR | The parameter is used for supporting DL-TDOA and/or Multi-RTT | | The maximum number of UE TxTEGs [for UL-TDOA and/or Multi-RTT] | [8] | [1, 2,4,6,8]  FFS: per UE/band /FL/FR | The parameter is used for supporting UL-TDOA and/or Multi-RTT | | The maximum number of UE-RxTx TEGs | [256] | [1, 2,4,6,8,12,16,24,32,64, 128, 256]  FFS: per UE/band /FL/FR | The parameter is used for supporting Multi-RTT |   Note: Above Proposal does not constrain in any way how features and feature sets are defined. The values in the table above may or may not be signalled to be different for different features or feature sets. |

Submitted proposals

* ***(vivo, R1-2111013[3]) Proposal 1:*** *Support to expand the maximum number of RSTD measurements per TRP pair to 32.*
* ***(LGE, R1-211973[13]) Proposal 6:*** *RAN1 should consider extending the current maximum number of DL RSTD measurements per TRP.*
* ***(LGE, R1-211973[13]) Proposal 7:*** *Regarding the number of UE Rx TEGs (N), N=8 seems appropriate by considering the supported maximum number of Rx antennas at UE.*
* ***(LGE, R1-211973[13]) Proposal 8:*** *RAN1 should allow UE to report a smaller value of measurement results than the reported capability.*

FL: This seems to be the common understanding for all measurements.

* ***(Qualcomm, R1-2112217[16])Proposal 10:*** *With regards to the maximum number of TEGs:*
  + *Support a separate maximum number of RxTEGs for UE-assisted DL-TDOA, and M-RTT*
  + *Support a separate maximum number of TxTEGs for UE-assisted UL-TDOA, and M-RTT*
* ***(Qualcomm, R1-2112217[16])Proposal 11:*** *If a UE supports the RxTEG capability with a value > 1, if the UE does not include an RxTEG-ID associated with a measurement, no assumption can be made on the mitigation of UE Rx timing delays for this measurement.*
* ***(Qualcomm, R1-2112217[16])Proposal 12:*** *If a UE supports the RxTEG capability with a value=1, the UE Rx timing errors differences between two measurements are within a margin only if the UE reports an Rx-TEG-ID associated with the measurements, otherwise, no assumption can be made about the timing error differences between these measurements.*
* ***(Ericsson, R1-2112339[18]) Proposal 11:*** *The UE shall report the number of UE TX TEGs as part of UE capabilities.*

FL: This seems already covered in UE feature session.

FL Comments

Two companies [3][13] suggest increase the maximum number of RSTD measurements per TRP pair to 32 given that it was agreed to support measuring the same DL PRS with multiple UE Rx TEGs. Similar proposal was discussed in the previous meeting. The issue is how to determine the maximum number properly, e.g., based on the Rel-16’s maximum number of RSTD measurements, which is 4, and the maximum number of UE RX TEGs, which is [8].

### Proposal 3.5a (H)

Make the following modifications on the previous agreement in RAN1#106bis-e:

Support the following parameters and values related to the accuracy enhancement for mitigating UE Rx/Tx and/or gNB Rx/Tx timing errors:

|  |  |  |  |
| --- | --- | --- | --- |
| **Parameter Description** | **Values in specifications (e.g., TS 37.355, TS 38.455)** | **Values that can be signaled as part of UE Capability** | **Comments** |
| The maximum number of UE RxTEGs for UE-assisted DL TDOA | 32 | [2,4,6,8,12,16,24,32]  FFS: per UE/band /FL/FR | The parameter is used for supporting DL-TDOA |
| The maximum number of UE RxTEGs for Multi-RTT | 32 | [2,4,6,8,12,16,24,32]  FFS: per UE/band /FL/FR | The parameter is used for supporting Multi-RTT |
| The maximum number of UE TxTEGs for UL-RTOA | 8 | [2,4,6,8]  FFS: per UE/band /FL/FR | The parameter is used for supporting UL-TDOA |
| The maximum number of UE-RxTx TEGs | 256 | [2,4,6,8,12,16,24,32,64, 128, 256]  FFS: per UE/band /FL/FR | The parameter is used for supporting Multi-RTT |
| The maximum number of UE TxTEGs for Multi-RTT | 8 | [2,4,6,8]  FFS: per UE/band /FL/FR | The parameter is used for supporting Multi-RTT |

**Note:** Above proposal does not constrain in any way how features and feature sets are defined. The values in the table above may or may not be signalled to be different for different features or feature sets.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | 1. We prefer the TEG capability is per band. And the candidate value of RxTEGs is the same as proposal 3.3 a. So, the candidate values of ‘Maximum number of Rx TEGs for UE-assisted DL-TDOA’ should be modified to [1,2,3,4,6,8] and the values in specification should be changed to 8. Correspondindly, the values for RxTx TEGs in specification should be changed to 64.  2. To define the maximum number per method is redundant since the capability is independent of the methods |
| Ericsson | We share the concern with vivo. We do not agree that the maximum number of UE Rx TEGs should be method specific. So the 2nd row is not needed. |
| CATT | Support. |
| Nokia/NSB | Not sure that this is a high priority topic. |
| Qualcomm | TO E//: For UTDOA/RTT, there needs to be separate capability because different signaling is specified for each one. We cannot assume that a UE supporting reporting of TEGs in RRC, will also do that in LPP, or vice versa.  For DLTDOA/RTT, a UE, in RTT, may only report RxTxTEG, and not RxTEGs, as it has been agreed. And actually we consider it a reasonable implementation for a UE to support RxTEG for DL-TDOA and RxTxTEGs for RTT (and not RxTEG for RTT, since RxTEG doesn’t provide what is really needed to mitigate the timing errors in RTT). |
| Huawei, HiSilicon | No need discuss capability.  For the maximum number supported in the RRC/LPP (not NRPPa), we prefer to clarify that the number is counted per UE, and so in general we are fine with the second column. |
| OPPO | We should make decision on “per UE/band /FL/FR” firstly. Then, we can further discuss on the value. |
| Samsung | Seems fine. |
| Intel | This is not a high priority for us now. We believe that it can be discussed under UE capability agenda. |
| ZTE | Agree with Ericsson. And we think UE capability is per band. |
| LGE | Agree. |

Proposal 3.5b (H)

* *Increase the maximum number of reported RSTD measurements per TRP pair from 4 to N(>4).*
  + *FFS: N=[32]*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support the intention, but we prefer up to 4 RSTD measurements(4 PRS resources) are chosen to be reported in the RSTD measurement, where each RSTD measurement can have multiple values associated with its Rx TEG |
| ericsson | Support. Could alternatively be formulated as:   * The maximum number of reported RSTD measurements per UE RX TEG is 4. * Signaling details left to RAN2 to decide |
| CATT | Support.  For the value of N, we prefer N=32, since Rel-16’s maximum number of RSTD measurements is 4, and the maximum number of UE RX TEGs is 8. |
| Nokia/NSB | Okay. |
| Qualcomm | We prefer the proposal from E//. |
| Huawei, HiSilicon | Ok with either the original one or the Ericsson’s proposal. |
| OPPO | Ericsson’s proposl is more aligned with the intention. |
| Samsung | E///’s version is fine. |
| Intel | OK with Ericsson’s version |
| ZTE | The proposal may be related to multiple measurement instances in Proposal 5-5. We can come back later after we agree the maximum number of measurement instances can be supported in a measurement report. |
| LGE | We are fine with both FL’s proposal and Ericsson’s revision. |

FL Comments

The proposal is revised with the consideration of Ericsson’s proposal, which seems to be preferred by the majority companies. Based on the previous agreement, we have “*N=[2, 3, 4, 6, 8]”,* maybe we should say *“The maximum number of reported RSTD measurements per UE RX TEG is 8”.* In addition, we may also need to cover the other TRP/UE measurements.

### (Round 2) Proposal 3.5b (H)

* *The maximum number of reported RSTD measurements per UE Rx TEG is 8.*
* *The maximum number of reported RTOA measurements per TRP Rx TEG is 8.*
* *The maximum number of reported UE Rx-Tx time difference measurements per UE Rx TEG is 8.*
* *The maximum number of reported TRP Rx-Tx time difference measurements per UE Rx TEG is 8.*
* *FFS: The maximum number of reported UE Rx-Tx time difference measurements per UE RxTx TEG is 8.*
* *FFS: The maximum number of reported TRP Rx-Tx time difference measurements per UE RxTx TEG is 8.*
* *Signaling details left to RAN2 to decide*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| ZTE | At least at UE side, we should explicitly mention that the maximum number is per TRP or per TRP pair. Which should be similar to the parameters in 37.355,  maxDL-PRS-RSTD-MeasurementsPerTRPPair  This field specifies the maximum number of. DL-PRS RSTD measurements per pair of TRPs. The maximum number is defined across all Positioning Frequency Layers.  maxDL-PRS-RxTxTimeDiffMeasPerTRP  This field specifies the maximum number of UE-Rx-Tx time difference measurements for different DL-PRS Resources or DL-PRS Resource Sets per TRP.  For example,   * *The maximum number of reported RSTD measurements* ***per TRP and*** *per UE Rx TEG is 8.*   + *The TRP can be either RSTD reference TRP or neighbor TRP* * *The maximum number of reported UE Rx-Tx time difference measurements* ***per TRP and*** *per UE Rx TEG is 8.*   In addition, we’re not quite sure whether the maximum number may have dependency on the Proposal 5-3 (FFS: Maximum number of measurement instances in a single measurement report). One question is that, the maximum number is total number across all measurement instances? |
| Huawei, HiSilicon | We do not understand why the original 4 proposed by Ericsson was changed to 8 in the FL update.  My understanding is that the intention is to align with Rel-16 that 4 TOA per TRP is now changed to per 4 TOA per Rx TEG, and the number of TOA per TRP can be further multiplied by the number of Rx TEGs per target resource.  Total number = Number of Rx TEGs per resource times number of resources per Rx TEG  The yellow one is dealt with in the proposals in 3.3, while the cyan one is dealt with under this proposal. Please FL check if my understanding is correct.  In addition, we proposal to change the wording to avoid the same controversy as in the Rel-16 spec. Some typos also corrected.   * *The maximum number of reported RSTD measurements per UE Rx TEG for a measured TRP is 4.* * *The maximum number of reported RTOA measurements per TRP Rx TEG for the measured SRS resources is 4.* * *The maximum number of reported UE Rx-Tx time difference measurements per UE Rx TEG for a measured TRP is 4.* * *The maximum number of reported TRP Rx-Tx time difference measurements per TRP Rx TEG for the measured SRS resource is 4.* * *FFS: The maximum number of reported UE Rx-Tx time difference measurements per UE RxTx TEG for a measured TRP is 8.* * *FFS: The maximum number of reported TRP Rx-Tx time difference measurements per TRP RxTx TEG for the measured positioning SRS resources is 8.* * *Signaling details left to RAN2 to decide* |
| Qualcomm | Same understanding with HW that the “4” has to remain. There is a “8” in the last 2 FFS. Which, btw, why are these FFS? |
| vivo | Assuming that the UE has an Rx TEG, based on this Rx TEG, the UE should report 4 RSTD measurements instead of 8. Therefore, per UE Rx TEG, at most 4 RSTD measurements can be reported.  However, we don’t think this proposal reflect the understanding of FL. We think the following is better.   * *The maximum number of reported RSTD measurements with different UE Rx TEGs for the same PRS resource ~~per UE Rx TEG~~ is 8.* * *The maximum number of reported RTOA measurements with different TRP Rx TEGs for the same SRS resource ~~per TRP Rx TEG~~ is 8.* * *The maximum number of reported UE Rx-Tx time difference measurements with different UE Rx TEGs for the same PRS resource ~~per UE Rx TEG~~ is 8.* * *The maximum number of reported TRP Rx-Tx time difference measurements with different TRP Rx TEGs for the same SRS resource ~~per UE Rx TEG~~ is 8.* * *FFS: The maximum number of reported UE Rx-Tx time difference measurements with different UE RxTx TEGs for the same PRS resource ~~per UE RxTx TEG~~ is 8.* * *FFS: The maximum number of reported TRP Rx-Tx time difference measurements with different TRP RxTx TEGs for the same SRS resource ~~per UE RxTx TEG~~ is 8.* * *Signaling details left to RAN2 to decide* |
| Huawei, HiSilicon | We think the proposal from vivo is duplicated from the discussion in previous sections, and does not address the issue intended for this section. |
| OPPO | The value of “8” should be 4. |

## Configuration of UE TX TEG association

FL Comments

* ***(InterDigital, R1-2111797[11]) Proposal 1:*** *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.*
* ***(Ericsson, R1-2112339[18]) Proposal 7:*** *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.*
* ***(Ericsson, R1-2112339[18]) Proposal 10:*** *Support UE TX TEG sweeping over SRS resources for positioning in a SRS resource set configuration.*
* ***(Ericsson, R1-2112339[18]) Proposal 12:*** *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*
* ***(EricssonProposl 13:*** *For UL-TDOA positioning, support LMF to request a gNB to report RTOA measurements separately for each SRS resource in an SRS resource set.*

FL Comments

In [11] and [18], it is proposed to configure 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, which allows the TRP uses the same Rx TEG to receive the UL SRS positioning signals, then it may potentially allow the LMF to obtain the time differences between UE Tx TEGs from the UL RTOA measurements.

Similar proposals were discussed in the previous meeting [19], but only few companies provided the comments, and it seems the majority of the feedbacks were not supportive. We would need more inputs from interested companies to above proposals to see if we need to have a further discussion on above proposals in this meeting.

### Proposal 3.6

* *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.*
* *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.*
* *Support UE TX TEG sweeping over SRS resources for positioning in a SRS resource set configuration.*
* *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*
* *For UL-TDOA positioning, support LMF to request a gNB to report RTOA measurements separately for each SRS resource in an SRS resource set.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support. |
| Ericsson | UE TX TEG sweeping or ‘configuration of UE TX TEG restriction’ is necessary to achieve full timing error mitigation for UL TDOA and multi-RTT (as shown by the simulation results attached). This is the main missing ingredient and should have **high priority!**    Figure 1 Utilization of UE antenna panel (or UE TX TEG) info is seen to give a very big improvement but still fails to fully mitigate the UE TX timing errors and to fulfill Rel. 17 positioning accuracy requirements in the InF-SH scenario. However, the combination of two techniques, 1) utilization of UE antenna panel (or UE TX TEG) info, and 2) sequential transmission of one UL SRS from each UE antenna panel towards the same TRP, result in complete mitigation of the UE TX timing errors and fulfillment of Rel. 17 positioning accuracy requirements.  UE TX beamsweeping is already supported in Rel. 16 by the SRS resource set structure, where the SRS resources in a SRS resource set correspond to different UE TX beams. This structure could be reused for this purpose. Only two things are needed:  1. UE reporting of the number of UE TX TEGs  2. An SRS configuration bit indicating that the UE should use the configured SRS resources for TEG sweeping  We would ideally like to see some more features in this area but since time is limited, let’s limit ourselves to what is critically necessary.  Proposal:   * Support gNB to configure the UE to transmit each SRS resource in an SRS resource set for positioning with a different UE TX TEG. * Support UE to report the number of UE TX TEGs to the LMF [FFS if this is made as part of UE capabilities]   We note that Huawei is proposing antenna switching. We believe this is just another name for the same thing.The nomenclature is not critical to us. In the proposal above we avoided the use of either ‘antenna switching’ or ‘TEG sweeping’ nomenclature. |
| InterDigital | Support. In our view, supporting the UE to sweep Tx TEGs is beneficial for LMF to aware of the Tx TEGs differences among different Tx TEGs. |
| Huawei, HiSilicon | We support the following bullets from Ericsson’s proposal. On the UE capabilities, it can be discussed over another thread.   * Support gNB to configure the UE to transmit each SRS resource in an SRS resource set for positioning with a different UE TX TEG. |
| ZTE | Don’t support. The association of TEG to SRS is totally left up for UE implementation. |
| **FL** | From the feedback of the 5 companies of the 1st round discussion, two companies support the proposals, and two companies do not support the proposals, while one company supports one of the proposals. It seems further discussion are needed on whether we can support one or more these proposals. |

## Report of the SRS port IDs with the RTOA measurements

Submitted Proposals

* ***(Huawei, R1-2110850[1]) Proposal 1:*** *Support gNB to report the associated SRS port ID of the RTOA measurement along with the SRS resource ID/resource set ID, when the measurements are based on multi-port SRS (e.g. MIMO-SRS).*
  + *The port index may take the value {0, 1, 2, 3} to map to the SRS ports {1000, 1001, 1002, 1003}, respectively.*
  + *Note: The use of SRS for MIMO resource is transparent to the UE*

Comments

In RAN1#105e, it was agreed “*Support gNB to report the associated SRS resource ID/resource set ID of the RTOA measurement to LMF”.* For MIMO SRS, the SRS signals can be transmitted in different ports. In [1], it was proposed to support gNB to report the associated SRS port ID of the RTOA measurement for improving the positioning performance. The proposed enhancement seems having no impact on UE.

A similar proposal was discussed in previous meetings, but only few companies provided the comments in the email discussions. During the discussion in RAN1#106bis-e, two companies provided the responses: one company supported it, while another company considered it was low priority for RAN1#106bis-e [19]. We would need more inputs from interested companies to the above proposal to see if we could adopt the proposed enhancement given that it seems having no impact on UE side.

### Proposal 3.7

* *Support gNB to report the associated SRS port ID of the RTOA measurement along with the SRS resource ID/resource set ID, when the measurements are based on multi-port SRS (e.g. MIMO-SRS).*
  + *The port index may take the value {0, 1, 2, 3} to map to the SRS ports {1000, 1001, 1002, 1003}, respectively.*
  + *Note: The use of SRS for MIMO resource is transparent to the UE*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support. |
| Huawei, HiSilicon | We consider this feature useful with only small specification impact, by adding a single higher layer parameter in the measurement report.  Is there any technical concern? |
| **FL** | Only two companies provided the feedback in the 1st round discussion. We would need more inputs from interested companies to see if we could adopt the proposed enhancement. |

## Positioning SRS with antenna/beam switching

Submitted Proposals

* ***(Huawei, R1-2110850[1]) Proposal 2:*** *Support positioning SRS with antenna switching as an optional UE capability.*
  + *Introduce a new parameter for the positioning SRS resource set indicating "antenna switching", and each positioning SRS resource in the set is associated with a different UE antenna port.*
  + *Introduce a new UE capability of antenna switching for positioning SRS resource, indicating*
    - *The number of positioning SRS resources in the positioning SRS resource set configured with "antenna switching"*
    - *The switching period follows the existing MIMO SRS antenna switching (15us as per R1-1710048).*
* ***(Ericsson, R1-2112339[18]) Proposal 14****: 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 Comments

In [1], it was proposed to support positioning SRS with antenna switching as an optional UE capability. In [18], it was proposed to support UE TX TEG and beam sweeping. Similar proposals were discussed in the previous meetings [19], but only few companies provided the comments. We would need more inputs from interested companies to the proposals to see if we need to have a further discussion on above proposals in this meeting.

### Proposal 3.8

* *Support positioning SRS with antenna switching as an optional UE capability.*
  + *Introduce a new parameter for the positioning SRS resource set indicating "antenna switching", and each positioning SRS resource in the set is associated with a different UE antenna port.*
  + *Introduce a new UE capability of antenna switching for positioning SRS resource, indicating*
  + *The number of positioning SRS resources in the positioning SRS resource set configured with "antenna switching"*
  + *The switching period follows the existing MIMO SRS antenna switching (15us as per R1-1710048).*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support. |
| Ericsson | We think this is an alternative way of formulating UE TX TEG sweeping (see proposal 3.6). We think, however, that the connection to UE TX TEGs needs to be defined, as in the revised proposal below:   * + *Introduce a new parameter for the positioning SRS resource set indicating "antenna switching", and each positioning SRS resource in the set is associated with a different UE antenna port.*   + *Introduce a new UE capability of antenna switching for positioning SRS resource, indicating the number of UE TX TEGs.*   + *The number of positioning SRS resources in the positioning SRS resource set configured with "antenna switching" should be equal to the number of UE TX TEGs indicated in UE capabilities*   + *The UE should transmit each SRS resource in in the positioning SRS resource set configured with "antenna switching" with a different UE TX TEG*   + *The switching period follows the existing MIMO SRS antenna switching (15us as per R1-1710048).* |
| Huawei, HiSilicon | OK. |
| **FL** | Only three companies provided the feedback in the 1st round discussion. We would need more inputs from interested companies to see if we could adopt the proposed enhancement. |

## Association of UE Tx TEGs with the MIMO SRS

Submitted Proposals

* ***(OPPO, R1-2111289[5]) Proposal 1:*** *Rel-17 doesn’t support the association of TEG with MIMO SRS port(s).*
* ***(Ericsson, R1-2112339[18]) Proposal 6****: 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 [19]. Given that only two companies have discussed the issue, and one proposes not to support *TEG with MIMO SRS port*, FL would suggest: “*no further discussion on the association of UE Tx TEG with MIMO SRS in Rel-17*”.

### (Closed) Proposal 3.9

* *No further discussion on the support the association of TEG with MIMO SRS.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Support the proposed conclusion. |
| OPPO | Support |
| ZTE | OK |
| **FL** | Based on the feedback of the 1st round discussion, suggest no further discussion on the topic in this meeting. I assume there is no need to have formal conclusion. |

## Reporting of UE Rx/Tx/RxTx TEG IDs with Rx-Tx time difference measurements

Background

|  |
| --- |
| Agreement (RAN1#104bis-e)  For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support one of the following alternatives:   * Alt.1: Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a pair of {Rx TEG, Tx TEG} to LMF, where the Rx TEG is used to receive the DL PRS and the Tx TEG is used to transmit the UL Positioning SRS; * Alt.2: Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF according to one of the 2 following options:   + Option 1: the UE RxTx TEG is associated with one or more {DL PRS resource, UL Positioning SRS resource} pairs     - FFS: whether UE provides the association information of DL PRS resources to UE Rx TEG to LMF for UE RxTx measurements specifically   + Option 2: the UE RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs where the Rx TEG is used to receive the DL PRS and the Tx TEG is used to transmit the UL Positioning SRS. * For both alternatives, the UE may provide the association information of SRS resources for positioning to UE Tx TEG to LMF   + FFS: Whether the association information is sent directly from UE to LMF, or is first provided to gNB and then forwarded to LMF * FFS: the details of the signalling, procedures, and UE capability   Agreement: (RAN1#104bis-e)   * For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support one of the following alternatives:   + Alt.1: Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a pair of {Rx TEG, Tx TEG} to LMF   + Alt. 2: Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a TRP RxTx TEG to LMF, if the TRP has multiple RxTx TEGs, according to one of the 2 following options:     - Option 1: the TRP RxTx TEG is associated with one or more {DL PRS resource, UL Positioning SRS resource} pairs       * FFS: whether gNB provides the association information of UL Positioning SRS resources to TRP Rx TEG to LMF, if the TRP has multiple Rx TEGs, for gNB RxTx measurements specifically     - Option 2: the TRP RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs where the Rx TEG is used to receive the UL Positioning SRS and the Tx TEG is used to transmit the DL PRS.   + For both alternatives, the gNB may provide the association information of DL PRS resources to TRP Tx TEG to LMF if the TRP has multiple Tx TEGs. * FFS: the details of the signalling, procedures   Agreement: (RAN1#105e)  For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, 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 RxTx TEG IDs are related/associated to Tx TEG IDs and/or Rx TEG IDs and to the Rx-Tx measurements. * Option 2: Reporting of UE RxTx TEG ID is not supported by the UE; reporting of Rx TEG ID and Tx TEG ID is supported. * In either option, a Tx TEG ID is associated with (downselection needed)   + Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement   + Alt. 2: the Tx timing of the Rx-Tx measurement   + Alt. 3: one or more UL SRS resources for positioning * Note: An 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 the 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: (RAN1#106bis-e)  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: (RAN1#106bis-e)   * 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 the association of the Tx TEG ID to the UL SRS resource(s) is determined by UE.   + FFS: details of the signalling   Agreement: (RAN1#106bis-e)   * + 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 Proposals

* ***(ZTE, R1-2110956[2]) Proposal 6****: When a UE Tx TEG ID is reported along with UE Rx-Tx time difference measurement, the UE Tx TEG ID corresponds to the Tx timing of the UE Rx-Tx time difference measurement.*
* ***(vivo, R1-2111013[3]) Proposal 7:*** *Regarding association information of Tx TEG for mitigating UE Tx/Rx timing errors in DL+UL positioning, support Alt.3: a Tx TEG ID is associated with one or more UL SRS resources for positioning.*
* ***(vivo, R1-2111013[3]) Proposal 8:*** *For mitigating UE Rx/Tx timing errors for DL+UL positioning, up to UE capability, the following should be supported.*
  + *UE providing the association information of UE Rx TEG(s) with each UE Rx-Tx time difference measurements to LMF.*
  + *UE providing the association information of UE Tx TEG(s) with all UL Positioning SRS resources to LMF.*
  + *UE providing the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs to LMF.*
* ***(OPPO, R1-2111289[5]) Proposal 7:*** *For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, a Tx TEG ID is associated with an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement (Alt.1).*
* ***(Intel, R1-2111495[8])Proposal 1:*** *Support reporting of the UE TX TEG ID and the UE RX TEG ID associated with the UE Rx-Tx time difference measurements, where:*
  + *The UE TX TEG ID is associated with the UL SRS Resource for positioning corresponding to the TX timing of the UE Rx-Tx time difference measurement*
  + *The UE RX TEG ID is associated with one DL PRS Resource (or more DL PRS Resources) corresponding to the RX time of the measurement*
* *(Intel, R1-2111495[8])Proposal 2: Support reporting of the TRP Tx TEG ID and the TRP Rx TEG ID associated with the gNB Rx-Tx time difference measurements, where:*
  + *The TRP Tx TEG ID is associated with the DL PRS Resource corresponding to the Tx timing of the gNB Rx-Tx time difference measurement*
  + *The association of the TRP TX TEG ID to the DL PRS Resource is performed prior to the RTT measurement and then shared with LMF using TRP information exchange, i.e., using TRP information request and TRP information response messages*
* ***(Samsung, R1-2111738[10])Proposal 1:*** *Both options for UE TEG reporting (i.e., reporting the UE RxTx TEG ID or reporting both UE Rx TEG ID and UE Tx TEG ID) are supported for DL+UL positioning subject to the UE capability.*
* ***(Samsung, R1-2111738[10])Proposal 2:*** *For the reporting of UE Tx TEG in DL+UL positioning, a Tx TEG ID is associated with an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement.*

**FL:** Further discussion in Proposal 3.3-1.

FL Comments

In the previous agreement, it includes three alternatives related to the Tx TEG ID association for the down-selection. The feedbacks in this meeting may be summarized as follows:

* A Tx TEG ID is associated with
  + Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement

**Supported by**: OPPO, Intel, Samsung

* + Alt. 2: the Tx timing of the Rx-Tx time difference measurement

**Supported by**: ZTE

* + Alt. 3: one or more UL SRS resources for positioning

**Supported by**: vivo

From the agreement of UE Tx TEG definition made in RAN1#104-e, a UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing errors within a certain margin. Thus, it is clear that a Tx TEG ID is associated with one or more UL SRS resources for positioning. In addition, based on the definition of the UE Rx – Tx time difference TUE-RX –TUE-TX, the TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i received from the TP. Therefore, if we want to further clarify the association of the Tx TEG ID of a Rx-Tx measurement, we may say that:

* *A Tx TEG ID of a Rx-Tx measurement is an identity of an Tx TEG, which can be associated with one or more UL SRS resources. The TUE-TX of the Rx-Tx measurement is determined by the UE transmit timing of a uplink subframe that contains at least one of the UL SRS resources for positioning of the UE Tx TEG.*

### Proposal 3.10

* *A Tx TEG ID of a UE Rx-Tx time difference measurement is the identity of an UE Tx TEG, which can be associated with one or more UL SRS resources. The TUE-TX of the Rx-Tx time difference measurement is determined by the UE transmit timing of a uplink subframe that contains at least one of the UL SRS resources for positioning of the UE Tx TEG.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We can not agree with the proposal, it seems to transmit timing of an uplink subframe contains to UL SRS timing so that “*TUE-TX* ” is different from Rel-16.  We are okay with the following two options   * *Alt 2: A Tx TEG ID of a UE Rx-Tx time difference measurement is associated with* TUE-TX (TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i received from the TP) * *Alt 3:* A Tx TEG ID is associated with one or more UL SRS resources for positioning   FL: The issue here is that we will need to define how the UE determines the Tx TEG ID for a UE Rx-Tx measurement. Let us assume there is no SRS transmission at that UL subframe #j, and the transmissions of two SRS resources with different Tx TEGs (Tx TEG ID1 and Tx TEG ID2) in the UL subframe #j+1. Then, by the current definition, “the transmit timing of the UE Rx-Tx time difference is defined by the UL subframe #j closest in time to the subframe #i received from the TP”, the TUE-TX is not related to either of the SRS resources. Then, the question is, which Tx TEG ID should be reported with the UE Rx-Tx time difference measurement? |
| Nokia/NSB | We are okay with the proposal and would like to highlight that how the UE reports this information (e.g., with UE Rx-Tx time difference report) is a critical step for us to complete this topic for Rel-17. |
| Ericsson | We can’t agree to this proposal. The transmit timing of the UE Rx-Tx time difference is defined by the UL subframe #j closest in time to the subframe #i received from the TP. We are fine with  Alt. 3 A Tx TEG ID is associated with one or more UL SRS resources for positioning  FL: Similar question as my response to vivo’s comments. |
| OPPO | One question for FL proposal and Alt.3. If the Tx TEG ID is associated with more than one SRS resources, what’s the consequence if these SRS resources are with different UL Tx TEGs? Or will RAN1 introduce another restriction that all these SRS resources should be with the same Tx TEGs? If such restriction is introduced, what’s the difference compared to Alt1?  FL: My understanding is that one SRS resource should not be associated with more than one Tx TEG at the same time. For Alt.3, I assume the assumptions from the proponents is that the “one or more UL SRS resources for positioning” belongs to the same Tx TEG. I assume the companies that prefer Alt.3 does not want to tight the TUE-TX  with SRS resources as commented by vivo and Ericsson. |
| ZTE | We support Alt.2,   * + Alt. 2: the   According to the definition of UE Rx-Tx time difference in TS 38.215, the Tx timing is the Tx connector/antenna of the UE, which means the Tx timing already include the timing error from BB to antenna.  FL: Agree.  Technically, UE may compensate a group delay in the Tx timing at BB, where timing error left after the compensated group delay is within the same margin as the timing error for the associated TEG ID.  FL: With above argument, I assume the Tx TEG ID should be associated with Tx timing errors (or error margin) of the Rx-Tx time difference measurement instead of a particular Tx timing.   |  | | --- | | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX  Where:  TUE-RX is the UE received timing of downlink subframe #*i* from a Transmission Point (TP) [18], defined by the first detected path in time.  TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the TP.  Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the TP.  For frequency range 1, the reference point for TUE-RX measurement shall be the Rx antenna connector of the UE and the reference point for TUE-TX measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for TUE‑RX measurement shall be the Rx antenna of the UE and the reference point for TUE‑TX measurement shall be the Tx antenna of the UE. | |
| CATT | Support.  And we prefer Alt.3 (A Tx TEG ID is associated with one or more UL SRS resources for positioning). |
| **FL** | **Questions to all:**  Instead of making a selection from the three alternatives, which seems we still diverged views, I am wondering if we can simply say the following to resolve the issue:  ***• Alt. 4: A UE Tx TEG ID associated with a UE Rx-Tx measurement indicates the Tx timing error margin of the UE Rx-Tx measurement.*** |

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

Background

|  |
| --- |
| **Agreement (RAN1#106e)**   * Consider supporting one of the following alternatives related to the UE Rx-Tx time difference (decision to be made in RAN1#106b):   + Option 1:     - Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.     - Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):       * If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.   + Option 2:     - Subject to a UE capability, a UE may optionally report Timing Adjustment (TA) change information       * Option 3A: The TA change information is included in the UE Tx TEG report       * Option 3B: The TA change information is included in the Rx-Tx measurement report       * Note: TA change information corresponds to: Tx Timing change with a timestamp that this change occurred.   + Option 3:     - Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.     - Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):       * If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it is up to UE to compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS, or include the difference (Timing Adjustment change) without compensation within the report   + Other options are not precluded. |

Submitted proposals

* ***(ZTE, R1-2110956[2]) Proposal 5:*** *Subject to a UE capability, a UE may optionally report Timing Adjustment (TA) change information*
  + *The TA change information is included in the UE Rx-Tx measurement report*
  + *Note: TA change information corresponds to: Tx Timing change with a time stamp that this change occurred.*
* ***(vivo, R1-2111013[3])Proposal 6:*** 
  + *Support Option 2 related to the UE Rx-Tx time difference with the following modifications.*

|  |
| --- |
| Option 2:   * + - Subject to a UE capability, a UE may optionally report Timing Adjustment (TA) change information       * ~~Option 2A:~~ The TA change information is included in the UE Tx TEG report       * ~~Option 2B: The TA change information is included in the Rx-Tx measurement report~~       * Note: TA change information corresponds to: Tx Timing change with a timestamp that this change occurred. |

* + *If no consensus can be made about this topic, conclude not to specify it in Rel-17.*
* ***(CATT, R1-2111256[4]) Proposal 4:*** *Supporting the following Option 4 related to the UE Rx-Tx time difference:*
  + *Option 4:* 
    - *Subject to UE capability, the UE may report an UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS, instead of original DL Timestamp.*
    - *The nr-TimeStamp field in the IE NR-Multi-RTT-SignalMeasurementInformation in LPP should be redefined to specify the time instance for the uplink subframe of a positioning SRS related to the Tx time of the UE Rx-Tx measurement, instead of the original time instance for which the measurement is performed, related to the Rx time of the UE Rx-Tx measurement*
    - *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):*
    - *If the UE does not transmit SRS in subframe #j, and if the UE reports a timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* *(****CATT, R1-2111256[4]) Proposal 5****: When the UE uses the multiple samples of UE Rx-Tx time difference to calculate the measured value of UE Rx-Tx time difference, the UE should be expected that the transmit timing of SRS-Pos corresponding to all the samples used to calculate one UE Rx-Tx time difference measurement report or one UE Rx-Tx time difference measurement instance, should be subject to either no timing adjustment, or the same timing adjustment.*
* ***(OPPO, R1-2111289[5]) Proposal 6****: Among the three options regarding the UE Rx-Tx time difference, support Option 1, i.e.,*
  + *Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.*
  + *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):* 
    - *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(Nokia, R1- 2111364[6]) Proposal 11:*** *Do not discuss the UE Rx-Tx time difference measurement definition options further in RAN1.*
* ***(CMCC, R1-2111609[9])*** *Proposal 3: Support Option 1 related to the UE Rx-Tx time difference:*
  + *Option 1:* 
    - *Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.*
    - *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):* 
      * *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(Samsung, R1-2111738[10])Proposal 3****:* 
  + *UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS*
  + *Add the following to the UE Rx-Tx time difference definition:*
  + *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(LGE, R1-211973[13]) Proposal 3:*** *Regarding TA change for UL positioning measurement, RAN1 should support option 2(reporting Timing Adjustment (TA) change information) to enhance Multi-RTT accuracy enhancement.*
* ***(LGE, R1-211973[13]) Proposal 4:*** *If reporting TA change information from UE is supported, RAN1 needs to consider the measurement report as conveying the TA change information.*
* ***(LGE, R1-211973[13]) Proposal 5:*** *To solve the differentiation problem from TA changes, consider introducing time duration (or window) where UE applies fixed TA.*
* ***(MTK, R1-2112071[14]) Proposal 2-1****: Support UE to report TX timing change information, not to compensate it within the UE report*
* ***Qualcomm, R1-2112217[16])Proposal 1:*** *For the purpose of enhancing the accuracy of RTT method, support Option 1.*
* ***(Ericsson, R1-2112339[18]) Proposal 18:*** *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, R1-2112339[18]) Proposal 19:*** *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

The feedbacks for the options may be summarised as follows:

* Option 1:
  + Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.
  + Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):
    - If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.

***Supported by:*** *CATT (with a suggestion on the modification of the timestamp), OPPO, CMCC, Samsung, Qualcomm,*

*Intel,*

* Option 2:
  + Subject to a UE capability, a UE may optionally report Timing Adjustment (TA) change information

***Supported by:*** *ZTE, vivo, LGE, MTK, Ericsson*

* + - Option 2A: The TA change information is included in the UE Tx TEG report
    - Option 2B: The TA change information is included in the Rx-Tx measurement report
    - Note: TA change information corresponds to: Tx Timing change with a timestamp that this change occurred.

One company (vivo) proposes that if no consensus can be made about this topic, conclude not to specify it in Rel-17, and one company (Nokia) proposed no further discussion in RAN1.

Significant efforts have been spent on the previous two meetings on the issue [19]. From the online/offline discussions in the previous meetings and the contributions submitted in this meeting, it seems that for each of these the options, there are still serious concerns by multiple companies, and possibility of reaching the consensus of accepting either or both of the options are very slim. Based on the consideration that we have many other high-priority issues that need to be resolved for the WI completion in this meeting, 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 would suggest making a conclusion that no further discussion of this topic in Rel-17.

### Proposal 3.11 (for conclusion)

* *No further discussion on the options for the mortification of the UE Rx-Tx time difference measurement definition in RAN1.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support |
| Ericsson | In our contribution we have made a compromise proposal caturing components both from option 1 and option 2. It would be nice to hear companies view on this.  The new proposal is based on compensation terms for time intervals between a DL PRS and an UL SRS as in option 1. TA changes at discrete points in time are not reported. The compensation term may consist both of TA changes and clock drifts during the time interval (exactly as in option 1).  The UE Rx-Tx measurements are, however, not compensated with the compensation term by the UE. Instead the compensation terms are sent separately in the same multi-RTT report as the UE Rx-Tx measurement. This separation is similar to the way TA changes are sent in option 2. It allows for sending multiple compensation terms for different UL SRS resources giving the LMF the possibility to match gNB Rx-Tx measurements, UE Rx-Tx measurements and compensation terms correctly.  The proposal looks as follows:  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.** |
| Nokia/NSB | Do not support further discussion on this topic. It was clear from the agreement that a decision was supposed to be reached at RAN1#106-b. However, no agreement was reached so we should drop this topic in our view. There are many open issues related to TEG which need to be resolved at this meeting and we feel that this issue should be dropped. |
| MTK | First we need to clarify what is the compensation term. As we mention in contribution, the time drift (relative SFO) causes UE TX and RX symbol boundary to be shifted. So when UE is aware that there is timing shift (through TRS from serving), UE will adjust its TX and RX symbol boundary. So, TA doesn't change because TA is the relatve time difference between TX and RX boundary, but TX timing is changed.  We consider to modify option 2 as TX timing change, then this is the compensation term in option 1. And the compensation term is additionally provided, not to be added within the UE RX-TX time difference. We already explain and show figure in our contribution.  To FL: our suggestion of change TA to TX timing change seems not be captured by you.. ☺  FL: I assume “TX timing change” could be a better wording. |
| OPPO | We prefer Option 1, and are also fine with FL proposal. |
| ZTE | Support the conclusion. |
| CATT | Support the FL proposal to no further discuss this issue, since it seems that we cannot reach the consensus on this topic at this meeting. |
| **FL** | From the feedback of the 1st round discussion, it seems 5 companies support the proposal of no further discussion on this topic, 2 companies provide further discussions/suggestions. It seems it is unlikely to reach the consensus for changing the definition of the UE Rx-Tx time difference measurement.  Without changing the definition of the UE Rx-Tx time difference measurement definition, I am wondering if companies are willing to support one of the following:  ***Alt. 1: Adding a second timestamp for the UE Rx-Tx time difference measurement, which is the starting time of 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.***  ***Alt. 2: Redefine the timestamp for the UE Rx-Tx time difference measurement as the starting time of 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.*** |

## Reporting of uncertainties of a Rx/Tx/RxTx TEGs

Submitted Proposals

* ***(Nokia, R1- 2111364[6]) Proposal 2:*** *RAN1 should prioritize discussion on the basic phases of the TEG concept: TEG declaration and TEG association.*
* ***(Nokia, R1- 2111364[6]) Proposal 3:*** *The UE should signal to the LMF as part of UE capability the certain margins associated with each TEG. FFS: possible values for certain margins.*
* ***(Nokia, R1- 2111364[6]) Proposal 4:*** *The TRP should signal to the LMF as part of TRP information reporting the certain margins associated with each TEG. FFS: possible values for certain margins.*
* ***(Qualcomm, R1-2112217[16])Proposal 9:*** *For mitigating timing errors, support the following timing error margin reporting:* 
  + *In DL-TDOA,*
    - *Subject to the UE capability, support LMF to request a UE to provide the timing error margin associated with a UE Rx TEG.*
    - *Support a TRP to provide the timing error margin associated with a TRP Tx TEG*
  + *In UL-TDOA,*
    - *Subject to the UE capability, support LMF to request a UE to provide the timing error margin associated with a UE Tx TEG.*
    - *Support a TRP to provide the timing error margin associated with a TRP Rx TEG*
  + *In DL+UL Positioning,* 
    - *Subject to UE capability, support LMF to request a UE to provide the timing error margin associated with a UE Rx/Tx/RxTx TEG*
    - *Support a TRP to provide the timing error margins associated with a TRP Rx/Tx/RxTx TEG*

FL comments

In [6][16], it was proposed to support the UE/gNB to report the error margins associated with TEGs*.* The information can be useful for LMF in estimating UE position with the reported measurements. There may need to have different capabilities to support the reporting of the error margins associated with Rx TEGs, Tx TEGs, or RxTxTEGs if the proposals are agreeable.

Similar proposals were discussed in the previous meetings. In previous discussions, only few companies provided the comments. Some companies commented that RAN4 is also discussing the issue. In FL’s opinion, it would be better that RAN1 can make the decision on the need for the request and response of the TEG margins, and then send LS to RAN4 for the confirmation on the feasibility.

Proposal 3.12

* *For mitigating timing errors in DL-TDOA,* 
  + *Subject to the UE capability, support LMF to request a UE to provide the timing error margin associated with a UE Rx TEG.*
  + *Support a TRP to provide the timing error margin associated with a TRP Tx TEG*
* *For mitigating timing errors in UL-TDOA,*
  + *Subject to the UE capability, support LMF to request a UE to provide the timing error margin associated with a UE Tx TEG.*
  + *Support a TRP to provide the timing error margin associated with a TRP Rx TEG*
* *For mitigating timing errors in DL+UL Positioning,* 
  + *Subject to UE capability, support a UE to provide the timing error margin associated with a UE Rx/Tx/RxTx TEG*
  + *Support a TRP to provide the timing error margins associated with a TRP Rx/Tx/RxTx TEG*
* *FFS: how the error margin is defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)*
* *FFS: signaling details of the reporting (e.g., event-triggered, a semi-static, and/or periodic reporting via LPP or RRC, etc.)*
* *Send LS to RAN4 to check the feasibility*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | In principle we are okay with the UE/TRP reporting the margin to the LMF. In fact this is a fundamental part of the TEG concept in our view. However, this should be done in UE capability and TRP information request/response in our view. This should be a high priority topic at this meeting. Without reporting of the margins we are not sure there is any benefit to this entire feature. |
| Ericsson | We think this has **high priority** but before agreeing to this, it’s necessary to make sure that we all have the same understanding of what the margin is as discussed in proposal 2.2. Reading company contributions, it still seems that some companies believe the margin puts limits on the timing error of one single measurement. This is not the case. It limits the difference in timing error between different measurements associated to the same TEG. This is the only way to achieve any transmit timing mitigation with the TEG concept. This is also the understanding of RAN4 as expressed in their LS ([R1-2108707](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108707.doc)),  Once the TEG margin definition is settled we can agree to the proposal with a minor change.The examples in the FFS on signaling details should also include ‘capability reporting’. |
| Qualcomm | We think it is useful to add the capabilities, and let RAN4 decide on the values of timing margins. If this is not agreed, there is a high risk, that Ran4 will just have very loose margins, if there is no capability.  We agree with Ericsson on the meaning of TEGs, its about timing error differences. However, we think it is clear. |
| InterDigital | Support the proposal in principal. TEG is defined based on the error margin. Without the margin information, LMF cannot know the timing error differences between two TEGs having same or difference TEG ID. As a consequence, the TEG reporting may not be useful. |
| Huawei, HiSilicon | Instead of UE to report the margin, we prefer to let LMF indicate the margin to the UE/TRP so that UE/TRP may provide the TEG association for the indicated margin.  In our understanding, the margin is determined by the location accuracy QoS. For high accuracy QoS, the TEG margin could be set to smaller ones, and could even be reasonable smaller value (e.g. <100ps), which means a TEG is equal to a single branch. For low accuracy QoS, the TEG margin could be set to higher ones, e.g. 50ns, to enable location request for emergency call. |
| OPPO | Not support. How to determine the margin depends on the hardware. Thus, it should be discussed in RAN4, rather in RAN1. |
| ZTE | As we only define timing error differences with the same TEG rather than the absolute timing error. We think a single margin is enough, which can be discussed by RAN4. That is, any transmissions/receptions that are declaimed to belong the same TEG should satisfy the requirement defined by RAN4 that timing error differences with the same TEG should be within the single margin. |
| CATT | Support. We prefer RAN1 to decide that the UE/TRP can provide the timing error margin associated with a UE/TRP Rx/Tx TEG, then RAN4 check the feasibility and define the performance requirements. |
| **FL** | In the 1st round discussion, 5 companies either support at least support further discussion of the proposal in RAN1, 2 companies consider the issue should be discussed in RAN4, and one company proposes an alternative to let LMF indicate the margin to the UE/TRP.  In my view, we may need to support both, i.e., the UE needs to inform LMF its capabilities to support different error margins, and then the LMF based on its QoS requirement to request which error margins the UE should use for the measurements. For example, if the UE tells the LMF that the UE is able to support the levels of different error margins of 1ns, 2ns, 4ns, 8ns, 16ns for RX TEG. Then, the LMF may indicates which error margins the UE should use. |

### (Round 2) Proposal 3.12 (H)

* *For mitigating timing errors in DL-TDOA,* 
  + *Subject to the UE capability, support a UE to provide the candidate timing error margins associated with UE Rx TEGs, which are supported by the UE*
  + *Support LMF to select and indicate the timing error margin of UE Rx TEG for the UE*
  + *Support a TRP to provide the candidate timing error margins associated with TRP Tx TEGs, which are supported by the TRP*
  + *Support LMF to select and indicate the timing error margins of TRP Tx TEG for the TRP*
* *For mitigating timing errors in UL-TDOA,*
  + *Subject to the UE capability, support a UE to provide the candidate timing error margins associated with UE Tx TEGs, which are supported by the UE:*
  + *Support LMF to select and indicate the timing error margin associated with UE Tx TEG for the UE*
  + *Support a TRP to provide the candidate timing error margins associated with TRP Rx TEGs, which are supported by the TRP*
  + *Support LMF to select and indicate the timing error margins of TRP Rx TEGs for the TRP*
* *For mitigating timing errors in DL+UL Positioning,* 
  + *Subject to UE capability, support a UE to provide the candidate timing error margins associated with UE Rx/Tx/RxTx TEGs, which are supported by the UE*
  + *Support LMF to select and indicate the timing error margin associated with UE Rx/Tx/RxTx TEGs for the UE*
  + *Support a TRP to provide the candidate timing error margins associated with TRP Rx/Tx/RxTx TEGs to the LMF, which are supported by the TRP*
  + *Support LMF to select and indicate the timing error margins of TRP Rx/Tx/RxTx TEGs for the TRP*
* *FFS: how the error margins are defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)*
  + *FFS: the candidate values of the timing error margins (e.g., [0.5ns, 1ns, 2ns, 4ns, 8ns, 16ns, 32ns, >32ns])*
* *FFS: signaling details of the reporting (e.g., event-triggered, a semi-static, and/or periodic reporting via LPP or RRC, etc.)*
* *Send LS to RAN4 to check the feasibility*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | Thanks for the update.  We suggest the following modification for the following reasons:   * Providing the supported candidate margins should be part the UE capability * We do not need this for TRP since TRP does not have capability signaling. * UL-TDOA, should be directed indicated by gNB, but LMF-gNB coordination can be left to RAN3. * *For mitigating timing errors in DL-TDOA,*    + *Introduce the candidate timing error margins with UE Rx TEGs in the UE capability signaling*   + *Subject to UE capability, support LMF to select and indicate the timing error margin of UE Rx TEG for the UE*   + *Support LMF to indicate the timing error margins of TRP Tx TEG for the TRP* * *For mitigating timing errors in UL-TDOA,*   + *Introduce the candidate timing error margins with UE Tx TEGs in the UE capability signaling*   + *Subject to UE capability, support gNB to select and indicate the timing error margin associated with UE Tx TEG for the UE*   + *Support LMF to indicate the timing error margins of TRP Rx TEGs for the TRP* * *For mitigating timing errors in DL+UL Positioning,*    + *Introduce the candidate timing error margins with UE Rx, Tx, and RxTx TEGs in the UE capability signaling*   + *Subject to UE capability, support LMF to select and indicate the timing error margin associated with UE Rx/Tx/RxTx TEGs for the UE*   + *Support LMF to indicate the timing error margins of TRP Rx/Tx/RxTx TEGs for the TRP* * *FFS: how the error margins are defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)*   + *FFS: the candidate values of the timing error margins (e.g., [0.5ns, 1ns, 2ns, 4ns, 8ns, 16ns, 32ns, >32ns])* * *FFS: signaling details of the reporting (e.g., event-triggered, a semi-static, and/or periodic reporting via LPP or RRC, etc.)* * *Send LS to RAN4 to check the feasibility* |
| OPPO | Not support as it should be discussed in RAN4 |
| CATT | Support.  We think UE needs to inform its capabilities to LMF, and then LMF will request which error margins the UE should use for the measurements. Both of the two aspects should be supported to build a complete procedure. |
|  |  |

## Reporting of group time delys/errors

Submitted Proposals

* ***(CATT, R1-2111256[4]) Proposal 6:*** *Support UE/gNB to report UE/TRP Rx+Tx group time delays for the multiple pairs of UE/TRP {Rx TEG, Tx TEG} to LMF.*
  + *Send LS to RAN4 to check whether it is feasible for UE/gNB to report of UE/TRP Rx+Tx group time delays*
* ***(OPPO, R1-2111289[5]) Proposal 8:*** *Rel-17 doesn’t support UE/TRP to report RX+TX group time delays to LMF.*
* ***(Sony, R1-2111397[7]) Proposal 2:*** *Support UE and gNB to report the estimated Tx/Rx Timing error to LMF.*
* ***(MTK, R1-2112071[14]) Proposal 5-1:*** *Up to UE capability, UE may further provide a pair of TX TEGs, and a RSTD value which has compensated with the RX+TX group delay within the DL-RSTD measurement report to support joint configuration of UL-TDOA and DL-TDOA.*
* ***(Ericsson, R1-2112339[18]) Proposal 26****: Timing errors per UE/gNB RX/TX TEG should not be signalled by the UE/gNB to the LMF, nor from the LMF to the UE.*
* ***(Ericsson, R1-2112339[18]) Proposal 27****: Timing errors differences between UE/gNB RX/TX TEGs should not be signalled by the UE/gNB to the LMF, nor from the LMF to the UE.*

FL comments

For the proposals in [4] and [7] to report the group time delays/errors, given that similar proposals were discussed in the previous meeting without consensus [19], and also two companies [5][18] do not want to support reporting the group time delays/errors, suggest no further discussion on reporting group time delays/errors in this meeting.

The proposal in [14] seems a new proposal without explicitly reporting the group time delays/errors, which may need a further discussion to see if it can be acceptable.

Proposal 3.13

* Up to UE capability, UE may further provide a pair of TX TEGs, and a RSTD value which has compensated with the RX+TX group delay within the DL-RSTD measurement report to support joint configuration of UL-TDOA and DL-TDOA.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | This isn’t acceptable to us. In fact it’s worse than reporting timing errors separately since UL TDOA measurements are compensated with TX group delays. The UE can’t know beforehand what TRPs will be able to hear the SRS. Thus, the UE doesn’ät know if the UL TDOA will be combined with a RTOA measurement or not. |
| MTK | Support.  1, to FL: this is not a new proposal. We have proposed this in previous meeting, considering not to disclose RX+TX group delay value.  2, the TX delay difference between TX TEGs of a UE relies on a TRP/gNB to measure and report. This is somehow UE can’t control as compared to the knowledge of RX delay difference between RX TEGs  3, Instead, if UE could do self-calibration with the knowledge of RX+TX group delay, then UE could compensate it within DL-RSTD report in order to pair with UL-RTOA reports to derive TX delay difference between TX TEGs. Please check our contribution  To E///  The thinking is beside DL-RSTD report, if a UE could do self calibration UE could additionally report another value with compensation. The intention is to pair with UL-RTOA measurement to calculate TX delay difference between TX TEGs.  So the original DL-RSTD report is still there. |
| Huawei, HiSilicon | We prefer to add UE RxTx TEG also for DL-TDOA method per request from the network, given that use of DL-TDOA + UL-TDOA is subject to network considering. |
| OPPO | One question for clarification. If UE can provide measurement with compensation, why does it report the non-compensated result? |
| ZTE | We think Huawei’s suggestion is a better way forward. |
| CATT | Support. |
| **FL** | From the 1st round discussion, two companies support it, two companies propose alternatives to report RxTx TEG ID with a DL-RSTD measurement, and one company does not support it. The alternative is added for further discussion. |

### (Round 2)Proposal 3.13

* *Support one of the following options for mitigating UE Tx timing errors when UL TDOA and DL-TDOA are used:*
  + *Option 1: Subject to UE capability, UE may further provide a pair of TX TEGs, and a RSTD value which has compensated with the RX+TX group delay within the DL-RSTD measurement report to support joint configuration of UL-TDOA and DL-TDOA.*
  + *Option 2: Subject to UE capability, UE may further provide a RxTx TEG ID with a DL-RSTD measurement.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We support Option 2, which can be understood based on the existing RxTx TEG reporting framework for multi-RTT. |
| CATT | Support. Maybe down-select one option at next meeting. |
| MTK | Let me explain how option 1 works,  1, the intention is that when UL-TDOA is mainly configured, the further configuration of DL-TDOA with longer periodicity (to save RS) allows LMF to compute TX group delay difference between 2 TX TEGs through transmission to 2 TRPs, when a TRP has a problem to measure SRS from different TX TEGs of UE. This is what we worry that, the TX TEG delay difference of a UE may rely on a TRP for measurement. So we are thinking some other solutions to work together to ensure LMF could get TX TEG delay difference of a UE  2, when a DL-RSTD is measured by 2 RX TEGs, and when UE knows RX+TX group delay per {RX TEG, TX TEG} pair through self calibration, mathematically, a DL-RSTD measurement is expressed as tof1 – tof2 + (Δtue\_Rxteg1 - Δtue\_Rxteg2 ) –(1)  When RX+TX group delay is measured through self calibration, namely (Δtue\_Rxteg1 + Δtue\_Txteg1 ) and (Δtue\_Rxteg2 + Δtue\_Txteg2 ) are measured, UE could add the RX+TX group delay difference to produce another DL-RSTD result:  (1) – (Δtue\_Rxteg1 + Δtue\_Txteg1 ) + (Δtue\_Rxteg2 + Δtue\_Txteg2 ) = tof1 – tof2 - (Δtue\_Txteg1 - Δtue\_Txteg2 ) --(2)  It is seen that the absolute value of RX+TX group delay doesn't disclose from observing (1) and (2) which could be confidential information related to UE implementation  LMF receives 2 UL-RTOA measurement, transmitted by TX TEG1 and TX TEG2 of a UE respectively, when taking differential, the UL-RSTD could be expressed as tof1 – tof2 + (Δtue\_Txteg1 - Δtue\_Txteg2 ) –(3)  Then (3) – (2) , it derives (Δtue\_Txteg1 - Δtue\_Txteg2 ) which is the TX group delay difference between 2 TX TEGs  We are also open to see how option 2 works. Also, we are open that the RX+TX group delay difference is not added within the report. Instead it is provided. |

# Reference devices for mitigating UE/gNB Tx/Rx timing errors

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) |

*Submitted Proposals*

* ***(Sony, R1-2111397[7]) Proposal 3:*** *Support UE as PRU.*
* ***(Sony, R1-2111397[7]) Proposal 4:*** *Support to introduce PRU identification based on the device capability, which enable LMF to select the capable devices UE to be PRU.*
* ***(Sony, R1-2111397[7]) Proposal 5:*** *PRU with known location support the following functionalities: Location uncertainty information, stationary status, providing positioning measurement and/or estimated Tx/Rx Timing error report.*
* ***(Intel, R1-2111495[8])Proposal 5:*** *Support LMF to request the PRU to provide the location information and antenna orientation information using one or both of following options:*
  + *Using direct report from the PRU to the LMF*
  + *Using report from the PRU to the LMF through a serving gNB*
* ***(Intel, R1-2111495[8])Proposal 6****: Continue discussion on reporting format of the precisely known PRU location coordinates to LMF and whether additional indication/signaling is needed so that LMF can distinguish over a PRU and the regular UEs*
* ***(Intel, R1-2111495[8])Proposal 7****: Specify reporting format of the PRU antenna orientation with respect to the GCS*
  + *FFS: LCS to GCS translation function can be reused by setting bearing, down-tilt, and slant angles*

FL comments

In [7], it proposes to support UE as PRU, to introduce PRU identification based on the device capability, and support a PRU with support the following functionalities: Location uncertainty information, stationary status, providing positioning measurement and/or estimated Tx/Rx Timing error report.

In [8], it proposes support different options for a LMF to request the PRU to provide the location information and antenna orientation information using one or both of following options, discussing reporting format of the known PRU location coordinates to LMF and whether additional indication/signaling is needed so that LMF can distinguish over a PRU and the regular UEs and reporting format of the PRU antenna orientation with respect to the GCS.

In FL’s view, most of the above proposed work can be done in RAN2 without the need of the support from RAN1.

### (Closed) Proposal 4

* *Support the following related to PRU:* 
  + *Introduce PRU identification based on the device capability, which enable LMF to select the capable devices UE to be PRU.*
  + *Support LMF to request the PRU to provide the location information and antenna orientation information using one or both of following options:*
    - *Using direct report from the PRU to the LMF*
    - *Using report from the PRU to the LMF through a serving gNB*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | We share FL’s view that no discussion is needed in RAN1. |
| Nokia/NSB | Agree with Ericsson. |
| Huawei, HiSilicon | Prefer to let RAN2 handle this. |
| OPPO | Leave it ot RAN2 |
| ZTE | Prefer to let RAN2 handle this. |
| Lenovo,Motorola Mobility | Prefer to wait for any RAN2 feedback. |
| Sony | RAN2 has made a good progress. We are fine with the FL’s view. |
| CATT | OK. RAN2 will discuss this issue. |

FL Comments

Based on the feedbacks, it seems there is no need to further discuss above proposal in this meeting.

# 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. |

## 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, R1-2110850[1]) Proposal 3:*** *Support both Option 1 and option 2 for MTW configuration of UE and gNB, respectively.*
* ***(Huawei, R1-2110850[1]) Proposal 4:*** *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 the multiple of PRS/SRS periodicity and can divide or can be divided by 10.24s SFN period.*
* ***(ZTE, R1-2110956[2]) Proposal 8****: There is no need to introduce measurement time window in Rel-17 NR positioning.*
* ***(vivo, R1-2111013[3]) Proposal 9:*** *Support to enable the UE to report PRS measurements derived from the most recent measurement instances in advance of a certain time before the measurement report.*
  + *The certain time before the measurement report is related to PRS processing capability.*
* ***(CATT, R1-2111256[4]) Proposal 7:*** *The configurable measurement time windows should be supported, in which the UE or TRP measurement instances are obtained.*
* ***(CATT, R1-2111256[4]) Proposal 8****: UE measurement time windows and TRP measurement time windows can be configured independently. They can be configured to be the same or different.*
  + *UE measurement time window refers to the time window in which UE measures DL-PRS resources. In this time window, UE obtains at least one UE measurement instance by measuring DL-PRS resources.*
  + *TRP measurement time window refers to the time window in which TRP measures SRS-Pos resources. In this time window, TRP obtains at least one TPR measurement instance by measuring SRS-Pos resources.*
* ***(CATT, R1-2111256[4]) Proposal 9****: UE (or TRP) is not expected to measure DL-PRS (or SRS-Pos) outside of the measurement time window.*
* ***(CATT, R1-2111256[4]) Proposal 11:*** *(Configuration method 1): UE/TRP measurement time window should 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.*
    - *J: The number of UE measurement instances included in the UE measurement time window.*
    - *Ni: The number of instances of DL-PRS resource set or DL-PRS occasions contained by the i-th UE measurement instance.*
  + *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.*
    - *K: The number of TRP measurement instances included in the TRP measurement time window.*
    - *Mi: The number of instances of SRS-Pos resource set or SRS-Pos occasions contained by the i-th TRP measurement instance.*
* ***(CATT, R1-2111256[4]) Proposal 14:*** *For configuration method 1 and the periodic DL-PRS, the length of UE measurement time window can be defined as:*
  + - * + *is the periodicity of DL-PRS resource set;*
        + *is the number of UE measurement instances included in the UE measurement time window,* ≥1;
        + *is the number of instances of DL-PRS resource set or DL-PRS occasions contained by the i-th UE measurement instance，*≥1.
* ***(CATT, R1-2111256[4]) Proposal 15:*** *For configuration method 1 and the periodic/semi-persistent SRS-Pos, the length of TRP measurement time window can be defined as:*
  + - * + *is the periodicity of SRS-Pos resource set;*
        + *is the number of TRP measurement instances included in the TRP measurement time window,* ≥1;
        + *is the number of instances of SRS-Pos resource set or SRS-Pos occasions contained by the i-th TRP measurement instance，*≥1.
* *(****CATT, R1-2111256[4]) Proposal 16****: For Configuration method 2, 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.*
* ***(CATT, R1-2111256[4]) Proposal 17****: Configuration method 1 should be adopted to configure the measurement time window, since it will help LMF to more effectively eliminate the influence of timing errors of TRPs and UE.*
* ***(OPPO, R1-2111289[5]) Proposal 10****: Rel-17 doesn’t support the measurement time window (MTW) for the measurement instance.*
* ***(Nokia, R1- 2111364[6]) Proposal 12****: If the MTW is agreed to be supported the UE/TRP is not mandated to use the resources inside the MTW for the positioning measurements*
* ***(CMCC, R1-2111609[9]) Proposal 4:*** *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.*
* ***(Samsung, R1-2111738[10])Proposal 4:*** 
  + *Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a single measurement report.*
* ***(InterDigital, R1-2111797[11]) Proposal 4:*** *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.*
* ***(LGE, R1-211973[13]) Proposal 10:*** *RAN1 should support configuring MTW for both UE and gNB.*
* ***(LGE, R1-211973[13]) Proposal 11:*** *Regarding configuration of measurement time window (MTW), RAN1 should consider following ways to indicate/configure it.*
  + *Type #1: predefined configuration*
    - *Introducing positioning radio frame (PRF) in which a single or multiple MTW(s) may exist.*
    - *Start timing offset and/or duration and/or repetition factor (and/or including time gap) for detail configuration of MTW(s).*
  + *Type #2:dynamic configuration*
    - *MTW can starts after the message from LMF such as positioning measurement request.*
    - *Start timing offset and/or duration and/or repetition factor (and/or including time gap) for detail configuration of MTW(s).*
* ***(LGE, R1-211973[13]) Proposal 12:*** *RAN1 should allow both UE and gNB to perform positioning measurement regardless of MTW.*
* ***(LGE, R1-211973[13]) Proposal 13:*** *Considering specific use cases that LMF wants to indicate both UE and gNB to perform positioning measurement within MTW, RAN1 also needs to discuss about it in detail such as related signaling, procedure and etc.*
* ***(MTK, R1-2112071[14]) Proposal 3-1****: Instead of indicating MTW by LMF, UE may report its measurement behaviour to LMF and LMF may further forward UE’s measurement behaviours to gNBs so that gNBs may selectively measure SRS to match UE’s behaviour*
* ***(Qualcomm, R1-2112217[16])Proposal 13:*** *Support both the following:*
  + *Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a single measurement report.*
* ***(Qualcomm, R1-2112217[16])Proposal 14:*** *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;*
  + *MTW periodicity for the cases of periodic reporting*
* ***(Lenovo, R1-2112323[17]) Proposal 1:*** *Support Options 1 and 2 for indicating the measurement time window for the UE and gNB, respectively.*
* ***(Lenovo, R1-2112323[17]) Proposal 2:*** *The MTW configuration for a UE and gNB should at least include parameters such as time window length and periodicity, where applicable.*
* ***(Lenovo, R1-2112323[17]) Proposal 3:*** *It should be possible to support reporting of timestamps outside the configured MTWs.*
* ***(Ericsson, R1-2112339[18]) Proposal 23:*** *The measurement time window (MTW) configuration for a UE/gNB should include: MTW starting time (e.g., the offset of SFN); MTW length, configured in the unit of 10msec; MTW periodicity for the cases of periodic reporting.*
* ***(Ericsson, R1-2112339[18]) Proposal 24:*** *A UE configured by the LMF to report the UE TX TEG association for an SRS resource should include this reporting in the multi-RTT report. The UE should report the UE TX TEG association of all TX instances of the SRS resource within the MTW configured for the multi-RTT report.*
* ***(Ericsson, R1-2112339[18]) Proposal 25:*** *Support the TEG concept only for single sample measurements.*

FL Comments

Based on the feedback, many companies (e.g., [1][4][9][10][11][13][16][17][18]) support LMF to configure the measurement time windows for UE and gNB. But, there are some companies (e.g., [2][5]) consider there is no need to do so. Whether to introduce the measurement time windows for UE and gNB have been discussed very intensively in the previous meetings (e.g., [19]), there is a need for us to make the final decision in this meeting, maybe with a compromised solution, e.g., UE/TRP is not mandated to use the resources inside the MTW for the positioning measurements [6], or allowing both UE and gNB to perform positioning measurement regardless of MTW as suggested in [13][17].

Proposal 5.1a (H)

* *Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Note: UE is not mandated to use the DL PRS resources inside the MTW for the positioning measurements*
* *Support LMF to optionally indicate the measurement time window for a TRP for the measurement instances included in a single measurement report.*
  + *Note: TRP is not mandated to use the UL SRS resources for positioning inside the MTW for the positioning measurements*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support |
| CATT | Support.  In our point of view, MTW is very important at least for facilitating the timestamps matching among various measurement instances, e.g., among UE Rx-Tx time difference measurement instances and gNB Rx-Tx time difference measurement instances for multi-RTT positioning method. |
| Nokia/NSB | Our preference is to not introduce this feature but if we need to have it then the notes are necessary in our view. |
| Qualcomm | support |
| InterDigital | Support |
| MTK | We doubt this useful. If both UE and TRP have their own agenda not to measure all the configured RS, we don't understand both sides will follow the configuration of MTW to do measurement within MTW.  We propose a compromise solution since last meeting. Pity that FL continues to ignore. Our solution is, if a UE has its own measurement behaviour, for example not to measure all occasions, and tend to measure for example the last shot before reportig, UE may report the behaviour to LMF and LMF may indicate this to TRP so that TRP can also do the measurement close to UE’s measurement.  FL: For MTK’s suggestion if I understand correctly, we may need to: a) first define a set of UE’s measurement behaviours that the UE will follow (maybe we also need to introduce different capacities for different behaviours) ; b) the UE needs to inform LMF its behaviour (or the capabilities); and c) the LMF needs to pass the information to all gNBs; and c) the gNBs needs to follow each UEs behaviour for the UL measurements. I could check other companies on the suggestion, but it seems to me it makes the issue unnecessarily complicated for the specs and the implementation, especially in gNB side.  Thus, the proposal is here simply is simply the network informs the MTW, and then it is up to the UE on whether to follow the network’s instruction to perform the measurement within the MTW in a best effort manner. |
| Huawei, HiSilicon | Support.  Agree with Nokia, the note is needed.  There are various example in Rel-16, e.g. k values in the TOA measurement report. |
| CMCC | Support |
| OPPO | Not support since it can be achieved by implementation.  FL: Yes, I assume it might be achieved by implementation, especially when RAN2 has agreed to introduce finer granularity for measurement reporting, which allows the LMF to force the UE and gNB to provide the DL/UL measurement at shorter reporting granularity to reduce the time difference between the DL RSTD and UL RTOA measurements for DL TDOA+ULTDOA, or UE and gNB Rx-Tx measurements for Multi-RTT. However, this would cause much larger impact on UE power consumption and also the traffic load, which could be avoided by simply introducing the MTW. Keep in mind that for most LCS applications, the positioning interval could be much longer than the DL PRS/UL SRS transmission intervals. For example, the measurement reporting interval can be up to 32 seconds as defined in TS 37.355. |
| Samsung | support |
| Intel | Prefer not to introduce this feature. Same view as MTK. |
| ZTE | Don’t support |
| NTT DOCOMO | Support |
| Lenovo,Motorola Mobility | Supportive of proposal. |
| LGE | Support. |
| **FL** | I assume the intention of configure the measurement time window (MTW) was well discussed so far. The suggestion is that we have a further discussion in the online to make the decision on whether to adopt or drop the concept of the MTW. |
| **FL** | Another issue we may want to consider is the reporting of the UE/TRP Tx TEGs, which is under discussion in Proposal 3.4. W/o TMW, I assume for Option 1, there is a need to consider reporting the UE/TRP Tx TEG information (including the changes of the Tx TEG) within each measurement reporting period, if UE Tx TEG reporting interval is configured to be the measurement reporting interval. With TMW, however, UE/TRP may only need to report the /TRP Tx TEG information within MTW.  During last Friday’s GTW session,   * there were comments related to the note. My understanding is that the note was added to address the comment that UE should be forced to provide the measurement during the configured MTW. * there was comment that if we may not have the time to work on the MTW details if we try to introduce MTW. In my understanding, the parameters are simply the start time, length, and periodicity as shown Proposal 5.1b (H). * there was also a proposal that if we can first having the MTW in TRP side. My understanding is that introducing MTW in TRP side only may not help much to resolve the DL/UL measurement aligned in time, but it may at least help for TRP side if we want to use the differential RTT to reduce the impact on TRP Rx/Tx timing errors, reduce TRP power consumptions, and others. So, I am wondering if we can first make an agreement in TRP side and have a further discussion for UE side by adding an “FFS” as follows:   *FFS: Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.* |

### (Round 2) Proposal 5.1a (H)

* *Support LMF to optionally indicate the measurement time window for a TRP for the measurement instances included in a single measurement report.*
  + *Note: TRP is not mandated to use the UL SRS resources for positioning inside the MTW for the positioning measurements*
* *FFS: Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Note: UE is not mandated to use the DL PRS resources inside the MTW for the positioning measurements*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | Our preference is to agree to both LMF and UE side, we can be fine with the modified proposal for now.  On other hand, one can interpret the MTW starting time as the measurement activation time so that all concerned entities can start the measurement on the occasions synchronously. So I wonder if we can also soften the proposal by saying   * *Support LMF to indicate a preferred measurement starting time to the UE/TRP for the measurement instances included in a single measurement report.*   + *Note: UE/TRP is not mandated to start measurement after the starting time*   Note that in the on-demand PRS, some companies objecting to this proposal are suggesting to have a parameter of start/end time as the on-demand PRS transmission, but there is no way of confirming the start/end time in the assistance data yet, and I think the MTW/measurement start time is the response from the LMF. |
| OPPO | Considering this is the last meeting, we suggest to remove the whole 2nd bullet, i.e., no further discussion on MTW for UE |
| CATT | We support both the two main bullets. |
|  |  |

### Proposal 5.1b (H)

* *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*
  + *MTW periodicity for the cases of periodic reporting*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support. Preference for option 2. |
| CATT | Support.  About the configuration of MTW length, we prefer Option 2. |
| Qualcomm | support |
| Huawei, HiSilicon | Support. |
| CMCC | Support |
| Samsung | General fine.  But clarification question for option2, maybe be some details are missing. For the MTW length, if it’s dependent on measurement instance and PRS/SRS instance. So does it means the length equals the total span of a configured number of measurement instances? And how many PRS/SRS insance in one measurement instance will be configured as well?  FL: My understanding is that in this case, the time length of the MTW is the sum of the time configured number of measurement instances. The time of each measurement instance depends on the number of PRS/SRS instances (or samples). |
| Lenovo,Motorola Mobility | Support |
| LGE | Support. |

## Timestamp of measurement instance

Background

It was agreed in RAM1#104bis-e that each measurement instance has its own timestamp. The definition of the timestamp was also discussed in previous meetings w/o conclusion. The latest proposal in discussion of the last meeting is as follows.

|  |
| --- |
| (Round 2) Proposal 5-2a (H) *The timestamp for a measurement instance in a measurement report is defined by one of the following options (downselection in RAN1#106b):*   * *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.* * *Option 2: The timestamp of the UE (or TRP) measurement instance corresponds to as a time window indicated by,*   + *A starting time instance corresponds to the reception time of the first instance of the DL PRS (or UL SRS) resources averaged/filtered over to give the reported measurement instance, and*   + *An ending time instance corresponds to a reception time of the last instance of the DL PRS (or UL SRS) resources averaged/filtered over to give the reported measurement instance* * *Option 3: Up to UE implementation.* |

Submitted proposals and FL comments

* ***(ZTE, R1-2110956[2]) Proposal 9:*** *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 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.*
* ***(vivo, R1-2111013[3]) Proposal 10:*** *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.*
* ***(CATT, R1-2111256[4]) Proposal 12:*** *When UE reports a measurement instance, it also reports the time stamp of the measurement instance, which corresponds to one certain reception time between the first and last DL-PRS resource sets that are used to determining the measurement instance.*
* *(****CATT, R1-2111256[4]) Proposal 13:*** *When TRP reports a measurement instance, it also reports the time stamp of the measurement instance, which corresponds to one certain reception time between the first and last SRS-Pos resource sets that are used to determining the measurement instance.*
* ***(OPPO, R1-2111289[5]) Proposal 9:*** *For the timestamps for the measurement instances in a measurement report, support either Option 1 or Option 3:*
  + *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. (1st preference)*
  + *Option 3: Up to UE implementation. (2nd preference)*
* ***(Lenovo, R1-2112323[17]) Proposal 4:*** *The timestamp should correspond to the reception time of the last received PRS resource for a single measurement instance.*
* ***(Lenovo, R1-2112323[17]) Proposal 5:*** *The existing UE timing quality indication can be extended to assist the LMF in indicating the quality of the timestamp.*
  + *FL comments: It is unclear why there is need to indicate “the quality of the timestamp”. The timestamp is not a measurement, but just an indication on when the measurement is obtained.*

FL Comments

It seems companies have different views preferences on the options discussed in the last meeting. In [2], it was proposed to use two timestamps for the starting/ending times instances; in [3][5][17], it was proposed the timestamp corresponding to the last DL PRS/UL SRS that are used to determining the measurement instance. In [4], it was proposed the timestamp can be between the first and the last DL PRS/UL SRS that are used to determining the measurement instance. In previous discussion [19], there were companies prefer Option 3.

### Proposal 5-2(H)

*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

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Option 1 |
| Ericsson | Option 1. This is trivial for the UE to implement and having a well defined UE behaviour gives improved accuracy for the timestamp. |
| CATT | Support.  We prefer Option 3. |
| Qualcomm | Option 2 |
| Huawei, HiSilicon | Option 1.  If UE drops the last PRS occasion for the final measurement report, then UE do not use the time stmap for the last PRS occasion, since the measurement of that occasion contributes nothing to the reported value. |
| CMCC | Our 1st preference is Option 1, and we are also open for Option 3. |
| OPPO | Option 1  One question for clarification: Does this proposal intend to support three options in spec or just to list 3 options for down-selection? |
| Samsung | Option1,  How option2 work? If it’s upto UE implementation, how gNB/LMF to use this information ? |
| ZTE | Option 1. |
| Lenovo,Motorola Mobility | Option 1. |
| LGE | The discussion for the issue at least seems unclear for us. In the current version of specification, the timestamp is defined as “This field specifies the time instance for which the measurement is performed.” And then the timestamp already includes the information about SFN and slot. In addition, as we all know, both providing association information of TEG and reporting TEG ID are also agreed. Considering all of them. We think LMF can know which SRS or PRS is used for measurement. So, we think the proposal is not necessary.  FL: The issue here is that when a UE uses the DL PRS resources from multiple time instances to get the measurements, how the timestamp is defined: should the timestamp be the first time instance of the DL PRS resources, or the last instance of the DL PRS resources, or anytime between. |
| **FL** | It seems most of the companies prefer Option 1, while one company prefers Option 2 and one company prefers Option 3. |

## Number of PRS resource set/SRS occasions for a measurement instance

Background

It remains undecided on how many whether a UE/TRP measurement instance can be configured with N/M instances of the DL-PRS Resource Set/ SRS measurement time occasions for the agreement made in Agreement (RAN1#104e).

|  |
| --- |
| 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. |

Submitted proposals

* ***(ZTE, R1-2110956[2]) Proposal 9:*** *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 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.*
* ***(vivo, R1-2111013[3]) Proposal 11:*** 
  + *Support N=1 and 4 instances of the DL PRS resource set in each measurement instance.*
  + *Support M=1 and 4 SRS measurement time occasions in a TRP measurement instance.*
* ***(CATT, R1-2111256[4]) Proposal 10****: Each UE or TRP measurement instance can be configured with at least one instance of DL-PRS resource set or SRS-Pos resource set.*
  + *Each UE measurement instance can be configured with N instances of the DL-PRS resource set. N = [1, 2, 3, 4], using 2 bits to indicate which value is configured for N.*
  + *Each TRP measurement instance can be configured with M SRS-Pos resource set. M = [1, 2, 3, 4] , using 2 bits to indicate which value is configured for M.*
* ***(Nokia, R1- 2111364[6]) Proposal 13:*** *RAN1 should define a measurement instance.*

FL: It is defined in the previous agreement as “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).”

* ***(Nokia, R1- 2111364[6]) Proposal 14:*** *The benefit and feasibility of the LMF to configure a specific number of resource set instances for measurement instances should be further clarified.*
* ***(NTT DOCOMO, R1-2112108[15])Proposal 1:*** *Rel-17 should support the followings:*
  + *Each measurement instance in a UE measurement report can be configured by LMF with at least N=1 instances of the DL-PRS Resource Set*
  + *Each measurement instance in a TRP measurement report can be configured by LMF with at least M=1 SRS measurement time occasions.*

FL Comments

It seems multiple companies (e.g., [2][3][4][15]) are supportive to support at least *N=1* and M=1. But, one company [16] proposes “the benefit and feasibility of the LMF to configure a specific number of resource set instances for measurement instances should be further clarified.” In FL’s understanding, N=1 instances of the DL-PRS Resource Set (or called one sample) was already agreed to be supported for obtaining one measurement in AI 8.5.4 to reduce positioning latency.

Proposal 5.3 (H)

* *Each measurement instance in a UE measurement report can be configured by LMF with at least N=1 instances of the DL-PRS Resource Set*
* *Each measurement instance in a TRP measurement report can be configured by LMF with at least M=1 SRS measurement time occasions.*
* *FFS: Maximum number of measurement instances in a single measurement report*
* *Send LS to RAN4 to inform RAN4 about RAN1’s decision.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Okay |
| Ericsson | Support. Our understanding is that this has already been agreed in the latency AI.  We think the maximum number of measurement instances in a single measurement report should be configurable by the NW to control overhead. The number of instances the UE will succeed to measure may in reality be smaller but still good to be able to limit the number. |
| CATT | Support. |
| Nokia/NSB | Somewhat same view as Ericsson that this seems very similar to the M=1 samples request agreed in the latency AI. Can the proponent explain what is needed on top? LMF can already request the UE to do a single sample measurement. Right now we can’t support this proposal.  FL: For latency AI, the intention is for the network to control (or reduce) the positioning latency. Here, we are trying to control the number of samples for each measurement instance (e.g., for the alignment of the reporting of the UP and DL measurements, and for the estimation of the timing errors or timing drifting errors), which may not necessarily related to the positioning latency, since one measurement report may have multiple measurement instances, each with its own time stamps. |
| Qualcomm | This has already been agreed.  FL: Agreed in latency AI. But, we may need to make it clear N=1 applies also to the same when one measurement includes multiple measurement instances. |
| CMCC | Support |
| OPPO | Support |
| ZTE | We think it’s a bit different from latency agenda. For latency reduction, M=1 means UE will only measure one instance of a periodical DL PRS resource for a location measurement report. However, we think the intention to support M=1in here is to track the time drift/ UE movement in different measurement instances. Therefore, UE should also measure multiple instances of a periodical DL PRS resource.  With said above, we propose to add a subbulet under first bullet,   * UE should follow the measurement period defined in Rel-16 for 4-sample measurement   FL: This could be further discussed, but in my view there is no need to have such constraint, considering that we may want to support both low latency and Rx/Tx timing error mitigation.  In addition, we should also support 4-sample measurement for the report of multiple measurement instances. For PRS processing sample number=4, if UE performs filtering or average, which implicitly indicates that UE has the confidence that the time drift of UE clock hasn’t shifted too much or UE’s location hasn’t changed a lot over the time duration. The reason to conduct the filtering or average is to increase the confidence of searching first detected path.  FL: Okay. We assume N=4 is already supported in Rel-16 for UE. We may consider adding M=4 for gNB. |
| NTT DOCOMO | Support |
| Lenovo,Motorola Mobility | Support. |
| LGE | We are on the same page with Ericsson and nokia. |

### (Round 2)Proposal 5.3 (H)

* *Each measurement instance in a UE measurement report can be configured by LMF with at least N=1 or 4 instances of the DL-PRS Resource Set*
* *Each measurement instance in a TRP measurement report can be configured by LMF with at least M=1 or 4 SRS measurement time occasions.*
* *FFS: Maximum number of measurement instances in a single measurement report*
* *Send LS to RAN4 to inform RAN4 about RAN1’s decision.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Support. |
| ZTE | OK. |
| Huawei/HiSilicon | The introduction of 1 or 4 samples is for the purpose of latency reduction. However the usage of course can be extended to other cases.  We only need to agree to the TRP part. |
| Qualcomm | Maybe what is needed is the TRP part, still the other is agreed. The fact that sth is for “latency reduction” does not mean it cannot be used for other reasons. Either way, we can accept to agree for both. |
| vivo | OK |
| Apple | Question for clarification, by reading above comments it seems to me that here “instance” refers to “each” PRS occasion within a periodicity, while in 8.5.4 (and in current spec) “All” PRS occasions within a periodicity make an instance. What is the definition of instance? |
| Ericsson | We share a similar understanding as QC. |
| OPPO | Support |

## Tx/Rx TEG for a measurement instance

Submitted proposals

* ***(ZTE, R1-2110956[2]) Proposal 7:*** *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 Comments

The similar proposal was discussed in the previous meeting without conclusion. Some companies commented that the UE may or may not necessarily to use the same UE Rx TEG ID. In FL’s view, use the same UE Rx TEG ID needs to be ensured if the UE Rx TEG ID is reported together with the measurement.

### Proposal 5.4

* *When multiple reference signals are used to determine the same Rx timing* ***for a measurement that is reported with a UE Rx TEG ID****, support the followings,*
  + *For DL RSTD measurement, if multiple DL PRS resources are used to determine the start of one subframe from a TP, the multiple DL PRS resources should be associated with the same UE Rx TEG ID.*
  + *For UE Rx-Tx time difference measurement, if multiple DL PRS resources are used to determine the start of one subframe of the first arrival path of the TP, the multiple DL PRS resources should be associated with the same UE Rx TEG ID.*
  + *For UL RTOA measurement, if multiple SRS resources are used to determine the start of one subframe containing SRS received at a RP, the multiple SRS resources for positioning should be associated with the same TRP Rx TEG ID.*
  + *For gNB Rx-Tx time difference measurement, if multiple SRS resources for positioning are used to determine the start of one subframe containing SRS, the multiple SRS resources for positioning should be associated with the same TRP Rx TEG ID.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support. |
| ZTE | Support. |
| **FL** | For the 1st round discussion, the proposal is supported by two companies w/o any objection. Other interested companies are encouraged for provide the comment to see if we make any progress for the proposal |

## Measurement instances in a measurement report

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.   ***Proposal 5-6 (RAN1#106bis-e) [19]***  *Further discuss the association between measurement instances and UE measurement report, at least consider one of the following options,*   * + *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.* * *FFS: The relationship between the value N and the association between measurement instances and UE measurement report.* |

Submitted proposals

* ***(Qualcomm, R1-2112217[16])Proposal 15:*** *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.*
  + *The Maximum number of measurement instances can be at least 32.* 
    - *Introduce a per-UE capability on the maximum number ofmeasurement instances which can be included with the values {2,4,5,8,10,16,20,32}*

Proposal 5-5

* *With regards to the association between measurement instances and UE measurement report, at least support the following:*
  + *For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
  + *The maximum number of measurement instances in a measurement report can be at least 32.* 
    - *Introduce a per-UE capability on the maximum number of measurement instances which can be included with the values {2,4,5,8,10,16,20,32}*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | It’s unclear to us what bullet one really means. Better for RAN2 to decide on the measurement reporting structure. When looking at the ASN.1 things become more concrete.  On bullet two, we don’t think this is a well formulated UE capability. The UE capability should be related to how many measurement instances a UE can make in a certain time period, given a DL PRS configuration.  The maximum number of measurement instances is something the NW should configure in order to limit signaling overhead. The UE may in the end be able to measure and report less than the maximum number of measurement instances configured by the NW. |
| **Qualcomm** | We think that this is an important issue. This feature is NOT complete if this is not agreed. For many meetings now, we haven’t been able to make any agreement with regards to this feature.  RAN2 cannot make an agreement here, because each Alternative has a different functionality and these functionalities should be debated/decided in RAN1.  From the alternatives above, we support Alt. 4 |
| Huawei, HiSilicon | We also think that this is RAN2 business, but we felt Alt.4 is the natural solution.  For the suggestion from Qualcomm on *NR-XXX-LocationInformation for UE-based positioning*, this currently only provides the time stamp for the UE-based location, not clear whether it is the intention. |
| ZTE | We can support Alt.4. In addition, we think Alt.1 can be useful to track UE’s time drift if multiple measurement instances are associated with the same DL PRS resource and the same Rx TEG. |
| **FL** | In my view, at least the second sublet need to be defined by RAN1. RAN1 needs to decide maximum number of measurement instances and the UE capability related to RAN1’s agreement in RAN1#104e. For the issue related to the first subbullet, the RAN2 could work on it without RAN1’s inputs. |

### (Round 2) Proposal 5-5

* *With regards to the association between measurement instances and UE measurement report, at least support the following:*
  + *The maximum number of measurement instances in a measurement report can be at least 32.* 
    - *Introduce a per-UE capability on the maximum number of measurement instances which can be included with the values {2,4,5,8,10,16,20,32}*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| CATT | Support. |
|  |  |
|  |  |
|  |  |

# Additional proposals

## Multiple reference timings

Submitted Proposals

* ***(LGE, R1-211973[13]) Proposal 14:*** *RAN1 needs to consider the configuration of multiple reference timings for DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements.*

FL comments

For DL PRS-RSRP and UE Rx-Tx time difference measurements, the understanding is up to UE on whether to use the configured reference, and thus it seems no need to consider the configuration of multiple reference timings.

A similar proposal was presented in previous meetings w/o conclusion since only few companies provided the comments. Interested companies are encouraged to further provide their comments in this meeting on the above proposal.

### Proposal 6-1

* *RAN1 needs to consider the configuration of multiple reference timings for DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Not supportive. The use of one single reference timing is critical. The LMF can change reference timing as it wants by subtracting a suitable DL RSTD measurement. |
| Huawei, HiSilicon | We have preference on RAN4 to discuss this.  One thing to note is that when RAN4 define the RSTD accuracy requirement, it could be possible that the intra-PFL RSTD could be accurate since the PRS on a PFL are measured locally, but if the target TRP and reference TRP are on differen PFLs, the requirement is now relaxed since there could be DL synchronization drift between now and then.  In summary, inter-PFL RSTD is not accurate, while intra-PFL RSTD could be accurate from RAN4 performance requirement perspective.  FL: I share the similar view that intra-PFL RSTD could be more accurate than inter -PFL RSTD. However, I assume the accuracy difference between them may not have much impact of expected RSTD and the uncertainty of expected RSTD. It seems no need to configure separate reference timings for different PFLs because of the potential the accuracy difference between them. |
| ZTE | Because of time drift, if the DL PRS for target TRP and DL PRS from reference TRP are separated too far away. The measurement will be biased. Therefore, we think support of multiple reference timings in DL RSTD measurement report can be beneficial.  FL: TRP are time-synchronized. The time draft between DL PRS is limited to the time-synchronization accuracy, which is normally much smaller than the expected RSTD and the uncertainty of expected RSTD for the configuration of reference timing. |
| LGE | We think there is no reason to restrict configuring UE with only one reference time? And then we also think there are no problems if the multiple reference time is supported. UE just reports multiple measurement results for each reference time and the number of measurement result can be increased. We think that advantage of configuring multiple reference time is degree of freedom for LMF. So, We are supportive of the proposal.  FL: I think the discussion is about whether there is a need to configure multiple reference timings instead whether there is a problem to configure multiple reference timings. The purpose of configuring the reference timing with the expected RSTD and the uncertainty of expected RSTD is to help the UE to determine the search window for the DL PRS. From the information provided by the LMF for one single reference timing, UE can choose any other TRP as reference time and derive the corresponding search windows as Ericsson commented. |

# References

1. [R1-2110850](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2110850.doc) Remaining issues of mitigating Rx/Tx timing error Huawei, HiSilicon
2. [R1-2110956](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2110956.doc) Positioning accuracy improvement by mitigating timing delay ZTE
3. [R1-2111013](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111013.doc) Remaining issues on potential enhancements for RX/TX timing delay mitigating vivo
4. [R1-2111256](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111256.doc) Remaining issues on mitigating UE and gNB Rx/Tx timing errors CATT
5. [R1-2111289](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111289.doc) Enhancement of timing-based positioning by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays OPPO
6. [R1-2111364](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111364.doc) Views on mitigating UE and gNB Rx/Tx timing errors Nokia, Nokia Shanghai Bell
7. [R1-2111397](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111397.doc) Remaining issues on mitigating Rx/Tx timing delays Sony
8. [R1-2111495](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111495.doc) Remaining Details of UE/gNB RX/TX Timing Errors Mitigation Intel Corporation
9. [R1-2111609](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111609.doc) Discussion on mitigation of gNB/UE Rx/Tx timing errors CMCC
10. [R1-2111738](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111738.doc) Discussion on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Samsung
11. [R1-2111797](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111797.doc) Discussion on accuracy improvements by mitigating timing delays InterDigital, Inc.
12. [R1-2111874](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111874.doc) Positioning accuracy enhancements under timing errors Apple
13. [R1-2111973](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2111973.doc) Discussion on accuracy improvement by mitigating UE Rx/Tx and gNB Rx/Tx timing delays LG Electronics
14. [R1-2112071](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2112071.doc) Mitigation of RX/TX timing delays for higher accuracy MediaTek Inc.
15. [R1-2112108](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2112108.doc) Discussion on mitigating UE and gNB Rx/Tx timing delays NTT DOCOMO, INC.
16. [R1-2112217](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2112217.doc) Remaining Issues on Timing Error Mitigations for improved Accuracy Qualcomm Incorporated
17. [R1-2112323](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2112323.doc) Considerations for mitigation of Tx/Rx Delays Lenovo, Motorola Mobility
18. [R1-2112339](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2112339.doc) Techniques mitigating Rx/Tx timing delays Ericsson
19. [R1-2110579](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2110579.doc), FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, Moderator (CATT)
20. R1-2112487 Introduction of NR Positioning Enhancements Nokia
21. [R1-2108707](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108707.doc) Reply LS on UE/TRP Tx/Rx timing error mitigation RAN4, CATT
22. [R1-2108696](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108696.doc) Reply LS on granularity of response time RAN2, Huawei
23. [R1-2108697](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108697.doc) Reply LS on Positioning Reference Units RAN3, Ericsson
24. [R1-2108706](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108706.doc) Reply LS on PRS processing samples RAN4, Ericsson
25. [R1-2110369](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2110369.doc) Discussion on RAN4 reply LS on UE/TRP Rx/Tx timing error mitigation