**3GPP TSG RAN WG1 Meeting #106-e [R1-2108242](file:////Users/renda000/Documents/1%20RAN1/2021_08_TSGR_106e/docs/R1-2106259.doc)**

**e-meeting, Aug. 16th – 27th, 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:

[106-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 August 19, 24 and 27 – 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 [1-19]:

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| 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
  + “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

*Background*

The following agreement was made in RAN1#104e for the definitions of the UE/TRP Tx/Rx timing errors and UE/TRP Tx/Rx TEGs. The definitions were agreed upon for purpose of discussion of methods, measurements, signalling, and procedures for mitigating UE Rx/Tx and/or gNB Rx/Tx timing errors, but was not agreed to be included in the specifications yet.

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| Agreement:  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 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. |

## Antenna phase center offset (PCO) and antenna reference point (ARP)

Submitted Proposals

* ***(Nokia,*** [***R1-2107057***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107057.doc)***[6]) Proposal 1: UE to include reporting of gNB specific SRS-Pos TOD offsets to gNB/LMF for post-compensation of direction specific UE antenna phase center offsets thereby enhancing the positioning accuracy.***
* ***(Nokia,*** [***R1-2107057***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107057.doc)***[6])) Proposal 2: UE to signal to gNB/LMF its capabiltiy to compensate for antenna phase center offsets for time based positioning. Note this could apply to both broad beam and narrow beam SRS-Pos transmissions.***
* ***(Nokia*** [***R1-2107057***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107057.doc)***[6]) Proposal 3: Include the impact of antenna PCO in the definition of RX/TX timing errors and associated TEGs.***
* ***(Fraunhofer,*** [***R1-2108101***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108101.doc)***[17]) Proposal 1: Support TRP to provide the LMF with ARP information related to the UL-SRS measurements. (similar to the DL-PRS ARP information).***
* ***(Fraunhofer,*** [***R1-2108101***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108101.doc)***[17]) Proposal 2: Support the UE to provide ARP information relative to a UE reference point using a UE coordinate system (UCS).***

FL comments

The phase center offsets (PCOs) can be different for different antenna panels and different beam directions, which may result in different timing delays or time of departure (TOD) for different beam directions, and have an impact on the measurement and positioning accuracy. Due to the impact of the PCOs, the true coordinates of the antenna center for the RF signal Tx/Rx may be different from the physical antenna reference point (ARP) for different beams and different positioning frequency layers (PFLs). Similar to the Rx/Tx timing errors, the impact of the PCOs could be compensated if they are known. However, the transmitter and/or the receivers may or may not know the PCOs, and if compensated, there can be remaining errors after the calibration. The impact of PCOs as a part of timing errors and included into the definition of the Rx/Tx timing errors and TEGs (as shown in the definitions of the Tx/Rx timing error, i.e., ‘*The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center.’*).

For DL PRS transmission, the effective ARPs of a TRP may be different for the transmission of different DL PRS resources/resource sets. In Rel-16, it is supported in NRPPa for gNB to report the location information of the effective ARPs to LMF. However, the specification currently does not support gNB to provide such information for UL-SRS measurements reception to the LMF.

### Proposal 2.1-1

* *Subject to UE’s capability, support UE to include reporting of gNB specific SRS-Pos TOD offsets to gNB/LMF for post-compensation of direction specific UE antenna phase center offsets thereby enhancing the positioning accuracy*
  + *FFS: whether the information is relative to a UE reference point in a UE local coordinate system (LCS).*
* *Support UE to signal to gNB/LMF its capability to compensate for antenna phase center offsets for time-based positioning.*

Comments

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| **Company** | **Comments** |
| Huawei, HiSilicon | This has been proposed for a couple of meeting.  To our understanding, the precondition of UE directionally specific PCO reporting would also require panel center reporting (inter-panel offset reporting), if we interprete PCO as intra-panel offset.  This can be considered low priority unless we made process on UE panel-specific ARP reporting first. |
| **OPPO** | Not support.  As commented last meeting, the definition of Tx timing error and Rx timing error has included the impact of the phase center offsets  Additionally, one question for the clarification on “*gNB specific SRS-Pos TOD offsets*”. What does “gNB specific” mean here? In our understanding, UE doesn’t know which TRP/gNB will measure the SRS-Pos. |
| Ericsson | The expected errors are typically smaller than filter group delay. This can be lower priority for Rel-17 and may be discussed in Rel. 18. |
| CATT | We prefer to treat it as low priority. |
| **FL** | **It seems it is lack of the support for the proposal for this release. We may consider to make the conclusion of no further discussion on the phase center offsets (PCOs) in the WI.** |
| Nokia/NSB | We will feel that this issue is very important to meeting the requirements for the IIoT, in particular for an FR2 UE. We understand that many companies feel this issue is lower priority but we have provided simulation results that show that if this issue is not fixed that the requirements of 20 cm for IIoT are already in danger. As such we make the following compromise proposal:  PCO impact on the Tx/Rx timing errors will be discussed during UE capability. |

Proposal 2.1-2

* *Support gNB to provide LMF with the information of antenna reference point(s) (ARPs) related to the UL-SRS measurements (e.g., RTOA, UL-AoA/ZoA)*
  + *FFS: whether to support gNB to provide the direction-specific antenna phase center offsets (PCO) relative to a ARP to LMF*

Comments

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| **Company** | **Comments** |
| Ericsson | The expected errors are typically smaller than filter group delay. This can be lower priority for Rel-17 and may be discussed in Rel. 18. |
| CATT | We prefer to treat it as low priority. |
| ZTE | Support in general. Different ARPs may have different locations. We prefer to discuss this issue in UL-AOA agenda to avoid duplicated discussion. |
| **FL** | **ZTE’s suggestion is reasonable.** |

### (Round 2) Proposal 2.1-2

Suggest closing the discuss in this AI and continue the discussion in UL-AOA agenda.

Comments

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| **Company** | **Comments** |
| Nokia/NSB | Don’t support. We will feel that this issue is very important to meeting the requirements for the IIoT, in particular for an FR2 UE. We understand that many companies feel this issue is lower priority but we have provided simulation results that show that if this issue is not fixed that the requirements of 20 cm for IIoT are already in danger. As such we make the following compromise proposal:  PCO impact on the Tx/Rx timing errors will be discussed during UE capability. |
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## Clarification of the ‘error margins’ in Rx/Tx/RxTx TEG definitions

Submitted proposals

* (Ericsson, [R1-2108164](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)[19])Proposal 26 RAN1 to clarify the definition of timing error groups as given by the text proposal.

***---------------------------------------------- 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 δ, 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 δ.
* **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 δ, 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 δ.
* **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 δ, 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 δ.
* **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 δ, 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 δ.
* **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 δ, 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 δ.
* **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 δ, 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 δ.

FL comments

The clarification of the definition of timing error groups proposed in [19] seems reasonable to me. For the proposed TP, it seems no need to include the symbol δ.

### Proposal 2.2-1

***Make the following modifications to the definition of timing error groups:***

* ***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.*

Comments

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| **Company** | **Comments** |
| Qualcomm | We think it will be useful in the Rx TEGs to clarify: “between two TOA measurements” and not just say “DL measurements”: We observed in both RAN1 and Ran4 some misuncerstanding might exist that, Rx TEG might correspond to timing error of RSTD measurements. However, we believe that most companies in RAN1, when the above agreement was made, had in mind that Rx TEGs are associated with the “TOA”, (i.e. one Rx TEG ID for the reference TRP, and another Rx TEG ID for a target TRP). |
| OPPO | Not sure how much additional information added by this proposal. From our understanding, it is the same as the existing agreement. We can keep open on it if majority companies support to update the agreement in such way  By the way, we think QC’s clarification on TOA is reasonable (although it is a common understanding in RAN1). |
| Intel | We are supportive of the proposal, but we prefer not to spend time online rediscussing. In our view this modification, if needed, can be done by RAN4 directly. |
| **FL** | To Qualcomm’s comments: Yes. I share the same view that in our mind, “ Rx TEGs are associated with the TOA. QC’s proposal is also fine to me. However, the concern is that we have not define “TOA measurements”. How about we say: “*one or more DL time measurements”/* “*one or more UL time measurements”?*  To Intel’s comments: Yes. Let us try to see if we can rach the consensus through email discussion. I don’t think we have the chance to bring this to GTW session, given that there are so many issues that needs to be closed. |
| Ericsson | Support the proposal. |
| CATT | Support the proposal with the modifications “one or more DL time measurements”/ “one or more UL time measurements” to address Qualcomm’s concern. |
| ZTE | FL’s latest comments seems reasonable. We’re fine with the updates if majority companies think it’s necessary. |
| **FL** | Let us what for more comments to see if we can reach offline consensus. |

FL Comments

Let us to see if we can reach offline consensus through email discussion.

### (Round 2) Proposal 2.2-1

***Make the following modifications to the definition of timing error groups:***

* ***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 time measurements, which have the Rx timing errors within a certain margin, i.e. the difference in UE Rx timing error between two DL time 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 time measurements, which have the Rx timing errors within a margin, i.e. the difference in TRP Rx timing error between two UL time 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.*

Comments

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| **Company** | **Comments** |
| Nokia/NSB | We agree in principle with QC’s comments above but feel this issue is low priority. We can add an accurate description to the spec when we write it and don’t feel it is critical to spend time discussing this when the solutions are already being agreed. |
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# Methods for mitigating UE/TRP Tx/Rx timing errors

## TRP Tx timing errors and/or UE Rx timing errors for DL TDOA

Background

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| **Conclusion** (RAN1#104-e):  Study the following options for mitigating TRP Tx timing errors and/or UE Rx timing errors for DL TDOA:   * Option 1:   + Support a TRP to provide the association information of DL PRS resources with Tx TEGs to LMF * Option 2:   + Support LMF to provide the association information of DL PRS resources with Tx TEGs to UE for UE-based positioning * Option 3:   + Support a TRP to provide the Tx timing errors per Tx TEG to LMF * Option 4:   + Support LMF to provide the Tx timing errors per Tx TEG of TRP to a UE for UE-based positioning * Option 5:   + Support a UE to provide the association information of RSTD measurements with UE Rx TEG(s) to LMF when the UE reports the RSTD measurements to LMF * Option 6:   + Support LMF to provide Rx timing errors per Rx TEG to a UE for UE-based positioning * Option7:   + Support a UE to provide Rx timing errors per Rx TEG to LMF for UE-assisted positioning * Option 8:   + Support a TRP to provide the Tx timing error differences between Tx TEGs of the TRP to LMF * Option 9:   + Support LMF to provide the Tx timing error differences between Tx TEGs of a TRP to a UE for UE-based positioning * Option10:   + Support a UE to provide Rx timing error differences between Rx TEGs to LMF for UE-assisted positioning * FFS: details of the ignaling, procedures, and UE capability * FFS: How the TEGs are determined by the UE or TRP (could be by implementation, i.e., no specification impact) * Note: Other options are not precluded. * Note: Depending on the discussion results, none/one/multiple of the above options may be adopted in Rel-17.   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 proposals

* *(ZTE,* [*R1-2106549*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)*[2]) Proposal 2: For DL-TDOA, subject to UE’s capability, support a UE to*
  + *Measure the same DL PRS resource from a TRP with different UE Rx TEGs, and report corresponding RSTD measurements.*
    - *the TRP can be both ‘RSTD’ reference TRP and neighbour TRP*
    - *all RSTD measurements share the same timestamp*

**FL:** Further discussion in Proposal 3-1.2a. The timestamp of the measurement instances in a report can be discussed in Section 5.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 1:* 
  + *The UE can be requested to provide the association information of RSTD measurements with UE Rx TEG(s) to LMF.*

**FL:** This seems already agreed.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 2:* 
  + *When the UE is able to measure PRS(s) from a TRP associated with different UE Rx TEGs, support the UE to report original RSTD measurements (uncompensated measurements) and related Rx TEGs information to the LMF, rather than compensating ‘Rx timing error difference’ by UE implementation and then reporting compensated RSTD measurements to the LMF.*

**FL:** Further discussion in Proposal 3-1.2a (Proposal 3-1.4 is also related)

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 3:* 
  + *In DL-TDOA method, to eliminate the positioning error caused by the UE Rx timing errors of more than one UE Rx TEGs, the RSTD measurement report of a certain TRP for more than one UE Rx TEGs needs to be guaranteed if the UE is able to measure PRS(s) associated with different UE Rx TEGs.*
* *FFS the UE reporting rules to guarantee the RSTD measurement report for more than one UE Rx TEGs.*

**FL:** Whether to guarantee or up to UE implementation to report the number of RSTD measurements under a particular condition seems related to performance requirement and thus can be handled by RAN4 in my view.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 4:* 
  + *In DL-TDOA method, to include different Rx TEG IDs for the same PRS resource in the DL RSTD measurement report, two options can be considered:*
    - *Option 1: Include one UE Rx TEG ID for one DL RSTD measurement.*
    - *Option 2: Include different UE Rx TEG IDs for one DL RSTD measurement, that is, associate additional UE Rx TEG ID with additional path group.*
  + *From the perspective of signallingg overhead, Option 2 is preferred.*

**FL:** Further discussion in Proposal 3-1.1

* *(Samsung,* [*R1-2106888*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc)*[5])Proposal 1: For DL-TDOA, the UE can report the association information of Rx TEGs associated with RSTD measurements to LMF (e.g., in the IE NR-DL-TDOA-SignalMeasurementInformation).*

**FL:** This seems already agreed. Which message to include the association information can be decided by RAN2.

* *(OPPO,* [*R1-2107213*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)*[8])Proposal 2: Subject to UE capability, UE can report the following information in a DL TDOA measurement report (NR-DL-TDOA-SignalMeasurementInformation)*
  + *One Rx TEG ID for the RSTD reference TRP*
    - *It can be achieved by setting nr-RSTD and nr-RSTD-ResultDiff to be zero for the corresponding DL RSTD measurement*
  + *One Rx TEG ID for each DL RSTD measurement (NR-DL-TDOA-MeasElement)*
  + *One Rx TEG ID for each DL RSTD measurement for an additional path (NR-DL-TDOA-AdditionalMeasurementElement)*
* **FL:** Further discussion in Proposal 3-1.1. Including Rx TEG ID in NR-DL-TDOA-AdditionalMeasurementElement does not mean “one Rx TEG ID for each DL RSTD measurement for an additional path” in my view.
* *(OPPO,* [*R1-2107213*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)*[8])Proposal 3: Rel-17 doesn’t support UE to report multiple DL RSTD measurement which are measured on the same DL PRS resource from a TRP with different UE Rx TEGs.*

**FL:** Further discussion in Proposal 3-1.2a. Most companies support reporting multiple DL RSTD measurements which are measured on the same DL PRS resource from a TRP with different UE Rx TEGs

* *(Qualcomm,* [*R1-2107345*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)*[9]) Proposal 2: Subject to UE capability, support UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement, in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different.* 
  + *Note: Two RSTD measurements derived on the same or different PFL can be associated with the same or different Rx TEG ID (i.e., Rx TEG IDs are defined across PFLs, and they are not PFL-specific).*

**FL:** Further discussion in Proposal 3-1.1. About the Note, while I share the same view that Rx TEGs should not be PFL-specific, my suggestion is not to add it. My consideration is that the definition of Rx TEG says clearly that the only condition for UE to determine whether two RSTD measurements belong to the same Rx TEG is based on the error margin, regardless of whether the margin is caused by the factors of time, frequency, etc. Adding the note may trigger the discussion of adding all these factors.

* *(Qualcomm,* [*R1-2107345*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)*[9]) Proposal 3: Support to include in the location request message, a request to report multiple RSTD measurements, if available, derived on the same DL PRS resources with different UE Rx TEGs.*
  + *Up to UE implementation whether/if the UE will include in the report multiple Rx TEGs in the report for the same PRS resource.*

**FL:** Further discussion in Proposal 3-1.2a. Whether to gup to UE implementation to include in the report multiple Rx TEGs in the report for the same PRS resource may be handled by RAN4 in my view.

* *(Qualcomm,* [*R1-2107345*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)*[9]) Proposal 5: For UE-based DL-TDOA, support a UE receiving the Tx-TEG information for each PRS resource in the unicast or broadcast assistance data.* 
  + *Send an LS to RAN2 to continue the design.*
* **FL:** We have the agreement to support the LMF to provide the association information of DL PRS resources with Tx TEGs to a UE for UE-based positioning. Share the similar view that RAN1 may send the LS to RAN2/3 for them to start working on the agreements made in RAN1.
* *(CMCC,* [*R1-2107403*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)*[10])Proposal 1: Subject to UE capability, support UE to include a UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report.*

**FL:** Further discussion in Proposal 3-1.1

* *(CMCC,* [*R1-2107403*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)*[10])Proposal 2: Subject to UE’s capability, support a UE to measure the same DL PRS resource from a TRP with different UE Rx TEGs, and report corresponding RSTD measurements.*

**FL:** Further discussion in Proposal 3-1.2a

* *(Intel,* [*R1-2107590*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107590.doc)*[12]) Proposal 1:*
  + *Support UE to include one UE RX TEG ID for the RSTD reference time (corresponding to the reference TRP) and one UE RX TEG ID for each DL RSTD measurement in a DL TDOA measurement report. The two UE RX TEG IDs can be the same or different.*

**FL:** Further discussion in Proposal 3-1.1

* *(InterDigital,* [*R1-2107643*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)*[13]) Proposal 4: For UE-B positioning methods, support the UE to request the information of gNB TEG.*

**FL:** We have the agreement to support the LMF to provide the association information of DL PRS resources with Tx TEGs to a UE for UE-based positioning. Assume RAN2 will work on the details of request/response messages.

* *(Apple,* [*R1-2107740*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)*[14]) Proposal 3: Subject to UE capability, support a UE reporting the RSTD measurements to the LMF to provide the association information of RSTD measurements with UE Rx TEG(s) for both the target and the reference TRPs to the LMF, if target and reference PRSs are associated with different RX TEG IDs*

**FL:** Further discussion in Proposal 3-1.2a

* *(MediaTek,* [*R1-2107822*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)*[15]) Proposal 4-1: UE may indicate whether the delay difference between 2 RX TEGs is compensated at UE side for DL-RSTD reporting*

**FL:** Further discussion in Proposal 3-1.2a

* *(MediaTek,* [*R1-2107822*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)*[15]) Proposal 4-2: If UE determines to compensate the delay difference between 2 RX TEGs for DL-RSTD measurement, then the delay difference reporting is not needed*

**FL:** Further discussion in Proposal 3-1.2a

* *(MediaTek,* [*R1-2107822*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)*[15]) Proposal 4-4: Support UE to measure different DL PRS resources from a TRP with the same UE RX TEG, and report corresponding RSTD measurements*

**FL:** Further discussion in Proposal 3-1.2b

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 1 Support a UE to provide the association information of RSTD measurements with UE Rx TEG(s) for both the target and the reference TRP to the LMF when the UE reports the RSTD measurements to the LMF if the UE has multiple TEGs*

**FL:** Further discussion in Proposal 3-1.1

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 2 Support a UE to perform multiple RSTD measurements towards the same TRP utilizing different UE RX TEGs and to report these measurements to the LMF.*

**FL:** Further discussion in Proposal 3-1.2a

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 3 Support a UE to perform multiple RSTD measurements towards the same TRP based on different repetitions of the same DL PRS, utilizing different UE RX TEGs and to report these measurements to the LMF.*

**FL:** Further discussion in Proposal 3-1.2a. A RSTD measurement may be obtained from one or more repetitions of the same DL PRS in Rel-16.

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 4 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:** Further discussion in Proposal 3-1.2a. Details of the signalling for the configuration can be handled by RAN2.

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 5 RAN1 to study further whether the UE should be capable of performing multiple RSTD measurements towards the same TRP utilizing different UE RX TEGs not only based on different repetitions of the same DL PRS but also based on a) different DL PRSs transmitted from the same TRP, b) different symbols of the same DL PRS, c) different occasions of the same DL PRS, d) different DL PRSs transmitted from the same TRP, and/or e) simultaneous reception of the same DL PRS.*

**FL:** Further discussion in Proposal 3-1.2b

## Association of UE Rx TEGs with RSTD measurements

FL comments

In RAN#105e, the association of the Rx TEG IDs with the RSTD measurements was discussed without conclusion. The last version for discussion in the previous meeting is as follows [21].

|  |
| --- |
| (RAN1#105e) Proposal 3.1-1 (Revision 4)(H)  * Subject to UE capability, support UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different. * FFS: Whether to include more than one UE Rx TEG ID for each DL RSTD measurement that including UE Rx TEG ID with each RelativeTimeDifference for the additional paths |

Based on the contributions submitted in this meeting, it seems the common view is that there should be one Rx TEG ID for the reference TRP(i.e., NR-DL-TDOA-SignalMeasurementInformation) (i.e., in *NR-DL-TDOA-MeasElement*) and one Rx TEG for each DL RSTD measurement (*NR-DL-TDOA-MeasElement* and *NR-DL-TDOA-AdditionalMeasurementElement*) (e.g., [2][3][5][6][7][8][9][10][12][14][19]). On the issue of whether to include Rx TEG ID for the RSTDs of the additional path, most companies do not think it is necessary. The consideration is that the RSTDs of the additional paths are all derived from the same CIR, and thus have the same Rx time delay. However, there are also suggestions to include Rx TEG ID for each DL RSTD measurement for an additional path (e.g., [3][8]).

NR-DL-TDOA-SignalMeasurementInformation-r16 ::= SEQUENCE {

dl-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,

nr-DL-TDOA-MeasList-r16 NR-DL-TDOA-MeasList-r16,

RxTEG ID for reference time

...

}

NR-DL-TDOA-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-DL-TDOA-MeasElement-r16

NR-DL-TDOA-MeasElement-r16 ::= SEQUENCE {

dl-PRS-ID-r16 INTEGER (0..255),

nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL,

nr-CellGlobalID-r16 NCGI-r15 OPTIONAL,

nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL,

nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL,

nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL,

nr-TimeStamp-r16 NR-TimeStamp-r16,

nr-RSTD-r16 CHOICE {

k0-r16 INTEGER (0..1970049),

k1-r16 INTEGER (0..985025),

k2-r16 INTEGER (0..492513),

k3-r16 INTEGER (0..246257),

k4-r16 INTEGER (0..123129),

k5-r16 INTEGER (0..61565),

...

},

RxTEG ID for each TDOA measurement

nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL,

nr-TimingQuality-r16 NR-TimingQuality-r16,

nr-DL-PRS-RSRP-Result-r16 INTEGER (0..126) OPTIONAL,

nr-DL-TDOA-AdditionalMeasurements-r16

NR-DL-TDOA-AdditionalMeasurements-r16 OPTIONAL,

...

}

NR-DL-TDOA-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..3)) OF

NR-DL-TDOA-AdditionalMeasurementElement-r16

RxTEG ID for each additional TDOA measurement

### (Closed) Proposal 3.1-1

* *Subject to UE capability, support a UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement (including each additional DL RSTD measurement), in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different.*
* *FFS: Whether to include UE Rx TEG ID for the additional paths*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We are supportive of the proposal, but we still think, in order to avoid future misunderstandings of what this proposal means, it would be good to clarify that the target TRP and the reference TRP can be in the same or different PFL, or can have same or different timestamp. If this is common understanding for everyone, we are OK to keep it as a note, but it is good to do keep discussion clear. |
| Huawei, HiSilicon | We are in general fine with this, since this was left-over from the last meeting. |
| Apple | Support |
| CATT | Support. Regarding the FFS, we don’t think it is necessary to include UE Rx TEG ID for the additional pahts based on the reasons mentioned by FL. |
| **vivo** | We are supportive of the proposal, but in order to avoid misunderstandings that a new parameter” the RSTD reference time” need to be introduced, it would be good to clarify that RSTD reference time can be the corresponding DL RSTD measurement that nr-RSTD and nr-RSTD-ResultDiff to be zero.  Therefore, we propose to change the proposal to Proposal 3.1-1 (H)  * *Subject to UE capability, support a UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement (including each additional DL RSTD measurement), in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different.* * *FFS: Whether to include UE Rx TEG ID for the additional paths*   *Note: RSTD reference time can be the corresponding DL RSTD measurement that nr-RSTD and nr-RSTD-ResultDiff to be zero.*  In addition, just to clarify our understanding regarding **‘***include UE Rx TEG ID for the additional paths***’** in our paper**.**  We are not to associate Rx TEG with additional path, but to associate Rx TEG with same level IE of additional path list. The paths in a path list/group are measured based on the same PRS resource with the same Rx TEG (e.g. Rx panel) and derived based on same CIR.  For the case where UE measures one PRS resource with different Rx TEG, the report overhead can be reduced, since the duplicate bit overhead such as TRP/PRS resource set/PRS resource ID, time stamp etc. for the same PRS resource is saved.  An example for ‘associate Rx TEG with same level IE of additional path list’ is below.   |  | | --- | | NR-DL-TDOA-MeasElement-r16 ::= SEQUENCE {  dl-PRS-ID-r16 INTEGER (0..255),  nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL,  nr-CellGlobalID-r16 NCGI-r15 OPTIONAL,  nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL,  nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL,  nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL,  nr-TimeStamp-r16 NR-TimeStamp-r16,  nr-RSTD-r16 CHOICE {  k0-r16 INTEGER (0..1970049),  k1-r16 INTEGER (0..985025),  k2-r16 INTEGER (0..492513),  k3-r16 INTEGER (0..246257),  k4-r16 INTEGER (0..123129),  k5-r16 INTEGER (0..61565),  ...  },  nr-RxTEGID NR-RxTEGID OPTIONAL  nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL,  nr-AdditionalRxTegMeasurementList NR-AdditionalRxTegMeasurement OPTIONAL  nr-TimingQuality-r16 NR-TimingQuality-r16,  nr-DL-PRS-RSRP-Result-r16 INTEGER (0..126) OPTIONAL,  nr-DL-TDOA-AdditionalMeasurements-r16  NR-DL-TDOA-AdditionalMeasurements-r16 OPTIONAL,  ...  }  NR-AdditionalRxTegMeasurementList -r17 ::= SEQUENCE {  nr-RxTEGID NR-RxTEGID OPTIONAL  NR-AdditionalPathList-r16 SEQUENCE (SIZE(1..3)) OF NR-AdditionalPath-r16  ...  } | |
| OPPO | We are fine with the proposal. |
| CMCC | We are general fine with the proposal, with one further comment. In the last meeting, some companies raised the point which was also the common understanding among most companies that, the DL measurement from the reference TRP is also carried in the DL-TDOA-MeasElement list, of which the value equals zero. In this sense, the UE Rx TEG ID of the reference time is either reported under the first highlight part shown in the above IE, or under the second highlight part, and will not be reported redundently, am I understanding correctly? |
| ZTE | Support. We should remove FFS since additional paths and TOA are from the same delay profile. Therefore, additional paths and TOA should of course be associated with the same TEG. |
| LG | We generally agree with the motivation of the proposal. But, before we discuss it, we think some clarification is needed first. We want to clarify whether the single PRS resource can be associated with multiple Rx TEG IDs or not?. If it is right, we have to consider how LMF can distinguish the specific Rx TEG which has a larger margin of error than the other Rx TEG that has a smaller margin of error. For example, UE has two Rx TEGs that are associated with a single PRS resource. And then, the one has larger values of margin of error than the other. There are some ambiguity problems when LMF receives the Rx TEG ID since the Rx TEG ID with larger value of error already covers the smaller value of error. |

Agreement:

* Subject to UE capability, support a UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement (including each additional DL RSTD measurement), in a DL TDOA measurement report. These UE Rx TEG IDs can be the same or different.
* Note: RSTD reference time is related to the DL\_PRS\_Reference\_Info IE

## RSTD measurement enhancements

FL Comments

|  |
| --- |
| (RAN1#105e) Proposal 3.1-3 (Revision 4)(H)  * Subject to UE’s capability, support a UE to   + **measure *the same* DL PRS resource from a TRP *with different UE Rx TEGs*, and report corresponding RSTD measurements.**   + measure different DL PRS resources from a TRP with the same UE RX TEG, and report corresponding RSTD measurements.   + measure *different* DL PRS resources from a TRP *with different UE Rx TEGs*, and report corresponding RSTD measurements.   + FFS: indicate whether the measured RX TEG timing error difference has been compensated at UE side. * Note: All RSTD measurements are relative to a single reference timing * FFS: Whether the TRP can be both “RSTD” reference TRP and neighbor TRP * FFS: details of the Signaling, procedures, and UE capability |

In RAN#105e, the proposal of UE measuring the same or different DL PRS resources from a TRP with the same or different UE Rx TEGs to obtain RSTD measurements was discussed without conclusion [21]. In this meeting, multiple companies propose to support measuring the same DL PRS resource from a TRP with different UE Rx TEGs, and report corresponding RSTD measurements (e.g., [2][3][5][9][10][15][19]). However, one company proposes not to support it [8]. The main purpose of measuring the same DL PRS resource from a TRP with different UE Rx TEGs is to obtain information of time difference of the different UE Rx TEGs. Some companies also propose to support measuring different DL PRS resources from a TRP with the same UE Rx TEGs, and report corresponding RSTD measurements (e.g., [15][19]), which may potentially allow the LMF to obtain the time difference of the different TRP Tx TEGs.UE reporting rule (e.g., whether UE should guarantee the RSTD measurements for more than one UE Rx TEGs or up to UE implementation to provide the RSTD measurements for more than one UE Rx TEGs) can be decided by RAN4 in my view.

Proposal 3.1-2a (H)

* *Subject to UE capability, support LMF to* ***request*** *a UE to measure and report multiple RSTD measurements from* ***the same*** *DL PRS resource of a TRP with* ***different*** *UE Rx TEGs.*
* *Support one [or both] of the following options for the reporting of the RSTD measurements:*
  + *Option 1: RSTD measurements are reported without compensation of the timing error difference between Rx TEGs*
  + *Option 2: RSTD measurements are reported with an indication that the timing difference between the TEGs are compensated.*
* *FFS: Whether the TRP can be both “RSTD” reference TRP and neighbor TRP*
* *FFS: details of the signalling, procedures, and UE capability*
* *Note: All RSTD measurements are relative to a single reference timing*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MTK | In our views, if UE has at least 2 RX TEGs, UE can actually measure a same DL PRS resource of a TRP with different RX TEGs, making them loke a single TEG. And this TRP could be set as reference TRP by UE. So, UE can perform the **measurement** but doesn't need to **report** it.  For the 2 options listed by FL, we think it can also be done during UE capability reporting. So, to FL, before having agreement on this proposal , we would like to clarify the UE capability. Whether the UE capability supports the following cases  1, UE reports itself to have single RX TEG. Then UE doesn't need to do such measurement and reporting  2, UE reports itself to have multiple RX TEGs. UE will do on-the-fly measurement to fill the difference between RX TEGs to make them like a single RX TEG  3, UE reports itself to have multiple RX TEGs. UE will do on-the-fly measurement for the difference between RX TEGs, and UE expects LMF to deal with the DL-RSTD measurement related to multiple RX TEGs  Or when doing the capability reporting, for the above 2), UE simply reports single RX TEG who will do on-the-fly measurement to fill the difference between RX TEGs to make them like a single RX TEG  Either way is fine for us for the case of performing the measurement without reporting for mitigating RX TEG difference. But we think we need consensus/agreement here |
| Qualcomm | We are supportive of the first bullet, but we do think that It will be useful to acknowledge that a UE will “optionally” report, even if it supports this feature (similar to RSRP reporting), that is change the firs bullet to:   * *Subject to UE capability, support LMF to* ***request*** *a UE to measure and optionally report multiple RSTD measurements from* ***the same*** *DL PRS resource of a TRP with* ***different*** *UE Rx TEGs.*   To explain the reasoning: Even though we acknowledge that most (if not all) positioning reports are optional, if the UE gets a request to measure the same PRS resource with multiple Rx TEGs, it may mean that the UE might have to do measurements with 2 panels simultaneously (or more antennas than what it was initially planning to do). That UE might not be capable of doing simultaneous processing/reception from both Rx TEGs, or might have other constraints that don’t allow the UE to do measurements from multiple Rx TEGs concurrently. Therefore, the measurement period might increase, or the UE might not be able to do the reporting.  We also think that RAN4 will need to know about this agreement:   * Up to RAN4 to study further any measurement requirements may be needed for this feature   We don’t really understand the 2nd bullet, and how it is related to the first bullet. It seems to us a UE capability disucsion or a separate topic. |
| Huawei, HiSilicon | Regarding the reporting options, we do not see the need to explicitly mention whether it is compsenstated. How could LMF utilize such information? |
| Apple | We share similar view as QC. In addition, the request for report subject to UE capability may be endorsed by UE “optionally, for UE assisted positioning, if UE indicates to have more than 2 RX TEG.” |
| CATT | Support the first bullet and both the two Options.  For the UE measure multiple RSTD measurements from the same DL PRS resource of a TRP with different UE Rx TEGs, UE may or may not compensate the timing error difference between the Rx TEGs. About the reason why UE cannot compensate it, it is because UE is lack of enough information(such as TRP location information), the UE may not finish accurate Rx timing error difference estimation. Therefore, in this case, UE can report the RSTD measurements without compensation of the timing error difference between Rx TEGs. |
| **vivo** | We prefer to discuss 1st bullet and 2nd bullet separately  Support the first bullet firstly.  For the 2nd bullet, we would like to understand whether the TEGs error can be seen as zero if an indication of TEGs are compensated is reported. If it is, RAN4 can guarantee this? If not, which may introduce new errors caused by unreasonable Rx timing error difference estimation after compensation in RSTD measurements. In addition, according to the evaluation result in our contribution, the performance of Rx timing error difference estimated and compensated by the LMF is better than the performance of Rx timing error difference estimated and compensated by the UE. |
| OPPO | In our understanding, this feature is not very usefull based on the following reasons:  1. there are less chance for a UE to measure the same PRS with different Rx TEGs with satisfied quality, especially considering that different panels of a UE are targeting different directions. In other words, it is likely that UE cannot report the measurement with different Rx TEGs  2. UE can companensate the difference itself and no need to report additional reporting.  The counterpart proposal of gNB to measure the same SRS resource with multiple Rx TEGs should also be considered together. |
| CMCC | Support the 1st main bullet.  Regarding the two options of the 2nd bullet, we think that it is either up to UE capability, or up to UE implementation, and we don’t see the benefits of the two options. |
| ZTE | * For the first bullet, we don’t need the request from LMF. If UE has such capability, it’s up to UE to decide whether to report measurements from multiple RX TEGs based on the same DL PRS. * We should assume that different UE Rx TEGs receive the same DL PRS simultaneously. Therefore, we would like to add another FFS: The multiple RSTD measurements share the same time stamp * Regarding the two options, it relies on whether UE has the capability to compensate locally so that only one TEG is assumed. We should confirm with RAN4 on the feasibility before any progress made by RAN1. |
| LG | * From our perspective, we are not sure the benetifs of supporting the proposal by restricting UE’s behaviour.. |
| Intel | We are OK with the first subbulet. Prefer to discuss separately the second subbulet. |
| InterDigital | We support the proposal.  For the first bullet, requesting the UE to use different Rx TEGs in one DL PRS resources can help the network aware of the TEG differences among Rx TEGs.  For the second bullet, two options should be supported. Option 1 can be used for the UE without Rx TEG compensation capability and Option 2 can be used otherwise. |
| Ericsson | We are supportive of the proposal except for the second bullet.  In particular, we are not supportive of Option 2 in the second subbullet. In fact, if the UE compensates for the measured timing error differences, then the reported RSTD measurements towards the same TRP using different UE Rx TEGs will be identical and thus redundant. Such a case effectively corresponds to a single UE Rx TEG.  The first bullet in the proposal allows for full mitigation of UE Rx-Tx timing errors as shown e.g. in section 2.2 in R1- 2108164 or in the figure below and is thus of top priority.  Chart  Description automatically generated  @ZTE: We think the part with ‘LMF to request’ is important to keep. This way, the UE that has this capability gets the particular request from the LMF to perform measurement of the same DL PRS resource with different UE Rx TEGs. |
| NTT DOCOMO | We are supportive of the 1st bullet. Regarding 2nd bullet, it can be handled in UE capability discussion. |
| ZTE2 | @Ericsson, We think we should allow more flexibility for UE decide whether to switch on or off more than one TEG for a single DL PRS resource measurement without mandatory request from LMF. |
| **FL** | Based on the comments, it seems most of the companies are supportive to the 1st bullet, except OPPO.  For the 2nd bullet, I assume there can be at least three different scenarios, as MTK lists. I assume the scenario that the UE simply reports what it has measured without internal compensations is in the mind of most companies for supporting 1st bullet. In this case, one way forward is simply list the reporting for other two scenarios as FFS.  To Qualcomm’s comments: It is unclear to me why there is a need to add “Optionally”. It seems “*optionally” is redundant.* If “*UE might not be capable of doing simultaneous processing/reception from both Rx TEGs, or might have other constraints that don’t allow the UE to do measurements from multiple Rx TEGs concurrently”,* then UE should not claim it has the capability to support it. In this case, the LMF will not make such request.  To Apple’s comments: Maybe we can add “for UE-assisted DL-TDOA” to address the concern.  For OPPO’s comments: I assume whether “ UE to measure the same PRS with different Rx TEGs with satisfied quality” is highly scenario dependent. It will be up to LMF on how to use the information. For UE that can companensate the difference itself, I assume the UE can simply let LMF know it does not support the capability.  I don’t see any comments on the “• FFS: Whether the TRP can be both “RSTD” reference TRP and neighbor TRP”. About the counterpart proposal of gNB to measure the same SRS resource with multiple Rx TEGs, I assume we can add it in once we have the agreement in UE side.  Also, it seems we may need to have a consideration on how many ***different*** *UE Rx TEGs* is supported by the UE to make the measurement. It should also be related to UE capability in my view. |

* *Subject to UE capability, support a LMF to* ***request*** *a UE to measure* ***different*** *DL PRS resources from a TRP with* ***the same*** *UE Rx TEG, and report corresponding RSTD measurements*

### (Round 2) Proposal 3.1-2a (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 RSTD measurements without the compensation of the timing error difference between the Rx TEGs.*
  + *FFS: N=[2, 3, 4], the value N depends on UE capability.*
  + *FFS: whether to support reporting the corresponding multiple RSTD measurements after the compensation of the timing error difference between the Rx TEGs.*
* *Note: The TRP can be either a “RSTD” reference TRP or a neighbor TRP*
* *FFS: details of the signalling, procedures, and UE capability*
* *Note: All RSTD measurements are relative to a single reference timing*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | We support the main bullet. We think we can just remove the 2nd FFS. |
| Qualcomm | We support the main bullet but some comments so that our reasoning is clear:   * Why we think keeping the word “optionally” is important:   + To FL’s comment: If “*UE might not be capable of doing simultaneous processing/reception from both Rx TEGs, or might have other constraints that don’t allow the UE to do measurements from multiple Rx TEGs concurrently”,* then UE should not claim it has the capability to support it. In this case, the LMF will not make such request.   + Capabilities are reported relatively statically, even though they can change, they cannot be reported in a dynamic fashion. A UE may turn on/off panels, antennas, repurpose antennas for other technologies, in a dynamic fashion, which are basic functionalities already existing. It is rather unfortunate to think that, when this request is received, a UE must keep both panels ON, or antennas, no matter what, in order to satisfy this secondary information reporting; it should be understood that these are secondary optimization features, and are more best-effort features. As is the case of RSRP reporting for TDOA/MRTT: The UE reports capability, and the LMF may receive a request, but the UE may not report RSRP at all.   + Also, if the UE is requested to measure with multiple Rx TEGs, the UE may NOT be able to do those measurements simultaneously, so the UE would take double the time (assuming 2 TEGs), and we don’t know whether RAN4 will adjust the measurement period accordingly (these discussions have not started yet). So overall, the word “optionally” is key here for us, and should be kept in the proposal. * I still don’t understand what the “*FFS: whether to support reporting the corresponding multiple RSTD measurements after the compensation of the timing error difference between the Rx TEGs.”* We prefer to remove it. * With regards to the “*Note: The TRP can be either a “RSTD” reference TRP or a neighbor TRP*”   + We preferred the previous “whether” option. We could finalize it next meeting. |
|  |  |

Proposal 3.1-2b

* *Subject to UE capability, support a LMF to* ***request*** *a UE to measure* ***different*** *DL PRS resources from a TRP with* ***the same*** *UE Rx TEG, and report corresponding RSTD measurements*
* *FFS: Whether the TRP can be both “RSTD” reference TRP and neighbor TRP*
* *FFS: details of the Signaling, procedures, and UE capability*
* *Note: All RSTD measurements are relative to a single reference timing*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| MTK | This reporting is more important than 3.1-2a, because this reporting may help to mitigate the TRP-specific impairment  3.1-2a is UE-specific impairment. UE can actually fix it through on-the-fly measurement. So the reporting is less critical than 3.1-2b |
| Qualcomm | We are OK to add this in 3.1-2a together. Also, we think the clarification that “and optionally report” will be useful to avoid any misunderstandings. |
| OPPO | Share the same view as MTK |
| **InterDigital** | We support the proposal. This feature is essential to allow the network to aware of its Tx TEGs. |
| Ericsson | We think this proposal follows from 3.1-2a and thus is superfluous. Possibly one could modify the wording in proposal 3.1-2a in the following way to make it more clear   * *Subject to UE capability, support LMF to* ***request*** *a UE to measure and report multiple RSTD measurements from* ***the same*** *DL PRS resource of a TRP with* ***~~different~~ all*** *UE Rx TEGs.*   Note that the UE will not always succeed in doing measurements with all TEGs due to signalstrength, noise and interference or inappropriately configured DL PRS. However, under conditions to be specified by RAN4, the UE will succeed**.** |
| CATT | Support. We think UE measures different DL PRS resources from a TRP with the same UE Rx TEG can let LMF to obtain the time difference of the different TRP Tx TEGs associated with mentioned different DL PRS resources from the TRP, then calibrate the Tx TEGs in TRP side. |
| ZTE | We think this proposal is whatever supported if Rel-17 supports the feature of TEG. Maybe what we need to discuss is to extend the maximum number of DL RSTD per pair of TRPs so that UE can report DL RSTD as many as possible. |
| FL | It seems many companies consider the proposal is, at least, as important as at least Proposal 3.1-2a. Thus, I would change its priority to high.  For Ericsson’s proposal: The “***~~different~~ all*** *UE Rx TEGs”* may have very significant impact on UE side. For example, if the UE has to use all 4 Rx TEGx.DL PRS. However, under conditions to be specified by RAN4, the UE will succeed**. How about we change it “N” Rx TEGs, where N is UE’s capability.** |

### (Round 2) Proposal 3.1-2b (H)

* *Subject to UE capability, support a LMF to* ***request*** *a UE to* ***optionally*** *measure* ***different*** *DL PRS resources from a TRP with* ***the same*** *UE Rx TEG, and report the corresponding RSTD measurements*
* *Note: The TRP can be either a “RSTD” reference TRP or a neighbor TRP*
* *FFS: details of the Signaling, procedures, and UE capability*
* *Note: All RSTD measurements are relative to a single reference timing*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Don’t feel this proposal is needed. Should be up to the UE. |
| Qualcomm | We could accept to have this request from LMF; UE could try to accommodate it, but clearly it may not be possible, so it will eventually be up to the UE.   * Again, the “*Note: The TRP can be either a “RSTD” reference TRP or a neighbor TRP*“, we would prefer to keep it “Whether” for now and come back next meeting. |
|  |  |

## Parameters related to the maximum numbers

Submitted proposals

* *ZTE,* [*R1-2106549*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)*[2]) Proposal 3: For DL-TDOA, increase the maximum number of measured and reported RSTD measurements per TRP pair, e.g. 8.*
* *(Qualcomm,* [*R1-2107345*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)*[9]) Proposal 4: With regards to the maximum number of RxTEGs, consider the specification to support at least 32 different Rx TEGs (4 PFLs \* 8 Rx Antennas = 32 Rx TEGs).* 
  + *Support a UE capability on the maximum number of RxTEGs the UE can support.*

FL Comments

Currently, the maximum number of measured and reported RSTD measurements per TRP pair is 4. It seems we may at least increase it to 8 if **measuring *the same* DL PRS resource from a TRP *with different UE Rx TEGs is agreed.***

In addition to the the maximum number of RxTEGs, proposed in [9], we will also need to decide the maximum numbers of UE/TRP Rx/Tx/RxTx TEGs for DL-TDOA, UL-TDOA and DL+UL, and consider to support UE capabilities on the maximum number of Rx TEGs/Tx TEGs/RxTx TEGs the UE can support.

### Proposal 3.1-3

* *For DL-TDOA, increase the maximum number of reported RSTD measurements per TRP pair from 4 to N(>4).*
  + *FFS: N=[8, 16]*
* *With regards to the maximum number of RxTEGs, consider the specification to support at least 32 different Rx TEGs (4 PFLs \* 8 Rx Antennas = 32 Rx TEGs).* 
  + *Support a UE capability on the maximum number of RxTEGs the UE can support*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We suggest to agree first on the maximum number of Rx-TEGs, before discussing the maximum number of RSTDs (since this will come naturally as an outcome of a few agreements). |
| OPPO | Prefer to discuss all TEGs together, e.g., Tx TEG at UE side, Rx TEGs at UE side, Tx TEG at gNB side, Rx TEGs at gNB side, and TxRx TEG if agreeded. In this way, we can have a cleaer whole picture on this feture |
| CATT | Support. It will benefit the mitigation and calibration of timing errors if the maximum number of reported RSTD measurements per TRP pair is extended from 4 to a larger number, considering the requirements from Proposal 3.1-2a and Proposal 3.1-2b. |
| ZTE | Although we think it’s necessary to discuss these issues, we should de-prioritize over other important issues since it’s more like UE capability discussion. |
| **FL** | Let us wait for the comments from other companies to see if we want to continue the discussion in this meeting or until the next meeting. |
| Nokia/NSB | The maximum number could be per Rx-TEG and otherwise we don’t need to increase the number. |

## Timing reference for RSTD measurement

Submitted Proposals

* *(Samsung,* [*R1-2106888*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc)*[5])Proposal 2: For the indication of TEG in DL-TDOA method, one single reference TEG plus the TEG differences (in case of multiple different TEGs) can be considered.*
* *(MediaTek,* [*R1-2107822*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)*[15]) Proposal 4-5: The definition of DL-RSTD measurement could be further extended for different types. The concept of “reference” could still be applied, but not limited to “reference TRP”. We may define the reference RX TEG, and the reference DL-PRS resource within a same TRP*

FL Comments

About the proposal in [5] to consider “*one single reference TEG plus the TEG differences (in case of multiple different TEGs*)”, it is unclear to me how it work, since the UE/gNB may not know the time difference between TEGs.

About the proposal in [15] to extend the concept of RSTD “reference” beyond reference TRP”, e.g., including reference RX TEG, and the reference DL-PRS resource within the same TRP, we may further discuss if it is necessary.

### Proposal 3.1-4

* *The definition of DL-RSTD measurement could be further extended for different types. The concept of “reference” could still be applied, but not limited to “reference TRP”. We may define the reference RX TEG, and the reference DL-PRS resource withithe a same TRP*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | We do not support the current formulation. It should be clear that there should be only one reference time for each DL TDOA measurement report. That unique reference time can be associated with one unique reference TRP, one unique reference RX TEG and one unique reference DL-PRS resource. |
| ZTE | We think all DL RSTD measurements should be relative to the same reference timing. Meanwhile, we should allow UE to report multiple RSTD values (i.e. not limited to zero value) for “RSTD” reference TRP. |
| **FL** | **It seems it is lack of the support for the proppsal. Suggest further email discussion.** |
| Nokia/NSB | Unclear. Low priority. |

## UE Tx and TRP Rx timing errors for UL TDOA

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.

|  |
| --- |
| Conclusion (RAN1#104e):  Study the following option(s) for mitigating UE Tx and TRP Rx timing errors for UL TDOA:   * Option 1:   + Support a TRP to provide the association information of RTOA measurements with Rx TEGs to LMF when the TRP reports the RTOA measurements * Option 2:   + Support a UE to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF for UL TDOA positioning. * Option 3:   + Support a UE to provide Tx timing errors per Tx TEG to LMF for UL TDOA positioning. * Option 4:   + Support a UE to provide Tx timing error differences between Tx TEGs to LMF for UL TDOA positioning. * FFS: the details of the ignaling, procedures, and UE capability * FFS: How the TEGs are determined by the UE or TRP (could be by implementation, i.e., no specification impact) * Note: Other options are not precluded. * Note: Depending on the discussion results, none/one/multiple of the above options may be adopted in Rel-17.   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   Agreement: (RAN1#105e)   * For mitigating UE Tx timing errors for UL TDOA, support one of the following options:   + Option 1:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.     - FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs   + Option 2:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.     - Support the *serving* gNB to forward the association information provided by the UE to the LMF     - FFS: Support LMF to forward the association information from the *serving* gNB for the UE to the neighboring gNBs * FFS: UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling * Support gNB to report the associated SRS resource ID/resource set ID of the RTOA measurement to LMF |

Submitted Proposals and FL comments

* *(Huawei,* [*R1-2106449*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)*[1])Proposal 2: Support UE to provide the SRS-TEG association to gNB and gNB forward the association to LMF if the association is static.*
  + *The RRC message can be RRCReconfigurationComplete.*

**FL:** Further discussion in Proposal 3-2.1. Which RRC message to use may be decided by RAN2.

* *(Huawei,* [*R1-2106449*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)*[1])Proposal 3: Support UE to provide the SRS-TEG association directly to LMF per LMF request if the association is dynamic.*
  + *In this case, UE should indicate to gNB that the SRS-TEG association can be dynamic in the RRCReconfigurationComplete message.*

**FL:** Further discussion in Proposal 3-2.1. May need further discussion of the benefits of defining static and dynamic SRS-TEG association.

* *(ZTE,* [*R1-2106549*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)*[2]) Proposal 1: For mitigating UE Tx timing errors for UL TDOA, support option 2, i.e., UE sends the association relationship firstly to the serving gNB, then serving gNB forwards it to LMF.*

**FL:** Further discussion in Proposal 3-2.1.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 5:* 
  + *The UE can be requested to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF when the UE supports more than 1 UE Tx TEG.*

**FL:** Further discussion in Proposal 3-2.1.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 6:* 
  + *Support the UE to directly provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF via LPP message.*
  + *Note: The way the UE provides Tx TEG association information to the LMF should be consistent with the way the LMF requests UE Tx TEG association information.*

**FL:** Further discussion in Proposal 3-2.1.

* *(vivo,* [*R1-2106595*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)*[3]) Proposal 8:* 
  + *Support LMF to forward the UE Tx TEG information associated with SRS resource(s) provided by the UE to the serving and neighboring gNBs.*

**FL:** Further discussion in Proposal 3-2.1.

* (Sony, [R1-2106809](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)[4])Proposal 1: For UL positioning, support UE to send association information directly to LMF.

**FL:** Further discussion in Proposal 3-2.1.

* *(Samsung,* [*R1-2106888*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc)*[5])Proposal 3: The association information of UL SRS resources for positioning with Tx TEGs is sent directly from UE to LMF.*

**FL:** Further discussion in Proposal 3-2.1.

* *(CATT,* [*R1-2106971*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)*[6])Proposal 1: For mitigating UE Tx timing errors for UL TDOA, support the following option1:* 
  + *Option 1: Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE has multiple Tx TEGs.*

**FL:** Further discussion in Proposal 3-2.1.

* *(CATT,* [*R1-2106971*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)*[6])Proposal 2: Don’t 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.*

**FL:** Further discussion in Proposal 3-2.1.

* *(Nokia, R1- 2107057[7]) Proposal 8: Support option 2 from the prior agreement: UE reports Tx TEG IDs to the serving gNB and the serving gNB forwards to the LMF.*

**FL:** Further discussion in Proposal 3-2.1.

* *(OPPO,* [*R1-2107213*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)*[8])Proposal 7: Rel-17 supports TRP/gNB to report a Rx TEG ID for each UL TROA measurement result.*

**FL:** It seems to me that the proposal is already covered by the previous agreement from RAN1’s perspective. How to associate Rx TEG ID for each UL TROA measurement result in NRPPa can be handled by RAN3

* *(OPPO,* [*R1-2107213*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)*[8])Proposal 5: For the association information of TEGs and SRS resources for positioning, Rel-17 supports UE to report it to gNB and gNB to forward it to LMF via NRPPa, i.e.g,*
  + *Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE has multiple Tx TEGs.*
  + *Support the serving gNB to forward the association information provided by the UE to the LMF*

**FL:** Further discussion in Proposal 3-2.1.

* *(OPPO,* [*R1-2107213*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)*[8])Proposal 6:* *R17 doesn’t support LMF to forward the association Tx TEG information of a UE from the serving gNB to the neighboring gNBs*

**FL:** Further discussion in Proposal 3-2.1.

* *(Qualcomm,* [*R1-2107345*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)*[9]) Proposal 6: Support TxTEG-to-SRS association reporting as part of the LPP signaling framework (Option 1 in previous agreement).* 
  + *The reporting of the association is happening after the SRS is transmitted, together with an UL timestamp, and an associated UL Timing Error margin.*

**FL:** Further discussion in Proposal 3-2.1.

* *(CMCC,* [*R1-2107403*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)*[10])Proposal 4: For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE has multiple Tx TEGs.*

**FL:** Further discussion in Proposal 3-2.1.

* *(LG,* [*R1-2107542*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc)*[11]) Proposal #1:* 
  + For providing association information related with UE Tx TEG, UE needs to provide gNB with the information first.

**FL:** Further discussion in Proposal 3-2.1.

* *(Intel,* [*R1-2107590*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107590.doc)*[12])* Proposal 2:
  + Support a UE providing the association information of the UL SRS resources for positioning with the TX TEGs directly to the LMF if the UE has multiple TX TEGs.
    - FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs.

**FL:** Further discussion in Proposal 3-2.1.

* *(InterDigital,* [*R1-2107643*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)*[13]) Proposal 3: Support Option 1 (support a UE providing the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE has multiple Tx TEGs)*

**FL:** Further discussion in Proposal 3-2.1.

* *(Apple,* [*R1-2107740*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)*[14]) Proposal 5: For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE has multiple Tx TEGs.*

**FL:** Further discussion in Proposal 3-2.1.

* *(NTT DOCOMO,* [*R1-2107858*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107858.doc)*[16])Proposal 1:*
  + *We can consider the following option to support mitigating UE Tx timing errors for UL-TDOA*
  + *Option 2:*
  + *Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE has multiple Tx TEGs.*
  + *Support the serving gNB to forward the association information provided by the UE to the LMF*
  + *FFS: Support LMF to forward the association information from the serving gNB for the UE to the neighboring gNBs*

**FL:** Further discussion in Proposal 3-2.1.

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 6 RAN1 to decide on option 2 in the agreement on UE Tx timing errors for UL TDOA at RAN1#105-e, i.e. the UE TX TEG association of UL SRS transmissions should be sent by the UE to the gNB and then forwarded to the LMF.*

**FL:** Further discussion in Proposal 3-2.1.

* *(Ericsson,* [*R1-2108164*](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)*[19])Proposal 23 The TEG association is reported independently for each measurement instance in a measurement report.*

**FL:** Further discussion in Proposal 3-2.1.

## Association information of SRS resources and UE Tx TEGs

FL Comments

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| --- |
| Agreement: (RAN1#105e)   * For mitigating UE Tx timing errors for UL TDOA, support one of the following options:   + Option 1:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.     - FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs   + Option 2:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.     - Support the *serving* gNB to forward the association information provided by the UE to the LMF     - FFS: Support LMF to forward the association information from the *serving* gNB for the UE to the neighboring gNBs * FFS: UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling * Support gNB to report the associated SRS resource ID/resource set ID of the RTOA measurement to LMF |

About the two options in above agreement, it seems we have a diverged views according to the contributions to this meeting. Option 1 is supported by about 10 companies (Huawei (if the association is static)[1], vivo[3], Sony[4], Samsung[5], CATT[6], Qualcomm[9], CMCC[10], Intel[12], InterDigital[13], Apple[14]), while Option 2 are supported by Huawei (if the association is dynamic)[1], ZTE[2], Nokia[7], OPPO[8], LG[11], DCM[16], Ericsson[19]).

It seems we may need to have a further discussion in this meeting to see if we can have a compromised solution, e.g., supporting both options. Also, one of the main arguments for either side is related to the signalling efficiency for the request and the response of the association information of SRS resources and UE Tx TEGs. Thus, we may also consider getting the inputs from RAN2 if it is necessary.

In addition, once we have decided which of the option(s) are supported, we may need to consider more details on the signalling and procedure, such as when/how the association information is requested from LMF or from serving gNB, as discussed in [3], and when the association is reported ( e.g.,  *The reporting of the association is happening after the SRS is transmitted, together with an UL timestamp, and an associated UL Timing Error margin[9]).*

Another issue is whether *LMF to forward the association information to neighboring gNBs, which is supported at least by N companies (e.g., [3][11]) and objected at least by (e.g., [6][8])*

Proposal 3.2-1 (H)

* *For mitigating UE Tx timing errors for UL TDOA,* *support one* ***or both*** *of the following options:*
  + *Option 1:* 
    - *Subject to UE’s capability, support* ***LMF to request and*** *a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE has multiple Tx TEGs.*
    - *FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs*
  + *Option 2:* 
    - *Subject to UE’s capability, support* ***serving gNB to request*** *and a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE has multiple Tx TEGs.*
    - *Support the serving gNB to forward the association information provided by the UE to the LMF*
    - *FFS: Support LMF to forward the association information from the serving gNB for the UE to the neighboring gNBs*
* *FFS: UE should be able to report capability information related to Tx TEGs to LMF via LPP signalling*
* *FFS: the need or the benefits of defining static and dynamic association information of UL SRS resources for positioning with Tx TEGs*
* *FFS: The details of the signalling and the procedures*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We support option 1. |
| Huawei, HiSilicon | In our view, we think that both options would useful, for different UEs and for different use cases.  We support both options. |
| CATT | Support Option 1.  In our point of view, since there are LPP signalling between UE and LMF, and LMF is responsible for the calculation of UE position, it is reasonable for UE to provide the association information of SRS-Pos with Tx TEGs directly to the LMF, so that LMF can use such association information to calculate the UE position. In addition, such direct provision to LMF can reuse current LPP signallings and introduce less standardization impacts. Therefore, we support Option 1 as the method of UE providing the association information to LMF.  About the FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs, we don’t 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. In our point of view, since LMF is responsible for the calculation of UE position, the serving and neighboring gNBs don’t need such association information, and the gNBs will report the associated SRS-Pos resource ID/resource set ID of the RTOA measurement to LMF, then LMF will know the Tx TEGs of the RTOA measurement after UE providing the association information of SRS-Pos with Tx TEGs to the LMF. |
| vivo | Support option1 |
| OPPO | In the main bullet, prefer to remove “or both” since it is not benefical to support the same functionality with two different signalling mechanism |
| CMCC | We don’t see the need to support both options, and we support Option 1. |
| ZTE | We prefer Option 2 since there is no such LPP reporting procedure for UL-TDOA in Rel-16. Option 1 is more proper for M-RTT.  We can accept that Option 2 is only used for UL-TDOA and Option 1 can be used for both UL-TDOA and M-RTT. |
| InterDigital | Support option 1 |
| LG | We are on the same page with OPPO. |
| Huawei, HiSilicon2 | We drew the following figure to show the difference between Option 1 and Option 2.  UE  gNB/TRP  gNB/TRP  gNB/TRP  gNB/TRP  LMF  Serving  Neighbour  0. NRPPaTRP Configuration Information Exchange  1. LPP capability Transfer  2. NRPPa POSITIONING INFORMATION REQUEST (TEG)  3. gNB determines UL SRS resources  3a. UE SRS configuration  3b.Reconfiguration Complete (TEG)  4. NRPPa POSITIONING INFORMATION RESPONSE (TEG)  5. LPP RequestLocationInformation (TEG)  9. LPP ProvideLocationInformation (TEG)  6. NRPPa MEASUREMENT REQUEST  7. UL SRS Measurements  8. NRPPa MEASUREMENT RESPONSE  For Option 1, it goes presumably with LPP RequestLocationInformation and LPP ProvideLocationInformation messages. We believe that it can only be reported after SRS transmission. It means that LMF has no knowledge on the SRS-TEG association when sending the SRS configuration to the TRPs.  For Option 2, it goes presumably with RRCReconfigurationComplete message and NRPPa POSITIONING INFORMATION REPONSE messages. We believe in this case, it is reported prior to SRS transmission. This would help LMF make the decision on the measurement request to the TRP, e.g. whether each TRP should receive SRS from moe than one TEGs or from a single TEG.  In addition, it could also help LMF to selectively activate the SRS based on the TEG association for e.g. SP-SRS or AP-SRS.  So among the two options, we think that Option 2 should at least be supported. We can be open to generalize gNB/LMF to network as Siva proposed and let RAN2 and RAN3 to work out which option is needed. |
| Intel | Support option 1 |
| **FL** | **To Huawei’s comments:** Based on Huawei’s comment, it seems the main motivation for Huawei to support Option 2 is that LMF can provide the UE Tx TEG information to TRPs before Step 6. In order to do that, it requires the UE to provide the information to the LMF after Step 3a as soon as possible. Then, the issue comes down which options has the shorter messaging delays for UE to provide the UE Tx TEG information to LMF after Step 3a. If this understand is correct, may be we can simply ask RAN2/RAN3 that: “RAN1 consider it is beneficial for the LMF to obtain the UE Tx TEG information after Step 3a and before Step 6 in above figure, and ask RAN2/3 which of the options is better from LPP/NRPPa signalling point of view. |
| Ericsson | As this is related to signaling, instead of agreeing to both options, one possibility is to send an LS to RAN2 and ask for input from RAN2. Then, based on RAN2’s input, we can downselect one of the options. Alternatively RAN1 could agree to the following high level proposal:   * + - *Subject to UE’s capability, support* ***the network to request*** *and a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the* ***the network*** *if the UE has multiple Tx TEGs.*     - *For RAN2 and RAN3 to decide whether to use LPP or RRC signalling and what signalling is needed between network nodes (i.e. serving gNB, neigboring gNBs, LMF) .*   Supporting both options seems like an overkill to us. |
| NTT DOCOMO | We share the similar view with Ericsson. |
| ZTE2 | We support Option 2.As we mentioned, LPP protocol is not mandatory UE feature for UL-TDOA in Rel-16. If we can’t get consensus, we prefer to send an LS as Ericsson suggested. |
| **FL** |  |

FL Comments

Based on the comments in online discussion and offline email feedbacks, it seems it would be difficult for RAN1 to decide whether to use LPP or RRC/NRPPa to send the association information of UL SRS resources for positioning with Tx TEGs. In order tof RAN2/RAN3 to decide which option to take, I think RAN1 needs to clearly state what is the purpose/intention of each option and why RAN1 cannot make the decision, and what kind of help we need from RAN2/RAN3.Since we already have the agreement to support one of the options. We can simply send the agreement to RAN2/RAN3, and asking for their inputs.

### (Round 2) Proposal 3.2-1 (H)

*Send an LS to RAN2/RAN3 with the following text content:*

For mitigating UE Tx timing errors for UL TDOA, RAN1 has made the following agreement in RAN1#105e:

|  |
| --- |
| Agreement: (RAN1#105e)   * For mitigating UE Tx timing errors for UL TDOA, support one of the following options:   + Option 1:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.     - FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs   + Option 2:     - Subject to UE’s capability, support a UE providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.     - Support the *serving* gNB to forward the association information provided by the UE to the LMF     - FFS: Support LMF to forward the association information from the *serving* gNB for the UE to the neighboring gNBs * FFS: UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling * Support gNB to report the associated SRS resource ID/resource set ID of the RTOA measurement to LMF |

In above agreement, RAN1 considers selecting one of the options for the UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the LMF. But, RAN1 cannot reach the consensus on which of options to support because the companies have different views on which of the options has less impact on the high signalling (i.e., LPP, *NRPPa or RRC signalling*).

From RAN1’s perspective,

* The UE is expected to send the association information of UL SRS resources for positioning with Tx TEGs after UE receives the *UE SRS configuration* from the serving gNB (Step 3a);
* It is desirable for the association information to reach the LMF before the LMF sends the *NRPPa MEASUEMENT REQUEST* to the serving and neighboring gNB/TRPs ((Step 6), so that the information may be used by the LMF for optimizing the parameters for the *NRPPa MEASUEMENT REQUEST.*
* The association information needs to be availableat the LMF before, or at the same time, when the LMF receives the LPP ProvideLocationInformation (Step 9) for the positioning calculation.

**Action Items to** RAN2/RAN3**:** RAN1 kindly request RAN2/RAN3 to let RAN1 know which of the option is preferred by RAN2/RAN3 based on the consideration of the message efficiency and the impact on the high signalling.

UE

gNB/TRP

gNB/TRP

gNB/TRP

gNB/TRP

LMF

Serving

Neighbour

0. NRPPaTRP Configuration Information Exchange

1. LPP capability Transfer

2. NRPPa POSITIONING INFORMATION REQUEST (TEG)

3. gNB determines UL SRS resources

3a. UE SRS configuration

3b.Reconfiguration Complete (TEG)

4. NRPPa POSITIONING INFORMATION RESPONSE (TEG)

5. LPP RequestLocationInformation (TEG)

9. LPP ProvideLocationInformation (TEG)

6. NRPPa MEASUREMENT REQUEST

7. UL SRS Measurements

8. NRPPa MEASUREMENT RESPONSE

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | We support Option 2. We don’t think we should push this issue to RAN2/3. How will they make the decision? The metrics and feature are better evaluated in RAN1 in our view. |
| Qualcomm | Option 1. We think RAN1 should make an agreement, and send an LS to if RAN2/3 have concerns. |
|  |  |

## RTOA measurements with multiple TRP Rx TEG(s)

FL Comments

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 9:*** 
  + *In UL-TDOA method, to eliminate the positioning error caused by the UE Tx timing errors of more than one UE Tx TEGs, the RTOA measurement report for more than one UE Tx TEGs needs to be guaranteed if the gNB is able to measure SRS resoures associated different UE Tx TEGs.*
    - *FFS the gNB reporting rules to guarantee the RTOA measurement report for more than one UE Tx TEGs.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 13*** *For UL-TDOA positioning, support a gNB to report RTOA measurements associated with different UE Tx TEGs from a UE*

FL Comments

It may be beneficial for a gNB to report RTOA measurements associated with different UE Tx TEGs from a UE, especially when the gNB uses the same Rx TEG to measure the RTOA measurements associated with different UE Tx TEGs. How to *guarantee* a gNB to report RTOA measurement for more than one UE Tx TEGs seems related to performance requirement that can be handled by RAN4.

### Proposal 3.2-2(H)

* *For UL-TDOA positioning, support a gNB to report RTOA measurements associated with different UE Tx TEGs from a UE.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | OK |
| Huawei, HiSilicon | We do not think (neighbouring) gNB/TRP should be aware of the UE Tx TEG information, but rather perform measurement and report the results using SRS resource ID. |
| MTK | It seems to us that this proposal is in order to measure TX TEG difference of UE. gNB doesn't know SRS from which TX TEG. LMF knows. So we think gNB just report the RTOA measurement based on measurable SRS  Unless we define a calibration period, in which the UE may transmit SRS iteratively between different TX TEGs. Otherwise this proposal is sort of strange to us |
| CATT | Support. |
| vivo | Support. |
| OPPO | We are fine with the proposal |
| CMCC | As our comments above, we think that the association information of UL SRS resources and UE Tx TEGs should be reported to LMF by LPP signalling, and therefore we don’t think that a gNB has this information. |
| ZTE | Share similar view with Huawei and MTK. |
| LG | We have a similar view of CMCC and MTK, we need to discuss whether gNB knows the information of UE Tx TEG or not firstly. We think the proposal can be varied depending on the discussion of Proposal 3.2.1. |
| Intel | UE Tx TEG association information is available on LMF side not gNB side. In our understanding gNB can report several RTOA measruements from a UE, which are measured from different SRS resources for positioning. |
| Ericsson | Support |
| ZTE2 | Not support. What gNB can do is to provide SRS resource ID information for UL-AOA measurement to LMF. If LMF has the SRS-TEG association information ,LMF will know what UE Tx TEG has been used to transmit SRS. |
| **FL** | Based on the feedback so far, at least 3 companies are not supportive to the proposal. Suggest further email discussion. |
| Nokia/NSB | Unclear that this is needed. The gNB/TRP doesn’t necessarily know about UE Tx TEG and in addition our understanding is that the UE uses one TX TEG per SRS resource. Doesn’t the spec already supports reporting multiple RTOA values for a UE and therefore support this feature in some sense? |

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

Submitted Proposals

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[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. Thus, we may consider whether to support gNB to report the associated SRS port ID of the RTOA measurement.

### Proposal 3.2-3

* *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

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| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | Support.  There is no UE requirement or impact. The spec change can be manageable in RAN3. |
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## *Association of UE Tx TEG*s with the MIMO SRS

Submitted Proposals

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 1****: Rel-17 doesn’t support the association of TEG with MIMO SRS port(s).*
* *(****OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 4****: Rel-17 doesn’t support the association of TEGs with MIMO SRS resources.*
* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 7****: Do not support Tx TEGs reporting for MIMO SRS.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 7****: The UE can be configured to send UE TX TEG association reports for all SRS types.*

FL Comments

In RAN1#104bis-e and RAN1#105e, 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.

### Proposal 3.2-4

* *Study whether to support a UE to provide the association information of Tx TEGs with UL SRS resources for MIMO to the LMF for UL-TDOA if the UE has multiple Tx TEGs.*

Comments

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| --- | --- |
| **Company** | **Comments** |
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## Additional proposals for UL-TDOA enhancements

Submitted Proposals

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[1])Proposal 4: Support positioning SRS with antenna switching.***
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 8*** *The UE can be configured with a list of SRS resource sets for which UE TX TEG association reporting should be performed.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 11*** *It shall be possible to configure a UE with an SRS with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 12*** *The UE shall report the number of UE TX TEGs as part of UE capabilities.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 14*** *Support SRS with beam and UE TX TEG sweeping.*

FL Comments

Above are some proposals which are proposed, but not fully discussed in previous meetings. Companies are encouraged to take a look these proposals and provide their opinions.

### Proposal 3.2-5

* *Further study the following enhancements:*
  + *Support positioning SRS with antenna switching.*
  + *Support configuring a UE with a list of SRS resource sets for which UE TX TEG association reporting should be performed.*
  + *Support configuring a UE with an SRS with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS.*
  + *Support a UE to report the number of UE TX TEGs as part of UE capabilities.*
  + *Support SRS with beam and UE TX TEG sweeping.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We believe it should be useful to indicate to the UE some degree of TEG/antenna sweeping is desired from network perspective. |
| **InterDigital** | We support the proposal. |
| Ericsson | The following two proposals are crucial to achieve full mitigation of the UE TX timing errors   * + *Support configuring a UE with an SRS with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS.*   + *Support a UE to report the number of UE TX TEGs as part of UE capabilities.*   Under the timing error mitigation agenda we are currently discussing numerous proposals without any justification in terms of evaluated and verified gains. For the above proposals, however, very strong gains have been demonstrated (see e.g. section 3.2 in R1- 2108164 or the figure below). These proposals should be prioritized and agreed.    An alternative solution to ‘configuring a UE with an SRS with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS’ is to   * + *Support SRS with beam and UE TX TEG sweeping.*   This could be discussed as an additional method to achieve the big gains demonstrated. |
| CATT | We support to further discuss these UL-TDOA enhancements. |
| Nokia/NSB | Low priority compared with other urgent issues to discuss at this meeting. |

## Mitigation of UE/gNB Rx/Tx timing errors for DL+UL positioning

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 |

Submitted Proposals

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[1])Proposal 5: Update the agreement as below:***

|  |
| --- |
| * + **For mitigating UE Tx/Rx timing errors for DL+UL positioning, both the following options are supported subject to UE capability:**   + **Option 1: Reporting of UE RxTx TEG ID 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 Rx TEG ID and Tx TEG ID** |

**FL:** The suggestion to remove the “Reporting of UE RxTx TEG ID is not supported by the UE” from Option 2 makes sense in logic, since the main bullet says “a UE may support, up to UE capability, one or both of the following options”. Further discussion in Proposal 3-3.1a.

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[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).***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[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 resources.***

**FL:** The details of signalling structure may be handled by RAN2/RAN3.

* ***(ZTE,*** [***R1-2106549***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)***[2]) Proposal 4: For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, 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.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(ZTE,*** [***R1-2106549***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)***[2]) Proposal 5: For Tx timing decision, support alt 3, i.e. a Tx TEG ID is associated with one or more UL SRS resources for positioning.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 10:*** 
  + ***For mitigating UE Rx/Tx timing errors for DL+UL positioning, up to UE capability, both of the following options can be supported.***
    - ***Option 1: Reporting of UE RxTx TEG ID is supported by the UE.***
    - ***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.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 11:*** 
  + ***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.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 12:*** 
  + ***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 (similar to DL-TDOA).***
    - ***UE providing the association information of UE Tx TEG(s) with all UL Positioning SRS resources to LMF (similar to UL-TDOA).***
    - ***UE providing the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs to LMF.***

**FL:** Further discussion in Proposal 3-3.1a.

* **(Sony,** [**R1-2106809**](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)**[4])Proposal 2: For DL+UL positioning, support UE to send UE RxTx TEG ID to the LMF,**

**FL:** Further discussion in Proposal 3-3.1a.

* **(Sony,** [**R1-2106809**](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)**[4])Proposal 3: The UE RxTx TEG ID is associated with a pair of Tx TEG and Rx TEG. One Rx TEG is associated with one or more DL PRS resources. One Tx TEG is associated with one or more UL SRS resources.**

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Samsung,*** [***R1-2106888***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc)***[5])Proposal 4: Both options for reporting the TEG (i.e., reporting the RxTx TEG ID or reporting both Rx TEG ID and Tx TEG ID) are supported for DL+UL positioning subject to UE capability.***
* **FL:** Further discussion in Proposal 3-3.1a.
* ***(Samsung,*** [***R1-2106888***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc)***[5])Proposal 5: 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 3-3.1a.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 3: For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, the following option 2 in the previous agreement of RAN1#105-e:***
  + ***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.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 4: A Tx TEG ID should be associated with one or more UL SRS resources for positioning and decoupled with the Tx timing of the Rx-Tx measurement.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Nokia, R1- 2107057[7]) Proposal 4: Support Alt. 2, Option 1 in the prior agreement from RAN1#104-bis on UE Rx-Tx time difference measurements.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Nokia, R1- 2107057[7]) Proposal 5: Don’t support UE providing association of PRS resources and Rx TEG to LMF for UE Rx-Tx measurements.***

**FL:** UE Rx-Tx measurement is impacted by both Rx and Tx timing errors**.** If UE does not report RxTx TEG, but Tx TEG, theRx TEG information should be useful for LMF in my view. Further discussion in Proposal 3-3.1a.

* ***(Nokia, R1- 2107057[7]) Proposal 6: Support Alt. 2, Option 1 in the prior agreement from RAN1#104-bis on gNB Rx-Tx time difference measurements.***

**FL:** Further discussion in Proposal 3-3.1b.

* ***(Nokia, R1- 2107057[7]) Proposal 7: Don’t support TRP reporting the association information of SRS resource to TRP Rx TEG for gNB Rx-Tx measurements.***

**FL:** Similar comment to UE side, if gNB does not report TRP RxTx TEG, but Tx TEG, theRx TEG information should be useful for LMF. Further discussion in Proposal 3-3.1b.

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 8: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, Rel-17 NR support Option 2, i.e.,***
  + ***UE provides the association information of a UE Rx-Tx time difference measurement with a pair of {Rx TEG ID, Tx TEG ID} 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***

**FL:** Further discussion in Proposal 3-3.1a/b.

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 9: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, a Tx TEG ID is associated with the Tx timing of the Rx-Tx measurement if there is no modification on the definition of Rx-Tx time difference measurements (Alt.2).***

**FL:** Further discussion in Proposal 3-3.1a/b.

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 10: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, Rel-17 NR support Alt.1, i.e.,***
  + ***gNB to provide the association information of a gNB Rx-Tx time difference measurement with a pair of {Rx TEG ID, Tx TEG ID } to LMF***

**FL:** Further discussion in Proposal 3-3.1a/b.

* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 8: For either UE capability (option 1 or Option 2):*** 
  + ***Support a UE to report the Tx TEG ID to SRS resource ID association in a separate report from the measurement report***
    - ***Use the same report also used for UL-TDOA.***
  + ***Support a UE to optionally report an SRS resource ID associated with an Rx-Tx measurement in the Rx-Tx measurement report.***
    - ***The associated SRS resource was transmitted with the Tx timing also used in the Rx-Tx measurement.***
  + ***Support a UE to optionally report an Rx TEG ID associated with an Rx-Tx measurement in the Rx-Tx measurement report.***

**FL:** Further discussion in Proposal 3-3.1a and Proposal 3-3.1c.

* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 6: For mitigating UE Tx/Rx timing errors for DL+UL positioning, up to UE capability, a UE may support reporting of UE RxTx TEG ID.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 7: The UE RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs, where the Rx TEG ID is associated with the Rx timing to receive the DL PRS, and the Tx TEG ID is associated with the Tx timing of the UE Rx-Tx measurement.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 8: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, 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 TEG.***

**FL:** Further discussion in Proposal 3-3.1b.

* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 9: The TRP RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs, where the Rx TEG ID is associated with the Rx timing to receive the UL SRS pos, and the Tx TEG ID is associated with the Tx timing of the gNB Rx-Tx measurement.***

**FL:** Further discussion in Proposal 3-3.1b.

* ***(LG,*** [***R1-2107542***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc)***[11]) Proposal #2:*** 
  + ***Support 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.’) and Alt.#1 (‘an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement’)***
* **FL:** Further discussion in Proposal 3-3.1a.
* ***(Intel,*** [***R1-2107590***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107590.doc)***[12])* Proposal 3:**
  + **Support UE to include (TX TEG ID, RX TEG ID) and RxTx TEG ID for each UE Rx-Tx time difference measurement in a Multi-RTT measurement report.** 
    - **The TX TEG ID is associated with the UL SRS Resource for positioning corresponding to the TX timing of the Rx-Tx time difference measurement.**
    - **The RX TEG ID is associated with the DL PRS Resource for positioning corresponding to the RX timing of the Rx-Tx time difference measurement.**

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Intel,*** [***R1-2107590***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107590.doc)***[12])* Proposal 4:**
  + **Support gNB to include (TX TEG ID, RX TEG ID) and RxTx TEG ID for each gNB Rx-Tx time difference measurement in a Multi-RTT measurement report.** 
    - **The TX TEG ID is associated with the DL PRS Resource for positioning corresponding to the TX timing of the Rx-Tx time difference measurement.**
    - **The RX TEG ID is associated with the UL SRS Resource for positioning corresponding to the RX timing of the Rx-Tx time difference measurement.**
* **FL:** Further discussion in Proposal 3-3.1b.
* ***(InterDigital,*** [***R1-2107643***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)***[13]) Proposal 1: For mitigating UE Tx/Rx timing errors for DL+UL positioning, support both Option 1 and Option 2. If supported by the UE capability, the UE reports RxTx TEG; otherwise, the UE reports Tx TEG and Rx TEG.***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(InterDigital,*** [***R1-2107643***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)***[13]) Proposal 2: Tx TEG is associated with an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement (i.e., support Alt. 1).***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(Apple,*** [***R1-2107740***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)***[14]) Proposal 4: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, “subject to UE capability” support the following***
  + ***Reporting of UE RxTx TEG ID is supported where the UE RxTx TEG is associated with the cumulative TEG for DL PRS resource Rx and UL Positioning SRS Tx***
  + ***the association information is sent from UE to LMF on LPP message***
  + ***UE is not expected to additionally provide the association information of Rx/Tx TEG IDs***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(MediaTek,*** [***R1-2107822***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)***[15]) Proposal 3-1: For a UE measurement report when a RXTX TEG ID is attached, a TX TEG ID needs to be attached together***

**FL:** Further discussion in Proposal 3-3.1a.

* ***(MediaTek,*** [***R1-2107822***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)***[15]) Proposal 3-3: A TX TEG ID of UE is associated with SRS resource IDs. It is Alt. 3***
* **FL:** Further discussion in Proposal 3-3.1a.
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 17 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 3-3.1a.

* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 23 The TEG association is reported independently for each measurement instance in a measurement report.***
* **FL:** Further discussion in Proposal 3-3.1a.

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

FL Comments

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| 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 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 |

In previous meeting, it was agreed to consider above two options for reporting of UE Rx/Tx/RxTx TEG IDs mitigating UE Tx/Rx timing errors for DL+UL positioning. Based on the feedbacks in this meeting[1-19], it seems there are still diverse opinions on which of the options should be supported. Among them, at least 5 companies propose to support both of the options.

* Option 1: Reporting of UE RxTx TEG ID is supported by the UE

**Supported by**: *Huawei, ZTE, vivo, Sony, Samsung, Nokia, Qualcomm, CMCC, Intel, InterDigital, Apple, MTK,*

* 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.

**Supported by**: *Huawei, ZTE, vivo, Samsung, CATT, OPPO, Qualcomm, LG, Intel, InterDigital*

**Not Supported by**:

About the “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”, it was proposed in [3][4][10] for ***UE providing the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs to LMF. However, somce companies (e.g., [14]) proposes “UE is not expected to additionally provide the association information of Rx/Tx TEG IDs”.***

About three alternatives on the Tx TEG ID association, the companies views may be summarized as follows:

* 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

**Supported by**: *Samsung, LG, Intel, InterDigital, Ericsson*

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

**Supported by**: *OPPO, CMCC*

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

**Supported by**: *ZTE, vivo, CATT, MTK*

To make the discussion easier, I draw the figure based on my understanding of the three alternatives:



In the figure, it is assumed that SRS1 and SRS2 are in the same Rx TEG, and both of them are transmitted in the same subframe from the BB.

For Alt.1, the Tx TEG ID in the Rx-Tx time difference is associated with *an UL SRS resource corresponding to the Tx timing of the Rx-Tx measurement*. Then, if the UL Tx time of SRS1 is used for the determination of the Rx-Tx time difference, the Tx TEG ID is associated with SRS1; and if the UL Tx time of SRS2 is used for the determination of the Rx-Tx time difference, the Tx TEG ID is associated with SRS2. Since SRS1 and SRS2 are in the same Tx TEG 1, the Tx TEG ID1 is included in the Rx-Tx time difference.

For Alt.2, I assume “the Tx timing of the Rx-Tx measurement” means the Tx timing used by the UE for the determination of the Rx-Tx measurement as shown in the figure. The Tx timing of the Rx-Tx measurement should be the same for the SRS in the same Tx TEG, i.e., Tx TEG1. Thus, the Tx TEG ID1 is included in the Rx-Tx time difference.

For Alt.3, the Tx TEG ID in the Rx-Tx time diffenrece is associated with one or more UL SRS resources for positioning. For the figure, the Tx TEG ID is associated with SRS1 and SRS2. The consideration for Alt.3 is that since the UE does not know the exact time of UL Tx for either SRS1 or SRS2, but with the margin of the Tx TEG. Thus, neither the Tx time of SRS1 nor the Tx of SRS2 is used for the determination of the reported Rx-Tx time difference, but the same Tx timing of Tx TEG1.

Therefore, in my view, regardless which of the alternative is adopted for the definition of the association of the Tx TEG ID in the Rx-Tx time difference measurement, the same Tx TEG ID is included the Rx-Tx time diffenrece measurement, and the UE needs to provide the association of the Tx TEG ID with SRS resources to the LMF.

As discussed in multiple companies (e.g., [1][3][4][5][6][9][10][12][13][15][19]), there is a need for UE to report the Tx TEG associate with SRS *SRS resources and Tx TEG association with UE Rx – Tx time difference measurement, i.e., the same Tx TEG ID is used to link the Tx time of UE Rx – Tx time difference measurement and the corresponding positioning SRS resource(s).*

Similarly, the Rx TEG, if included in the *UE Rx – Tx measurement, should be associated with* DL PRS r*esources [3][4][9][10][12][15]. However, one company proposes not to support UE providing association of PRS resources and Rx TEG to LMF for UE Rx-Tx measurements.*

In addition, the association of the Tx TEG ID with the SRS resources are expected to be the same for DL+UL positioning and UL-TDOA as previously discussed and also pointed out in some contributions (e.g., [3][9]).

In [9], it was proposed “Support a UE to optionally report an SRS resource ID associated with an Rx-Tx measurement in the Rx-Tx measurement report”, which may need to be further discussed.

Based on the above discussion, it is suggested to modify the previous meeting agreement as follows

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| --- |
| Modification of the previous the agreement of 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.   + ***UE providing the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs to LMF.*** * Option 2: Reporting of UE Rx TEG ID and Tx TEG ID is supported by the UE. * If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Tx TEG ID to SRS resource(s) corresponding to the Tx time of the measurement   + Note 1: The association can be in a separate report from the Rx-Tx time difference measurement report.   + Note 2: The association is the same for both UL-TDOA and DL+UL positioning by default * If a Rx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Rx TEG ID to DL PRS resource(s) corresponding to the Rx time of the measurement   + Note 1: The association can be in a separate report from the Rx-Tx time difference measurement report.   + Note 2: The association is the same for both DL-TDOA and DL+UL positioning by default * 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 |
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The following is clean version of the proposal for UE side for further discussion. We can further discuss the corresponding requirements in TRP side once we reach the agreement for UE side.

Proposal 3.3-1a(H)

*Replacing the previous agreement of RAN1#105e as follows:*

* *For mitigating UE Tx/Rx timing errors for DL+UL positioning, subject to UE capability a UE should support one or both of the following options:*
  + *Option 1: Reporting of UE RxTx TEG ID*
    - *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 Rx TEG ID and Tx TEG ID*
* *If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Tx TEG ID to SRS resource(s) corresponding to the Tx time of the measurement*
  + *Note 1: The association can be reported separately from the Rx-Tx time difference measurement report.*
  + *Note 2: The association is the same for both UL-TDOA and DL+UL positioning by default*
* *If a Rx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Rx TEG ID to DL PRS resource(s) corresponding to the Rx time of the measurement*
  + *Note 1: The association can be reported separately from the Rx-Tx time difference measurement report.*
  + *Note 2: The association is the same for both DL-TDOA and DL+UL positioning by default*
* *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 UE Rx-Tx time difference measurements*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | 1st comment: For us it was clear in the previous agreement that BOTH options are supported. There was no downselection in the previous agreement, and I remember clarifying this in the GTW online also. So, any discussion related to downselecting is not productive at this stage. What needs to be finalized is how the Tx-TEG is associated to the Rx-Tx measurement and/or the SRS resources.  So, with regards to this question, We are generally supportive of the first 2 bullets, even though the two “Notes” seem unclear.   * Does the first Note mean that we agree that the association of Tx-TEG to SRS is reported separately, or that we are going to discuss it in a separate proposal? We are OK to discuss it separately, but it needs to be clear in the Note. * Not sure what the 2nd Note means. The UE will report an SRS-resource-ID (likely with a timestamp) to an Tx-TEG. How could it be that the same SRS instance be associated with different TEGs for different methods? It looks to me that any SRS resource at a specific time, can only be associated with one Tx-TEGs, and the UE cannot say different TxTEGs for each method; to put it differently, there will not be a “method” (TDOA or RTT) in the report. It will be a generic Tx-TEG to SRS association reporting. Is that what the Note wants to say?   With regards to the Rx-TEG ID (3rd bullet), why would a separate report is needed? The UE includes a DL-PRS resource ID already in the measurement report! So, by adding a Rx-TEG ID, all the information is already available. |
| Huawei, HiSilicon | We may need some clarification first. The previous agreement reads  a UE may support, up to UE capability, one or both of the following options:  Whether an interpretation on this agreement as “spec supports both” and “UE supports either” is correct.  Then for the Tx TEG ID reporting, our view is that there should exist two types of information. One is common to all TRPs (TEG-ID and SRS association, which is applible also to UL-TDOA methods), and one is TRP specific (TEG-ID and UE measurement association, which is not applicable to UL-TDOA methods).  I think the interpretation may be implied in the following:   * *If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Tx TEG ID to SRS resource(s) corresponding to the Tx time of the measurement*   + *Note 1: The association can be reported separately from the Rx-Tx time difference measurement report.*   However, we think the wording may be improved, e.g.   * *If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Tx TEG ID to the Tx time of the measurement*   + *Note 1: The association between Tx TEG ID and SRS resource(s) can be reported separately from the Rx-Tx time difference measurement report.*   In addition, we are not sure whether Note 1 for the Rx TEG ID is needed, since we think that the Rx TEG ID, DL PRS resource, and DL TOA measurement should only be reported for each TRP, and thus would have the following suggestion.   * *If a Rx TEG ID is included with a Rx-Tx time difference measurement report, the UE should report the association of the Rx TEG ID to DL PRS resource(s) corresponding to the Rx time of the measurement*   + *Note 1: Void*   + *Note 2: The association is the same for both DL-TDOA and DL+UL positioning by default* |
| CATT | We share the same view with Huawei that we should clarify whether we still need to discuss the down-selection from option 1 and option 2, or we should support both options without any further discussion.  About the issue of the associated information of a UE Tx TEG ID, there are three alternatives in the previous agreement of RAN1#105-e for further down-selection:   * 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   We prefer Alt.3, i.e., a Tx TEG ID is associated with one or more UL SRS resources for positioning. In fact, we prefer UE Tx TEG ID to be decoupled with a particular UE Rx-Tx time difference measurement to avoid the issue of potential mismatch between UE and gNB Rx-Tx time difference measurements, i.e., the UE indicates the UE Rx-Tx time difference measurement associated with one UE TX TEG ID, but the gNB only receives the SRS-Pos associated with other UE Tx TEG ID and use this SRS-Pos to derive the gNB Rx-Tx time difference measurement. Therefore, LMF will use incorrect UE Tx TEG ID to mitigate the UE Tx/Rx timing errors for Multi-RTT positioning.  In a word, a Tx TEG ID should be associated with one or more UL SRS resources for positioning and decoupled with the Tx timing of the Rx-Tx measurement. No need to change the definition of UE Rx-Tx time difference measurement provided in Rel-16. |
| **vivo** | For the first bullet, we think both options can be supported subject to UE capability.  For the second bullet, we are not sure if it wants to express the meaning of ‘alt1+alt3’ based on the agreement of the last meeting? And does it restrict to the case where SRS(s) is transmitted in Tx time? if it is, we can not support this.   * 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   For the third bullet, we don’t think a separate report is needed as it is natural to include Rx TEG in Rx-Tx measurement report. And the association is clear when the DL PRS resource index is in Rx-Tx measurement report. |
| OPPO | Similar to Hua/CATT, we support to clarify whether down-selection is in the scope of discussion or not.  Regarding Note 1, we have similar feeling as QC. |
| CMCC | As clarified by QC, if it is the common understading, we are fine with the first bullet to support both options.  Regarding the 2nd bullet, share similar view with CATT that the associated information of a UE Tx TEG ID with one or more UL SRS resources is beneficial for further resolve the potential mismatch between UE and gNB Rx-Tx time difference (captured by FFS, and also by Proposal 3.3-2).  On the other hand, we are also confused by Note 1 under the 2nd and 3rd bullets. |
| ZTE | According to our understanding, the previous agreement means both options are supported, which is up to UE capability.  We prefer Huawei’s revisions on the Notes. How to report the association between the TEG and RS may be up to signaling design in RAN2. |
| LG | Regarding Rx TEG ID for UE Rx – Tx time difference, since there is description that “Multiple DL PRS resources can be used to determine the start of one subframe” in current specification (38.215) , we agree with third main bullet. However, for the decision on Tx timng for UE Rx – Tx time difference, there is no such descprition. So, considering it, we think it depends on the discussion on wheter the multiple SRS resources are used or not. From the perpective, we discuss it first. |
| Huawei, HiSilicon2 | In our view, the same discussion on SRS-TEG association by RRC+NRPPa or LPP should be expected.  For Multi-RTT, one is certain, that we may TEG ID reporting associated with UE Rx – Tx time difference for each TRP, which means that the Tx time in the measurement is associated with the TEG ID that is linked to the SRS resources further. TEG ID linkage to SRS resource is either RRC+NRPPa or LPP, subject to further discussion. |
| Intel | Support both options. Additionally, we support subbulets 2 and 3 except of the note 2. |
| InterDigital | We support the proposal. In addition, we support both options. |
| Ericsson | We are not pro to the current proposal.  The reason for the UE to transmit multiple SRSs for positioning is that they have different spatial relations and thus are transmitted in different directions. A TRP will only be able to hear the SRS transmitted in the direction of that TRP, i.e. the SRS with a spatial relation to the DL PRS/SSB of that TRP. The choice of which UL SRS to associate to a certain UE Rx-Tx time difference measurement can therefore not be left to UE implementation. Even if the association is signalled by the UE, it can’t be used unless it points to the SRS that is actually transmitted towards and heard by the TRP. Instead of UE signaling the SRS association, the SRS association has to be configured by the network as part of the UE Rx-Tx time difference measurement configuration (i.e. the multi-RTT measurement configuration in LPP).  To make timing error mitigation work for multi-RTT the following agreement is needed:   * *For mitigating UE Tx/Rx timing errors for DL+UL positioning, subject to UE capability a UE should support one or both of the following options:*   + *Option 1: Reporting of UE RxTx TEG ID*     - *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 Rx TEG ID and Tx TEG ID* * *In both options, the multi-RTT measurement configuration should include an association to a UL SRS for each TRP and the TX timing of the UE Rx-Tx time difference measurement for a TRP should be based on the UL SRS associated to that TRP.* * *For Option 1, the reported UE RxTx TEG ID should be based on the DL PRS RX and UL SRS TX associated to the given UE Rx-Tx time difference measurement.* * *For Option 2, the reported UE Tx TEG ID should be based on the UL SRS TX associated to the given UE Rx-Tx time difference measurement.* |
| ZTE2 | Seems it’s diverse on how to associate Tx TEG ID with SRS (or Tx timing). We suggest to agree both Option1 and Option 2 first.  Regarding the SRS-TEG association, it can be discussed together with UL-TDOA. |
| **FL** | 1. About whether to suppot both options, I think the previous agreement says clearly “a UE may support, *up* ***to UE capability, one or both of the following options***:” My interpretation is: depending on UE ***capability***, a UE may support Option 1, or Option 2, or both. So, I don’t see the confusion comes. If the common understanding is that UE needs to always support both options, then it should say: “a UE may support, *up* ***to UE capability, ~~one or~~ both of the following options***”. But, I am not sure if this is all companies want. 2. For the 2nd main bullet “Note 2: The association is the same for both UL-TDOA and DL+UL positioning by default”, my thinking was the same SRS resources can be used for RTOA measurements and/or gNB Rx-Tx measurement to supporting UL-TDOA and DL+UL positioning. In this case, the *association between Tx TEG IDs and SRS resource(s) should be the same for both* UL-TDOA and DL+UL positioning, and UE does not need to report separate reports for the *association between Tx TEG IDs and SRS resource(s).* If it causes any confusion, we can remove it for now. 3. For the 3rd main bullet, “Note 1: *The association can be reported separately from the Rx-Tx time difference measurement report*”. I would agree that it can be removed, since the association of the Rx ID with DL PRS resource is always included with each *Rx-Tx time difference measurement report.*   To vivo’s comments: For “*the Tx TEG ID to SRS resource(s) corresponding to the Tx time of the measurement”,* my thinking is that this is a general statement, similar to: “*DL PRS resource(s) corresponding to the Rx time of the measurement”.* As I commented with the previous figure, UE may not know exactly the “*Tx time of the measurement”.*  To Huawei’s comment: Yes, we may have to discuss the transmission of SRS-TEG association by RRC+NRPPa or LPP. It might be easier after have a conclusion on Proposal 3.2-1(H).  To Ericsson’s comment: SRS configuration has included the QCL’ed DL PRS of a TRP. However, the UL beam may or may not be sent (only) to the TRP (e.g., UL antenna beam is much wider than the DL beam). Thus, it is unclear to me how the UE to report “the *multi-RTT measurement configuration* to include *an association to a UL SRS for each TRP.* In either option, the Tx TEG ID included in a Rx-Tx time difference measurement report should be the SRS resource(s) corresponding to the Tx time of the measurement. |

### (Round 2) Proposal 3.3-1(a1)(H)

Make the following modification of the previous agreement:

*For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE 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 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 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*

Comments

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| **Company** | **Comments** |
| MTK | SRS transmission has spatial relation with a SSB/PRS of a TRP. UE can know which panel as RX TEG could hear the SSB/PRS of a TRP, and then use a same panel as TX TEG to transmit SRS. So UE can determine using which TX TEG to transmit a SRS resource  A TX TEG could transmit multiple SRS resources. It is like UE to perform beam sweeping which has been supported in Rel-16. So a TX TEG is linked to multiple SRS resources. This one-to-many mapping table could be provided to LMF separately from the measurement report. This is why we support Alt. 3  There should be 2nd level details for the two options, which could be done next week or next meeting  For Option 1, the reporting of UE RXTX TEG ID has some meanings,  1, it is to indicate that UE has compensated RX+TX group delay in the UE measurement report. For original UE measurement at baseband, RX group delay is involved. So when UE compensate RX+TX group delay, it means RX group delay is cancelled but TX group delay is additionally added (subtracted with a mins sign). This added TX group delay will be cancelled when combining with a gNB measurement report, since the actual SRS transmission resulting in the TX group delay happens for gNB-side measurement. Therefore, TX TEG ID should be reported together within UE RX-TX time difference measurement report. It seems to us that TX TEG ID reporting within UE measurement report is more important than RXTX TEG ID because TX TEG ID is the key to pair UE-side and gNB-side measurement. And RXTX TEG ID is to indicate how well the compensation could be done  2, it is also to indicate the confidence how UE could compensate RX+TX group delay. So, a RXTX TEG ID should also be linked with a range of residual error. The range of residual error would be different for TDD, FDD or different bands. This requires careful test case design to check whether UE bluff its capability of controlling the residual within a certain range  For Option 2, it is to indicate that UE may not have RX+TX group delay compensation capability, since it consumes a certain implementation cost. Therefore UE expects LMF to do TDOA-like processing to cancel UE side group delay. Then for UE, where to transmit SRS, and where to receive DL-PRS needs to indicate to LMF so that LMF can pair the gNB-side and UE-side measurements to be like performing DL-TDOA+UL-TDOA. RX TEG ID is used to perform like DL-TDOA, and TX TEG IS is used to perform like UL-TDOA  We are also thinking that, for option 2, if the reported pair of RX TEG ID and TX TEG ID could be linked with a range of residual error |
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### (Round 2) Proposal 3.3-1(a2)(H)

* *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), which are related to the Tx time of the UE Rx-Tx time measurement;*
  + *Note 1: The association of the Tx TEG ID to the UL SRS resource(s) can be reported separately from the Rx-Tx time difference measurement report.*

Comments

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| **Company** | **Comments** |
| MTK | Yes, we need a one-to-many table since a TX TEG ID is linked with multiple SRS resources. This table could be separately reported from the UE measurement reports. But a TX TEG ID should be within UE measurement reports |
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### (Round 2) Proposal 3.3-1(a3)(H)

* *If a RxTx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE may also report the association of the RxTx TEG ID with a pair of {Rx TEG ID, Tx TEG ID}.*

Comments

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| **Company** | **Comments** |
| MTK | When a RXTX TEG ID is reported, to further report TX TEG ID is enough, not a pair of {RX TEG ID, TX TEG ID}  Also it is more important to have association between a RXTX TEG ID and a range of residual error |
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### Proposal 3.3-1b(H)

* *For mitigating TRP Tx/Rx timing errors for DL+UL positioning, a TRP should support one or both of the following options:*
  + *Option 1: Reporting of TRP RxTx TEG ID*
    - *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 Rx TEG ID and Tx TEG ID*
* *If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the TRP should report the association of the Tx TEG ID to DL PRS resource(s) corresponding to the Tx time of the measurement*
  + *Note 1: The association can be in a separate report from the Rx-Tx time difference measurement report.*
  + *Note 2: The association is the same for both DL-TDOA and DL+UL positioning by default*
* *If a Rx TEG ID is included with a Rx-Tx time difference measurement report, the TRP should report the association of the Rx TEG ID to UL SRS resource(s) corresponding to the Rx time of the measurement*
  + *Note 1: The association can be in a separate report from the Rx-Tx time difference measurement report.*
  + *Note 2: The association is the same for both UL-TDOA and DL+UL positioning by default*
* *FFS: The potential impact and modification on the definition of gNB Rx-Tx time difference measurements*

Comments

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| **Company** | **Comments** |
| Huawei, HiSilicon | We do not think we should propel on the TRP part, but if so, some wording suggestions as below.   * *For mitigating TRP Tx/Rx timing errors for DL+UL positioning, a TRP should support one or both of the following options:*   + *Option 1: Reporting of TRP RxTx TEG ID*     - *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 TRP Rx TEG ID and Tx TEG ID* * *If a Tx TEG ID is included with a Rx-Tx time difference measurement report, the TRP should report the association of the Tx TEG ID to the Tx time of the measurement*   + *Note 1: The association between Tx TEG ID and DL PRS resource(s) can be in a separate report from the Rx-Tx time difference measurement report.*   + *Note 2: The association is the same for both DL-TDOA and DL+UL positioning by default* * *If a Rx TEG ID is included with a Rx-Tx time difference measurement report, the TRP should report the association of the Rx TEG ID to UL SRS resource(s) corresponding to the Rx time of the measurement*   + *Note 1: Void*   + *Note 2: The association is the same for both UL-TDOA and DL+UL positioning by default* * *FFS: The potential impact and modification on the definition of gNB Rx-Tx time difference measurements* |
| CATT | We prefer to discuss this similar issue in UE side firstly, then consider how to apply it in the TRP side. |
| vivo | At least, change UE Rx TEG ID and Tx TEG ID to TRP Rx TEG ID and Tx TEG ID in option 2 |
| LG | Same with our view’s in proposal 3.3-1a |
| Intel | Support both options. Additionally, we support subbulets 2 and 3 except of the note 2. |
| Ericsson | In the first bullet, Option 2 should be revised as follows:   * + *Option 2: Reporting of UE TRP Rx TEG ID and Tx TEG ID* |
| FL | It might easier that we will continue the discussion for gNB after we reach the consensus on Proposal 3.3-1a for UE. |

## Configuration of the association between DL PRS and UL SRS

Submitted Proposal

* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 15 Support signaling from the LMF to the UE of an association between each DL PRS resource set with an UL SRS, either in the NR Multi-RTT Location Information Request or in the NR Multi-RTT Assistance Data (details for RAN2 to decide). Based on what DL PRS the UE utilizes for the RX timing in the UE Rx-Tx time difference measurement, the UE shall find the associated UL SRS and utilize that UL SRS to define the TX timing in the UE Rx-Tx time difference measurement.***

FL Comment

In the previous agreement, there is a remaining issue on “*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*)”. For resolving the issue, it was proposed in [19] to support signaling from the LMF to the UE of an association between each DL PRS resource set with an UL SRS, either in the NR Multi-RTT Location Information Request or in the NR Multi-RTT Assistance Data (details for RAN2 to decide). Based on what DL PRS the UE utilizes for the RX timing in the UE Rx-Tx time difference measurement, the UE shall find the associated UL SRS and utilize that UL SRS to define the TX timing in the UE Rx-Tx time difference measurement.

### Proposal 3.3-2 (H)

* *Support signaling from the LMF to the UE of an association between each DL PRS resource set with an UL SRS, either in the NR Multi-RTT Location Information Request or in the NR Multi-RTT Assistance Data (details for RAN2 to decide).*

Comments

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| **Company** | **Comments** |
| Huawei, HiSilicon | We believe if it is the case for FR2, when directional SRS transmission is possible, it can be done via existing spatial relation or pathloss reference.  For FR1, since the UE is using omni transmission, it is difficult to assign one-to-one mapping between SRS and PRS. |
| CATT | We believe the issue on“*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)*” can be solved by a Tx TEG ID should be associated with one or more UL SRS resources for positioning and decoupled with the Tx timing of the Rx-Tx measurement (Alt.3).  The signaling from the LMF to the UE of an association between each DL PRS resource set with an UL SRS may also solve the issue, but it need additional standard efforts, so we prefer the previous one. |
| OPPO | We understand the intension. However, we would like to know more details how LMF match PRS and SRS when PRS and SRS are transmitted with specific directions and how UE works, and we may provide, if necessary, some details/examples to RAN2 to facilitate the siganling design, which may impact NRPPa as well. For example, X(>1) PRS resources with in a set is transmitted for different direction, how should a UE to determine the Tx beam for the associated SRS to ensure that the TRP can have a good reception? |
| Ericsson | Support the proposal. |
| ZTE | This might be useful for FR2 when UE can do Tx beam sweeping. OK for further study. |
| Nokia/NSB | We are a bit unclear what exactly we are proposing. It also says between each DL PRS resource set and an UL SRS. Is the intention to map the PRS resource sets to a single SRS resource? |

## Definition of UE Rx-Tx time difference measurements

Submitted proposals

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])****Proposal 5: No need to change the definition of UE Rx-Tx time difference measurement provided in Rel-16.*
* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 1****: For the purpose of enhancing the accuracy of RTT method, support one of the following options:* 
  + *Option 1: Support a UE to optionally include in the UE Rx-Tx measurement report, an UL timestamp for a UE Rx-Tx measurement, which corresponds to the uplink [subframe/slot] used by the UE to derive the UE transmit timing* TUE-TX  *used to derive the measurement.*
  + *Option 2: Support a UE to optionally include in the UE Rx-Tx measurement report, TA change information.*
  + *FFS: Downselection and further details*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])****Proposal 16 Redefine the UE Rx-Tx time difference measurement as: UE Rx – Tx time difference is defined as mod(TUE-RX – TUE-TX, 1ms) 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~~ for the transmission of the associated SRS resource.*

FL comments

In my understanding, the main intention of the proposal in [9] to add an UL timestamp for a UE Rx-Tx measurement, which corresponds to the uplink [subframe/slot] used by the UE to derive the UE transmit timing is to address the potential UL timing changes between the time when the UE Rx-Tx measurement is reported to the time when the SRS is transmitted. Unless the UE, at the time of reporting Rx-Tx measurement, knows the potential changes of UL Tx time at a future UL subframe, the UE Rx-Tx measurement derived by the use of the current UL subframe should be the same as that derived by the use of a future uplink [subframe/slot] to derive the UE Rx-Tx measurement. Thus, Option 1 and Option 2 are only meaningful if at the time when the UE reports the UE Rx-Tx measurement report, the UE has the information of potential changes of UL Tx time (TA changes) of the future UL subframe for SRS transmission.

### Proposal 3.3-3 (H)

* *For the purpose of enhancing the accuracy of RTT method, support one of the following options (downselection):* 
  + *Option 1: Support a UE to optionally include in the UE Rx-Tx measurement report, an UL timestamp for a UE Rx-Tx measurement, which corresponds to the uplink [subframe/slot] used by the UE to derive the UE transmit timing TUE-TX  used to derive the measurement.*
  + *Option 2: Support a UE to optionally include in the UE Rx-Tx measurement report, TA change information.*
* *Support signaling from the LMF to the UE of an association between each DL PRS resource set with an UL SRS, either in the NR Multi-RTT Location Information Request or in the NR Multi-RTT Assistance Data (details for RAN2 to decide).*
* *Make the following modifications to the UE Rx-Tx time difference definition:* 
  + *UE Rx – Tx time difference is defined as mod(TUE-RX –TUE-TX, 1ms)*

*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~~ for the transmission of the associated SRS resource.*

Comments

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| **Company** | **Comments** |
| Qualcomm | Isnt the 2nd bullet a separate proposal in 3.3-2? Is it related to this proposal? In this proposal, the focus is on Rx-Tx reporting enhancement. We support to study both, but we generally support Option 1: Adding an UL timestamp should have been done from rel-16; the rel-16 implicit way of determing the UL-timestamp (i.e. the UL subframe closest in time to the DL PRS) has several limitations in real scenarios (e.g. mobility scenarios, or cases where SRS is far away from PRS).  The definition can change in a backward compatible fashion:  *TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i received from the TP, unless the UE has reported an UL Timestamp associated to the measurement, in which case, it corresponds to the UE transmit timing of the reported uplink [subframe #j].* |
| Huawei, HiSilicon | We think that including UL timing should be a simple solution.  Regarding changing the definition, we believe a simple way is to add a Note similar to HD-FDD case in LTE: e.g.  If the UE does not transmit SRS in subframe #j, 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 | It looks like no need to change the definition of UE Rx-Tx time difference measurement provided in Rel-16, if a Tx TEG ID is associated with one or more UL SRS resources for positioning and decoupled with the Tx timing of the Rx-Tx measurement. |
| **vivo** | We don’t think the modification of ‘Rx-Tx time difference’ is needed. Considering that Tx TEG information report has been supported, the similar mechanism can be used for ‘TA change report’. |
| OPPO | The 2nd bullet is discussed in Proposal 3.3-2  The 3rd bullet seems unnecessary. In the current definition, the slots for reception and transmission are also possible to be separated by some subframe(s), but there is no operation of mod. In our understanding, the received timing and transmit timing refer to the timing relative to the boundary of subframe |
| Intel | We do not support the proposal in the current form. Multiple aspects are combined in one proposal, we suggest to simplify the proposal dividing it on several parts. |
| Ericsson | as pointed out by others, 2nd bullet is part of Proposal 3.3-2.  We support bullest 1 and 3 in the proposal. |
| ZTE | The new definition may have problems as mentioned by CATT. |
| Qualcomm | To vivo/CATT: lets then start from the 1st bullet only, and not try to overload/overly-complicate discussions:   * *For the purpose of enhancing the accuracy of RTT method, support one of the following options (downselection):*    + *Option 1: Support a UE to optionally include in the UE Rx-Tx measurement report, an UL timestamp for a UE Rx-Tx measurement, which corresponds to the uplink [subframe/slot] used by the UE to derive the UE transmit timing TUE-TX  used to derive the measurement.*   + *Option 2: Support a UE to optionally include in the UE Rx-Tx measurement report, TA change information.*   Do we acknowledge that there can be a big time gap between the transmitted SRS and the UE Rx-Tx report? A UE could provide an UL timestamp to show to the network when the Rx-Tx measurement was derived? It is a measurement that has 2 compnets: DL measurement and UL transmission time. I don’t understand why the concept of “UL timestamp” in the report has created so much controversy.  For us, we are confident that any reasonable UE implementation cannot follow the 38.215 definition if it wants good UE Rx-Tx accuracy. |

FL Comments

It seems either adopting the proposal from Qualcomm or take the solution from LTE, as suggested by Huawei, may resolve the issue.

### (Round 2) Proposal 3.3-3 (H)

Select one of the following alternatives related to the definition of *the UE Rx-Tx time difference definition:*

**Option 1:**

* *Make the following modifications to the UE Rx-Tx time difference definition:* 
  + *UE Rx – Tx time difference is defined as mod(TUE-RX –TUE-TX, 1ms)*

*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, unless the UE reports an additional UL Timestamp associated to the measurement, in which case, TUE-TX corresponds to the UE transmit timing of the uplink subframe of the UL Timestamp.*

**Option 2:**

* *Add the following note to the UE Rx-Tx time difference definition:* 
  + *Note 1: If the UE does not transmit SRS in subframe #j, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*

Comments

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| **Company** | **Comments** |
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## Reporting of group time delys of RxTx TEGs

Submitted Proposals

* ***(MediaTek,*** [***R1-2107822***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)***[15]) Proposal 4-3:*** *If UE determines not to compensate the delay difference between 2 RX TEGS for DL-RSTD measurement, then the delay difference reporting is required*
* ***MediaTek,*** [***R1-2107822***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)***[15]) Proposal 5-1:*** *Support UE to report RX+TX group delay measurement for each pair of {RX TEG, TX TEG} to solve transmission timing difference between TX TEGs and receiving timing difference between RX TEGs mathematically at the location server.*
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 24*** *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,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 25*** *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 RxTx TEG, the self-calibration of UE for RX+TX group delays is discussed in [15]. With the acapability of the self-calibration, the UE may have the information on RX+TX group delay, and thus, in [15], MTK proposes to support UE to report RX+TX group delay measurement for each pair of {RX TEG, TX TEG} with the consideration that the LMF can use the information for positioning enhancement (e.g., to derive the transmission timing difference between TX TEGs and receiving timing difference between RX TEGs mathematically. We may also need RAN4 to check the feasibility of UE/TRP to report RX+TX group delays.

In [19], Ericsson proposes not to support reporting the timing errors of UE/gNB RX/TX TEGs and the timing errors differences between UE/gNB RX/TX TEGs this case, the suggestion is no further discussion on the reporting of timing errors of UE/gNB RX/TX TEGs as well as reporting of timing errors differences between UE/gNB RX/TX TEGs in Rel-17. Due to the lack of the support, suggest no further discussion in this meeting on reporting the timing errors and timing errors differences related to UE/gNB RX/TX TEGs.

### Proposal 3.3-4 (H)

* *Subject to UE’s capability, support UE to report UE RX+TX group time delays for each pair of UE {RX TEG, TX TEG} to LMF if the UE supports multiple Rx TEGs and/or multiple Tx TEGs;*
* *Support gNB to report TRP RX+TX group delays for each pair of TRP {RX TEG, TX TEG} to LMF if the TRP supports multiple Rx TEGs and/or multiple Tx TEGs*
* *Send LS to RAN4 to check the feasibility of UE/TRP to report RX+TX group delays*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | We think an easier way to allow UE to report RxTx TEG ID for DL-TDOA+UL-TDOA methods, e.g. in the DL-TDOA reporting. |
| MTK | 1, We support the proposal since in earlier we have analysed that it is feasible to derive RX TEG difference and TX TEG difference when the RX+TX group delay is measured through self-calibration  2, We are also okay to send LS to RAN4 for checking the self-calibaration feasibility, including for TDD, FDD |
| CATT | Support.  This proposal can solve the issue of how to let LMF to know whether two pairs of {UE Rx TEG ID, UE Tx TEG ID} have the same Rx+Tx timing errors or are within the same range of Rx+Tx timing errors, UE can provide the mapping information of {UE Rx TEG ID, UE Tx TEG ID} pairs to the range of Rx+Tx timing errors, so LMF can determine which UE Rx-Tx time difference measurements have the same Rx+Tx timing errors or are within the same range of Rx+Tx timing errors based on the mapping information. |
| vivo | Support. |
| OPPO | We need RAN4’s input on the feasibility before we can agree it. |
| Intel | Support to ask RAN4 about the feasibility of two first subbulets. |
| Ericsson | We do not support this proposal. As outlined in our contribution, we stated the following reasons for not reporting the timing errors to the LMF:   1. If the UE/gNB knows the timing error then it can compensate for the timing error by correcting measurements and thus there is no need to signal the timing error to the LMF. 2. A TEG is defined as a group of measurements or RS transmissions which have timing errors within a certain margin relative to each other. Thus, a TEG doesn’t have a timing error that can be signaled. 3. For the gNB case a timing error relative to some global clock is identical to the network synch error which is out of scope of the Rel. 17 positioning enhancement work item. |
| ZTE | Check with RAN4 on the feasibility to estimate timing error or wait for RAN4’s response on the LS sent by RAN1 in two meetings ago. |
| Nokia/NSB | Don’t support. |
| MTK2 | To E/// and Nokia,  1, the reason to report measured RX+TX group delay per pair of {RX TEG, TX TEG} is, the RX delay difference between 2 RX TEGs and TX delay difference between 2 TX TEGs could be resolved at LMF.  2, knowing RX+TX group delay doesn't mean the respective RX group delay and TX group delay could be known.  3, If both infra vendors have concern on this bullet,   * *Support gNB to report TRP RX+TX group delays for each pair of TRP {RX TEG, TX TEG} to LMF if the TRP supports multiple Rx TEGs and/or multiple Tx TEGs*   We can only support the first one, which is   * *Subject to UE’s capability, support UE to report UE RX+TX group time delays for each pair of UE {RX TEG, TX TEG} to LMF if the UE supports multiple Rx TEGs and/or multiple Tx TEGs;*   The reason is, we do have concern to solve UE side RX delay difference between 2 RX TEGs through measuring same signal of a same TRP. This consumes UE power for finding out a suitable TRP for measurement. To report RX+TX group delay, together with DL-TOA+UL-TDOA, UE can perform TOA measurement in each RX TEG by a good TRP signal. So each RX TEG could find a TRP with good signal quality, which is easier than finding a suitable TRP signal for 2 RX TEGs  We are also okay to send LS to RAN4 to check the feasibility of RX+TX group delay measurement. But in our mind, reporting RXTX TEG ID for M-RTT technique is equivalent to having RX+TX group delay measurement capability at UE side. For UE RX-TX measurement within M-RTT technique, we can surely compensate RX+TX group delay before reporting, But for DL-TDOA, we need RX delay difference, and for UL-TDOA, we need TX delay difference |

## Reporting of multiple UE RX-TX time difference measurements

Submitted Proposals

* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 18*** *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 comments

In [19], it was proposed to configure UE measure and report multiple UE RX-TX time difference measurements with multi UE Rx TEGs for the same DL PRS resource of a TRP for LMF to obtain the information of the timing difference of the UE Rx TEGs.

### Proposal 3.3-5

* *Introduce the possibility to configure the UE to measure and report multiple UE RX-TX time difference measurements with multi UE Rx TEGs for a TRP, i.e. one UE RX-TX time difference measurement for each UE RX TEG.*

Comments

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| **Company** | **Comments** |
| Ericsson | Support. This is necessary to achieve full timing error mitigation also for multi-RTT positioning and is thus of top priority.  It’s the corresponding proposal for multi-RTT as proposal 3.1-2 for DL-TDOA and bullet two and three in proposal 3.2-5 for UL TDOA. |
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## Reporting of Rx/Tx/RxTx TEGs

## Updating of Rx/Tx/RxTx TEGs

Submttted proposals

* ***(vivo, R1-2106595[3]) Proposal 7:***
  + ***The UE should report the information of the UE Tx TEG(s) change associated with transmission of SRS resource(s) to the LMF.***
    - ***The report of UE Tx TEG information should be continuous multiple reports, instead of a single report.***
    - ***The continuous multiple reports should be event-triggerred report, e.g. UE should report Tx TEG change information to the LMF when Tx TEG change happens compared with the last Tx TEG report.***
* **(Sony,** [**R1-2106809**](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)**[4])Proposal 4: Support the time-varying property of TEG. The association information (e.g. between TEG and SRS resources) can be used to identify the TEGs at different time.**
* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 9: With regards to TEG Information reporting, a device (UE or gNB) should be able to provide TEG-ID consistency information (e.g., a flag when TEG IDs are being reset). This applies to both Tx TEG, Rx TEG for both UEs and gNBs.***
* ***(LG,*** [***R1-2107542***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc)***[11]) Proposal #4:*** 
  + ***RAN1 has to consider the reporting overhead for UE if the reported information of TEG changes frequently***
* ***(InterDigital,*** [***R1-2107643***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)***[13]) Proposal 5: Support a UE to indicate TEG in the measurement reporting when TEG information is changed compared to the previous reporting.***
* ***(InterDigital,*** [***R1-2107643***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc)***[13]) Proposal 6: Support validity time for UE TEG, i.e., upon expiration of the validity time, the UE needs to update TEG***
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 9 TX TEG association reports should have a configurable periodicity and the reports should include information on the UE TX TEG association of each transmission occasion of each SRS resource during the reporting period. The exact coding of this information is up to RAN2.***
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 10 RAN1 to study further whether to support also UE TX TEG association reporting to be triggered by a change in UE TX TEG association.***

FL Comments

The timing errors of UE Rx/Tx/RxTx TEGs may changes with time for various reasons as discussed by multiple companies (e.g., [3][4][9][10][11][13][19]). Different options were proposed:

* In [3], it was proposed that the report of UE Tx TEG information should be continuous multiple reports, instead of a single report, and the continuous multiple reports should be event-triggered report;
* In [4], it was proposed that the association information (e.g. between TEG and SRS resources) can be used to identify the TEGs at different time.
* In [9], it was proposed that UE/gNB should be able to provide TEG-ID consistency information (e.g., a flag when TEG IDs are being reset)
* In [11], it was proposed that the reporting overhead needs to be considered for UE if the reported information of TEG changes frequently
* In [13], it was proposed to support a UE to update TEG information when it is changed compared to the previous reporting and to support validity time for UE TEG, i.e., upon expiration of the validity time, the UE needs to update TEG
* In [19], it was proposed to support periodic TX TEG association reports as well as the reporting to be triggered by a change in UE TX TEG association.

### Proposal 3.5-1 (H)

* *Support one or both of the following options for the UE/TRP to update the information of UE/TRP Rx/Tx/RxTx TEGs to LMF:*
  + *Option 1: UE/TRP is configured by LMF to provide the periodic update of the TEG information based on a configured periodicity;*
    - *FFS: the values of the configurable periodicities*
  + *Option 2: UE/TRP provide the update of the TEG information whenever the UE/TRP determines the previous TEG information is no longer valid*

Comments

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| **Company** | **Comments** |
| Huawei, HiSilicon | We think the best approach is for the LMF to request to report if the association is dynamic. No need to suppor either options. |
| CATT | Support.  We think both options will benefit the compensation of Timing erros for the positioning engine, since the TEG information is time-varying and should be updated periodically or event-triggered. |
| vivo | Support |
| OPPO | This is proposal is not clear. As we discussed in other proposals (e.g., 3.1-1), the new field for TEG information is optional and the UE can report TEG with each reporting. Thus, why do we need additional periodic reporting for the TEG information updating? |
| Intel | Same view as Huawei. |
| InterDigital | We support the proposal.  In addition, we support both options. In our view, both type of reporting (periodic-based or even-triggered based) are beneficial to determine the TEGs. |
| Ericsson | Support FL’s proposal. |
| NTT DOCOMO | We share the similar view with OPPO. |
| ZTE | Not support. |
| Nokia/NSB | In our view the UE/TRP reports the Tx/Rx TEG information in the beginning and then dynamically assigns IDs in the measurement reports. No need for this proposal. |
| Qualcomm | Generally supportive of the proposal, but we are proponets of Option 2: TEG information can change dynamically. E suggest to have at least a dynamic option (Option 2) specified.  To OPPO/DOCOMO: Tx-TEG reporting will not be together with any report. But even for TDOA, RTT, imagine a UE sends a first report that says a measurement is in TEG1. Then, 1 day later, sends another report that says that some other measurement is in TEG1. Should the LMF assume that these 2 measurements are really on the same TEG, just because they were associated with TEG1? Clearly not.. If we agree with this extreme example, then, we can consider some more reasonable examples: UE gets confgirued with periodic reporting, every 100 msec. In first report, UE says that same measurements are in TEG1; after 100 msec, UE says that some measurements are in TEG1. Are these measurements, across different reports, in the same or different TEG? LMF need to know whether the “TEG” has really changed or not; A flag/information/signaling needs to be sent when the previous information is no longer valid. |

## Reporting of uncertainty/margin of a Rx/Tx TEG

Submitted Proposals

* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 10: For mitigating timing errors in DL-TDOA, UL-TDOA or DL+UL Positioning:***
  + ***Support providing at least a timing Error uncertainty/margin associated with a TEG ID.***
  + ***Consider either a UE capability reporting or a semi-static reporting (e.g. in an LPP message) of the timing margin associated with a TEG ID.***
* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 3: Support UE to report the statistics (variance) of differences of the RX TEGs to LMF for mitigating TRP Tx timing errors and/or UE Rx timing errors for DL TDOA***
* ***(CMCC,*** [***R1-2107403***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc)***[10])Proposal 5: Support a UE to provide the statistics (variance, bound, etc.) of the Tx timing error differences between Tx TEGs to LMF.***
* ***(MediaTek,*** [***R1-2107822***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc)***[15]) Proposal 3-2: A RXTX TEG ID is associated with the a range of residual error***

FL Comments

If a UE/TRP is able to provide the error margins for a Rx/Tx/RxTx TEGs to the LMF, the information should be very useful for the positioning calculation in the LMF.

### Proposal 3.5-2

* *For mitigating timing errors in DL-TDOA,* 
  + *Support a UE, subject to UE capability, to provide the timing error margin associated with a Rx TEG*
  + *Support a TRP to provide the timing error margin associated with a Tx TEG*
* *For mitigating timing errors in UL-TDOA* 
  + *Support a UE, subject to UE capability, to provide the timing error margin associated with a Tx TEG*
  + *Support a TRP to provide the timing error margin associated with a Rx TEG*
* *For mitigating timing errors in DL+UL Positioning,* 
  + *Support a UE, subject to UE capability, to provide the timing error margin associated with a Rx/Tx/RxTx TEG*
  + *Support a TRP to provide the timing error margins associated with a 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.)*

Comments

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| **Company** | **Comments** |
| Ericsson | Do not support. We think the timing error margin can be static and the same for all TEGs. It could be defined by RAN4 or be different for different UEs based on UE capability. We have seen no arguments why different TEGs should have different margin or why the margin would need to be non-static. |
| ZTE | Doubt whether UE or TRP can accurately get the margin. |
| Qualcomm |  |
|  |  |

## Indexes for UE Rx/Tx TEGs

Submitted proposals

* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 19 In NR Rel-17, support the UE to associate both a spatial and a temporal UE RX TEG index to each TOA measurement and to indicate both these indices in RSTD and UE RX-TX time difference measurements.***
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 20 In NR Rel-17, support the UE to associate both a spatial and a temporal UE TX TEG index to each UL SRS transmission and to signal the associated indices in a message to the LMF.***
* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 21 Study how to handle frequency-dependent timing errors in NR Rel-17.***

FL comments

Rx/Tx timing errors may be different for different times, different beam directions and different frequencies. When different indexes are used, when there is an update of the TEG information, it may allow the indication of the update is triggerd by the change of time, or change of beam direction, or other reasons.

### Proposal 3.5-3

* *Support the UE to associate both a spatial and a temporal UE RX TEG index to each TOA measurement and to indicate both these indices in RSTD and UE RX-TX time difference measurements.*
* *Support the UE to associate both a spatial and a temporal UE TX TEG index to each UL SRS transmission and to signal the associated indices in a message to the LMF.*
* *Study how to handle frequency-dependent timing errors in NR Rel-17*

Comments

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| **Company** | **Comments** |
| Ericsson | Support.  Filter group delays may vary with time due to temperature variations that are in turn due to variations in UE heat generation e.g. when turning on and off radio transmission. In addition the UE may perform timing adjustments that impact the timing errors.  Some mechanism is needed to handle this. One possibility is to have a one bit temporal TEG index. This would be equivalent to the TEG reset bit proposed by Qualcomm. Alternatively two or more bits could be used for the temporal TEG index. Such an index would work as a counter that is incremented with time or when an event like a timing adjustment happens. Measurements with small enough difference in the temporal TEG index can be assumed to have timing errors within the margin. Note that for three consecutive measurements this would allow measurement 1 and 2, as well as measurements 2 and 3 to ‘be in the same TEG, i.e. to have timing errors within the margin’ while measurements 1 and 3 would not be in the same TEG. |
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# Reference devices for mitigating UE/gNB Tx/Rx timing errors

Background

The following agreement was made in agreement was RAN1#105e related to the use of a reference device with a known location to support the mitigating UE/gNB Tx/Rx timing errors:

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| --- |
| 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_08_TSGR_106e/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_08_TSGR_106e/docs/R1-2106326.doc) (Email endorsement) |

Submitted Proposals

* ***(Sony,*** [***R1-2106809***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)***[4])Proposal 5:*** *Support UE as PRU.*
* ***(Sony,*** [***R1-2106809***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)***[4])Proposal 6:*** *Support to introduce PRU identification based on the device capability, which enable LMF to select the capable devices UE to be PRU.*
* ***(Sony,*** [***R1-2106809***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc)***[4])Proposal 7:*** *PRU with known location support the following functionalities: Location uncertainty information, stationary status, providing positioning measurement and/or estimated Tx/Rx Timing error report.*
* ***(Apple,*** [***R1-2107740***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)***[14]) Proposal 1:*** *At least for UE-based method, LMF will provide the effective error to UE, e.g., through the LPP message Provide Assistance Data, or it may ask gNB to broadcast the effective error within posSIB*
  + *Each effective error value may be associated with a set of TRP IDs of candidate NR TRPs for measurement*
* ***(Apple,*** [***R1-2107740***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)***[14]) Proposal 2:*** *UE will indicate, e.g., through LPP message Provide Location Information, to the LMF whether or not the effective error is compensated/applied to the positioning measurements and/or location calculation*

FL comments

* In RAN1#105e, RAN1 made the decision “*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*”. Thus, my suggestion is that we may wait for the responses from RAN2/RAN3 to see there is a need for RAN1 to do additional work related to the use of the PRU for performance enhancement.

Comments

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| **Company** | **Comments** |
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# Measurement enhancements for mitigating UE/gNB Tx/Rx timing errors

Background

The following agreement was made in RAN1#104e related to the measurement enhancements for mitigating UE/gNB Tx/Rx timing errors:

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| --- |
| Agreement:  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

One of the remaining issues is: “FFS: The measurement instances are within a [configured] measurement time window”. In RAN1#105e, the following proposal was discussed without conclusion.

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| (RAN1#105e) Proposal 5-1 (H)  * Support LMF to configure the measurement time window (MTW) for a UE for the measurement instances included in a measurement report. UE is expected to perform measurements during the configured MTW. * Support LMF to configure the measurement time window for a gNB for the measurement instances included in a measurement report. gNB is expected to perform measurements during the configure MTW * FFS: the details of the MTW configuration * Note: UE/gNB’s behaviors outside of the MTWs are undefined |

Submitted Proposals

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 6: The configurable measurement time windows should be supported, in which the UE or TRP measurement instances are obtained.***

**FL:** Further discussion in Proposal 5-1.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 7: 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.***

**FL:** Further discussion in Proposal 5-1.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 8: UE (or TRP) is not expected to measure DL-PRS (or SRS-Pos) outside of the measurement time window.***

**FL:** Further discussion in Proposal 5-1.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 9: (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.***

**FL:** May be further discussed after measurement time window can be agreed in Proposal 5-1.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 12:*** ***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,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 13:*** ***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.

**FL:** May be further discussed after measurement time window can be agreed in Proposal 5-1.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 14: (Configuration method 2): 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.***
* ***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.***

**FL:** Details of measurement time window can be discussed after RAN1 makes the agreement to introduce the measurement time window.

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 15: 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.***

**FL:** May be further discussed after measurement time window can be agreed in Proposal 5-1.

* ***(Nokia, R1- 2107057[7]) Proposal 9: UE to provide gNB its measurement time window for UE Rx-Tx time difference measurement.***

**FL:** Further discussion in Proposal 5-1.

* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 11: For UE-assisted/network-based Positioning, for enabling a device to include measurements in a single report across multiple measurement instances (i.e. Batch reporting feature), support LMF sending an optional “Time-domain Window” configuration(s) to both UE and gNBs that define the time at which the measurements are to be obtained.*** 
  + ***Each window is defined with a start/End configuration (and potentially a period for periodic location requests).***
  + ***If startTime is provided, the device (UE/gNB) shall strive to include, in a single report, measurements derived on instances that start no earlier than the startTime.***
  + ***If EndTime is provided, the device (UE/gNB) shall strive to include, in a single report, measurements derived on instances that end no later than the EndTime.***

**FL:** Further discussion in Proposal 5-1. Details of measurement time window can be discussed after RAN1 makes the agreement to introduce the measurement time window.

* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 12: With regards to the requested Time-domain measurement Window:*** 
  + ***Study further the UE behavior when a limited number (or none) of PRS instances appears within a configured time-domain window.***
* **FL:** Details of UE behavior can be discussed after RAN1 makes the agreement to introduce the measurement time window.
* ***(LG,*** [***R1-2107542***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc)***[11]) Proposal #3:*** 
  + ***RAN1 should consider average measurement time window for positioning measurement.***

**FL:** Further discussion in Proposal 5-1.

* ***(Apple,*** [***R1-2107740***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc)***[14]) Proposal 6: At least for UE-assisted method, UE may be indicated by LMF to perform measurements corresponding to both DL-TDOA and DL-AoD positioning techniques***
  + ***The measurements at least include DL-RSTD together with DL-PRS-RSRP over a set of (TRPs, antenna panels, PRS configurations, etc)***
  + ***Additional UE capabilities may be needed***

**FL:** The proposal seems already covered by the agreement in RAN1#104bis “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.

* ***(Ericsson,*** [***R1-2108164***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc)***[19])Proposal 22 It shall be possible to configure the measurement window for a measurement instance to be so short that there is no risk for the TEG associations to change during the measurement window.***

**FL:** Further discussion in Proposal 5-1. Details of measurement time window can be discussed after RAN1 makes the agreement to introduce the measurement time window.

FL Comments

The intention for proposing LMF to configure the measurement time windows for both the UE and the gNB is to enable the UE and gNB to provide the one or multiple measurement insances in the same time window with the same measurement report to avoid miss-match the UL and DL measurements, which may be specially for DL+UL positioning. However, some companies consider the miss-match the UL and DL measurements may be resolved based on the timestamp included in the measurement reports, and thus there is no need for LMF to configure the measurement time window.

### Proposal 5-1 (H)

* *Support LMF to configure the measurement time window (MTW) for a UE for the measurement instances included in a measurement report. UE is expected to perform measurements during the configured MTW.*
* *Support LMF to configure the measurement time window for a gNB for the measurement instances included in a measurement report. gNB is expected to perform measurements during the configure MTW*
* *FFS: the details of the MTW configuration*
* *FFS: the UE/TRP behavior when a limited number (or none) of PRS/SRS instances appears within a configured time-domain window*
* *Note: UE/gNB’s behaviors outside of the MTWs are undefined*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We are generally supportive of the proposal. We suggest to change the stronger wording of “ UE/gNB is expected” to : “UE/gNB shall strive to perform measurements during the MTW”.  The reasoning is the following: A device (UE/gNB) may perform additional measurements outside the window, I assume that the devices could still report those. Similarly, a device may ave additional constraints and had to skip some of the measurement instances that was requested to reported. In this case, the device could report for a subset of the instances. |
| Huawei, HiSilicon | We think this window should better be jointly discussed with regard to SA2 support of scheduling location in advance. |
| CATT | Support.  The configurable measurement time window can help LMF to eliminate the influence of timing errors of TRPs and UE. The purposes for introducing measurement time window are as follows:   * Limit the measurement behaviour of UE or TRP, and only DL-PRS/ SRS-Pos resources within the measurement time window will be measured. * Limit the measurement time of each measurement instance, and support the measurement instance which only corresponds to one DL-PRS/SRS-Pos occasion for one-shot measurement. * Facilitate 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. * Indicate whether the measurement instances are measured within the same measurement time window. * Help LMF to track and mitigate the timing error drift over time. |
| OPPO | Measurement time window is not needed. Each measurement instance is reported with its own timestamp and LMF can know whether these measure instance is close enough or not. We also have the same comment as Nokia made in last meeting: what’s the relationship between MTW and the timing error mitigation? |
| Lenovo,Motorola Mobility | Generally fine with the FL’s proposal of an LMF configured measurement window for both UE and gNB. We are also fine to discuss this under a common measurement window configuration in the NLOS/multipath AI as the requirements (in terms of duration) and motivation are different to timing error mitigation. |
| LG | We are generally supportive of the proposal. |
| Intel | We are not convinced by current motivation to introduce the MTW concept. The note in the last subbulet is confusing. |
| Ericsson | We support the proposal. |
| ZTE | Not support. We have similar view with OPPO. |
| Nokia/NSB | Okay with the update from QC. We need to be very clear that LMF does not have control over how the radio resources are used (unless that is the intention of the proposal in which case we are opposed). |

## Timestamp of measurement instance

Background

It was agreed in RAM1#104bis-e that each measurement instance has its own timestamp. However, there is no definition on how the UE/TRP provide the timestamp for the measurement.

Submitted proposals and FL comments

* ***(Huawei,*** [***R1-2106449***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc)***[1]) Proposal 8:*** *Support for single report containing multiple measurement instances*
  + *Specifying the time stamp selection for each measurement instance.*
  + *Scattering the measurement instances throughout the measurement time.*

**FL:** Further discussion in Proposal 5-2a and 5-2b..

* ***(ZTE,*** [***R1-2106549***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)***[2]) Proposal 8:*** *Define the time stamp for a measurement instance, where the time stamp is a time window indicated by,*
  + *A starting time instance that corresponds to a reception time of the first reference signal for determining a measurement instance, and*
  + *An ending time instance that corresponds to a reception time of the last reference signal for determining the measurement instance.*

**FL:** Further discussion of timestamp in Proposal 5-2a.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 14:*** 
  + *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.*

**FL:** Further discussion of timestamp in Proposal 5-2b. For this proposal, it is unclear on how the certain time before the measurement report is determined by the UE. If there are multiple measurement instances in a measurement report obtained in a measurement time duration, in my opinon, the UE is expected to report the measurement instances (evenly) distributed in the measurement time duration similar to the proposal in [1]

* ***(CATT,*** [***R1-2106971***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc)***[6])Proposal 10:*** *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.*

**FL:** Further discussion of timestamp in Proposal 5-2a.

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 14:*** *For the timestamps for the measurement instances in a measurement report, support Option 1 with the following modification:*
  + *Option 1: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last ~~DL-PRS resource set/~~PRS resource (or the last ~~SRS resource set/~~SRS resource for the positioning purpose) that are used to determining the measurement instance.*

**FL:** Further discussion of timestamp in Proposal 5-2a.

* ***(Lenovo,*** [***R1-2108142***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108142.doc)***[18]) Proposal 1:*** *The timestamp should correspond to the reception time of the last received PRS in a set of one or more measurement instances.*

**FL:** Further discussion of timestamp in Proposal 5-2a.

### Proposal 5-2a (H)

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

* *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 the reception time of the last DL-PRS resource set (or the last SRS resource set) that are used to determining the measurement instance.*
* *Option 3: The timestamp of the UE (or TRP) measurement instance corresponds to as a time window indicated by,*
  + *A starting time instance that corresponds to a reception time of the first reference signal for determining a measurement instance, and*
  + *An ending time instance that corresponds to a reception time of the last reference signal for determining the measurement instance.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | Option 1. The time stamp is associated with measurement for a DL PRS resource. |
| CATT | Support Option 3 or the following Option 4:   * Option 4: 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. |
| vivo | Option 1 is preferred |
| OPPO | We prefer Option 1 since it can avoid some uncertainty. |
| Lenovo,Motorola Mobility | Option 1 |
| LG | We are generally fine with the proposal. Also, we think one option can be selected among option 1 and option 3. |
| Ericsson | We prefer Option 3 with some modifications:   * *Option 3: The timestamp of the UE (or TRP) measurement instance corresponds to as a time window indicated by,*   + *A starting time instance that corresponds to a reception time of the first instance of the DL PRS (or UL SRS) resource averaged/filtered over to give the measurement reported in the measurement instance, and*   + *An ending time instance that corresponds to a reception time of the last instance of the DL PRS (or UL SRS) resource averaged/filtered over to give the measurement reported in the measurement instance .* |
| ZTE | Support Option 3. In our understanding, a measurement instance should correspond to measurements conducted in a time window. The timing error shift is relatively small or can be neglected within the time window. UE is aware of its time error shift, so it’s better let UE to decide the duration of the time window. Therefore, the time stamp should be defined by a starting instance and an ending instance. |
| Nokia/NSB | Okay to agree and downselect at next meeting. |
| Qualcomm | Up to UE implementation as it has been traditionally been. The UE decides what the timestamp will be. |

### Proposal 5-2b (H)

*When multiple measurement instances are reported in a measurement report, the reported measurement instances are expected to be:*

* *Option 1: Scattering evenly throughout the measurement time.*
* *Option 2: Most recent measurement instances in advance of a certain time before the measurement report.*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | Option 1. Even though we support Option 1, we would consider it as a recommendation, instead of mandating UE behaviour. |
| CATT | Support Option 1. |
| vivo | We think the two options are different thing  Option 1 is the intention of multiple instances that the different instances(instance gap is periodicity) are used for resistance to channel fading, e.g. frequency-domain selective fading    Option 2 is which available instance is chosen to be reported. The most recent measurement instances are reasonable for this case. |
| OPPO | It is up to UE implementation. UE should have the flexibility to drop some measurement instance with the bad quality due to the intereference. Moreover, UE know better its velocity and it can make better decision on which subset of the measure instances are more useful. |
| Ericsson | We think it’s unclear what is meant with the two option. If there are 12 occasions of a periodic DL PRS within the measurement time and four measuremenmt instances are reported, each based on three consecutive occasions of the DL PRS then the reported measurement instances are ‘scattered evenly throughout the measurement time’ but they are also the four most recent measurement instances. |
| NTT DOCOMO | We see the motivation to specify the expectation of measurement instances. However, considering the flexibility at UE behaviour, it may be better to leave it to UE implementation. |
| ZTE | Agree with Ericsson. |
| Nokia/NSB | Not sure we need to specify anything here. |
| Qualcomm | If there is a measurement window, there will not be a need of this proposal. The UE reports the measurements derived in all the instances inside the window. |

## 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.*

|  |
| --- |
| * *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)* |

Submitted proposals

* ***(ZTE,*** [***R1-2106549***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)***[2]) Proposal 6:*** *Further discuss how to configure the number of instances of DL PRS resource set in a UE measurement instance (i.e. the value N), at least consider one of the following alternatives,*
  + *Alt.1: configured by LMF per DL PRS resource set.*
  + *Alt.2: configured by LMF per TRP.*
  + *Alt.3: configured by LMF per positioning frequency layer.*
  + *Alt.4: configured by LMF per measurement report.*

*FFS: The relationship between the value N and the association between measurement instances and UE measurement report.*

**FL:** Further discussion in Proposal 5-3.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 15:*** 
  + *The relationship between ‘the number of DL-PRS Resources Set instances related to each UE measurement instance’ and ‘the number of PRS samples for RSTD/Rx-Tx time difference/PRS-RSRP measurements’ defined by RAN4’ should be clarified.*
    - *Send an LS to RAN4 for consistent understanding.*

**FL:** The decision here on ‘the number of DL-PRS Resources Set instances related to each UE measurement instance’ can be independent on RAN4’s definition of the PRS samples for the moment. After RAN1 makes the decision, RAN1 may send LS to RAN4 for the alignment of the terminology.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 16:*** 
  + *For N instances should be ensured, wherein, the TEG includes UE Rx TEG and TRP Tx TEG.*
  + *For M SRS measurement time occasions in one TRP measurement instance, the same TEG across M instances should be ensured, wherein, the TEG includes TRP Rx TEG and UE Tx TEG.*

**FL:** The issue seems important to be discussed. Further discussion in Proposal 5-3b.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 17:*** 
  + *For N instances of the DL-PRS Resource Set within one UE measurement instance, N can be recommended by the LMF and determined by the UE.*
  + *For M SRS measurement time occasions within one TRP measurement instance, M can be recommended by the LMF and determined by the TRP.*

**FL:** Further discussion in Proposal 5-3.

* ***(Qualcomm,*** [***R1-2107345***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc)***[9]) Proposal 13:*** *Support LMF requesting the UE or gNB to perform measurements on specific PRS/SRS resources across multiple time-domain instances.*

**FL:** The issue may be complicated, since UE/gNB may not be able to detect all of the signals of specific PRS/SRS resources across multiple time-domain instance. Further discussion in Proposal 5-3c.

### Proposal 5-3a (H)

* *Each UE measurement instance in a measurement report can be configured by LMF with N instances of the DL-PRS Resource Set, where N can be configured with one or more of the following alternatives:*
  + *Alt.1: per measurement report*
  + *Alt.2: per TRP*
  + *Alt.3: per positioning frequency layer*
  + *Alt.1: per DL PRS resource set*
* *The values of N can be*
  + *Option 1: N=[1,2, 4, 8,…,256]*
  + *Option 2: N is decided by RAN4*
* *Each gNB measurement instance in a measurement report can be configured by LMF with M SRS measurement time occasions, where M can be configured by LMF with one or more of the following alternatives:*
  + *Alt.1: per measurement report*
  + *Alt.2: per UE*

*The values of M can be*

* + *Option 1: M=[1,2, 4, 8,…,256]*
  + *Option 2: M is decided by RAN4*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Huawei, HiSilicon | * *Each UE measurement instance in a measurement report can be configured by LMF with N instances of the DL-PRS Resource Set, where N can be configured with one or more of the following alternatives:*   + *Alt.1: per measurement report*   + *Alt.2: per TRP*   + *Alt.3: per positioning frequency layer*   + *Alt.4: per DL PRS resource set*   We support Alt. 1   * *The values of N can be*   + *Option 1: N=[1,2, 4, 8,…,256]*   + *Option 2: N is decided by RAN4*   We support Option 1.   * *Each gNB measurement instance in a measurement report can be configured by LMF with M SRS measurement time occasions, where M can be configured by LMF with one or more of the following alternatives:*   + *Alt.1: per measurement report*   + *Alt.2: per UE*   We think Alt.1 and Alt.2 are the same, since NRPPa measurement procedure is non-UE associated. Alt. 1 would be more aligned with RAN3 terminology.  *The values of M can be*   * + *Option 1: M=[1,2, 4, 8,…,256]*   + *Option 2: M is decided by RAN4*   We support Option 1. |
| CATT | Support to further discuss the concret values of N and M. We prefer the values of N and M as follows,   * Each UE measurement instance can be configured with N instances of the DL-PRS resource set. N = [1, 2, …, 256], using 8 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, … , 256] , using 8 bits to indicate which value is configured for M. |
| vivo | Alt.1 is preferred |
| OPPO | We prefer Option 1. One clarification question for Alt.1: Does it mean different N will be used for RSTD, Multi-RTT or different N will be used for different RSTD measurements? |
| Lenovo,Motorola Mobility | Support downselecting the following alternatives/options.  UE measurement instance: Support Alt. 1:per measurement report, Option 1: N=[1,2, 4, 8,…,256]  gNB measurement instances: Support Alt. 1:per measurement report, Option 1: N=[1,2, 4, 8,…,256] |
| Ericsson | Support the proposal |
| ZTE | Support the proposal. |
| Nokia/NSB | We don’t see the benefit of such an agreement and don’t support it. We feel the measurement configuration is already quite flexible. |
| Qualcomm | We are OK to have this proposal |

### Proposal 5-3b (H)

* *The same Rx TEG(s) should be used to measure all instances of the DL-PRS Resource Set for one UE measurement instance of RSTD and/or UE Rx-Tx time difference measurement;*
* *The same Rx TEG(s) should be used to measure all instances of the SRS measurement time occasions for one TRP measurement instance of RTOA and/or gNB Rx-Tx time difference measurement.*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Qualcomm | We do not agree. The reason the UE reports this information is exactly because it is inevitable in some occasions that different Rx-TEGs are used. We are OK to say that the UE is requested to do something, and the UE to optionally attempt to do so, but not how the proposal is written now. |
| Huawei, HiSilicon | I am assuming the same UE Rx TEG applied for a TRP throughout the time, instead of across all TRPs.  It should be OK from our side if the above understanding is the intention. |
| CATT | We think it will benefit the combination of multiple measurement instances for one measurement report if the same Rx TEG is used to measure all instances which are used to derive one measurement report. |
| OPPO | When UE is moving/rotating, UE may change the Rx panels for the same PRS. |
| Ericsson | Ok. Somewhat confusing to use the word instance both for ‘DL PRS occasions’ and for ‘measurement instances’. |
| vivo | OK  If the intention is that for the same PRS resource across multiple PRS instances in a measurement instance, the same Rx TEG across multiple PRS instances is required, we agreed. Therefore, we propose: Proposal 5-3b (H)  * *The same Rx TEG(s) should be used to measure all instances of the DL-PRS Resource Set on a PRS resource for one UE measurement instance of RSTD and/or UE Rx-Tx time difference measurement;* * *The same Rx TEG(s) should be used to measure all instances of the SRS measurement time occasions on a SRS resource for one TRP measurement instance of RTOA and/or gNB Rx-Tx time difference measurement.* |
| ZTE | Low priority for this meeting. We should finalize the framework of measurement instance first. |
| Nokia/NSB | Don’t think this restriction is needed. |

## The quality of timing-based measurement instances

Submitted proposals

* ***(Lenovo,*** [***R1-2108142***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108142.doc)***[18]) Proposal 2:*** *The existing UE timing quality indication can be extended to indicate the quality of timing-based measurement instances such as RSTD and UE Rx-Tx time difference measurements.* 
  + *FFS if the indication is applicable to one or more measurement instances.*

**FL:** It seems reasonable to allow each timing measurement instance (e.g., RSTD, RTOA, UE/gNB time difference measurements) to has its own indication of the measurement quality (e.g., NR-TimingQuality-r16)

### Proposal 5-4

* *The existing UE/TRP timing quality indication of of RSTD, RTOA and UE/gNB Rx-Tx time difference measurements can be extended to indicate the quality of the measurement instances of RSTD, RTOA and UE/gNB Rx-Tx time difference measurements.*

Comments

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| --- | --- |
| **Company** | **Comments** |
| Lenovo,Motorola Mobility | Support FL’s proposal. |
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## Measurement instances in a measurement report

Submitted proposals

* ***(ZTE,*** [***R1-2106549***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc)***[2]) Proposal 7:*** *Further discuss the association between measurement instances and UE measurement report, at least consider one of the following options,*
  + *Option 1: For each indicated DL PRS resource in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource.*
  + *Option 2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.*
  + *Option 3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.*
  + *Option 4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*
  + *Option 5: Multiple measurement instances are directly associated with a measurement report*

**FL:** The proposal seems related to how the associate the measurement measurement instances with the DL PRS/SRS resources, in the measurement report, which may be best handled by RAN2/RAN3 in my view.

* ***(vivo,*** [***R1-2106595***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc)***[3]) Proposal 13:*** 
  + *The UE or the TRP can be configured to report one or more measurement instances in a single measurement report to the LMF.*

**FL:** The proposal seems to be part of the previous agreement.

* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 11:*** *The current LPP signaling can support the feature that UE reports one or more measurement instances in a single measurement report to LMF, with potential extension to support a larger number than 4.*
* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 12:*** *No enhancement is needed for the current NRPPa signaling to support the feature that TRP reports one or more measurement instances with the same quantity in a single measurement report to LMF.*
* ***(OPPO,*** [***R1-2107213***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc)***[8])Proposal 13:*** *Enhancement on the association of measurement instances should be introduced to support the feature that TRP reports one or more measurement instances with different quantities in a single measurement report to LMF.*

**FL:** Once RAN1 reaches the final agreement on the enhancement on the measurement instances and reports, RAN1 will send LS to RAN2/3/4. The impact on LPP/NRPPs signalling may be discussed in RAN2/3.

FL comments

Based on the previous agreement that a single measurement report may contain one or more measurement instances of different types (e.g., RSTD/RTOA, DL/UL RSRP, and/or UE/gNB Rx-Tx time, and each measurement instance may be measured from one or more PRS/SRS resources. The impact of the agreements on LPP/NRPPs signalling may be discussed in RAN2/3.

Comments

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| --- | --- |
| **Company** | **Comments** |
| ZTE | It’s better that RAN1 can discuss some basic assumption of reporting structure since it has connection with configuration level of value N and M. |
|  |  |
|  |  |
|  |  |

# Additional proposals

## Multiple reference timings

Submitted Proposals

* ***(LG,*** [***R1-2107542***](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc)***[11]) Proposal #2:*** 
  + *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

The benefits and necessary to have multiple reference timings work for DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements may need to be studies. For DL PRS-RSRP and UE Rx-Tx time difference measurements, my understanding is no need for UE to select the reference timing. For RSTD, it is up UE to use or not use the configured reference timing. Thus, the benefits of configuring multiple reference timings need further study.

### Proposal 6-1

* *Study the benefits of configuration of multiple reference timings for DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements.*

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| LG | Support |
| Ericsson | Not support. There should only be one reference time used for all measurements in a measurement report. Consequently it should not be possible to configure multiple reference timings. |
|  |  |
|  |  |

# References

1. [R1-2106449](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106449.doc) Enhancement to mitigate gNB and UE Rx/Tx timing error Huawei, HiSilicon
2. [R1-2106549](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106549.doc) Positioning accuracy improvement by mitigating timing delay ZTE
3. [R1-2106595](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106595.doc) Discussion on potential enhancements for RX/TX timing delay mitigating vivo
4. [R1-2106809](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106809.doc) On mitigating Rx/Tx timing delays Sony
5. [R1-2106888](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106888.doc) Discussion on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Samsung
6. [R1-2106971](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106971.doc) Discussion on mitigating UE and gNB Rx/Tx timing errors CATT
7. [R1-2107057](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107057.doc) Views on mitigating UE and gNB Rx/Tx timing errors Nokia, Nokia Shanghai Bell
8. [R1-2107213](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107213.doc) Enhancement of timing-based positioning by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays OPPO
9. [R1-2107345](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107345.doc) Enhancements on Timing Error Mitigations for improved Accuracy Qualcomm Incorporated
10. [R1-2107403](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107403.doc) Discussion on mitigation of gNB/UE Rx/Tx timing errors
11. [R1-2107542](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107542.doc) Discussion on accuracy improvement by mitigating UE Rx/Tx and gNB Rx/Tx timing delays LG Electronics
12. [R1-2107590](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107590.doc) Details of UE/gNB RX/TX Timing Errors Mitigation Intel Corporation
13. [R1-2107643](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107643.doc) Discussion on accuracy improvements by mitigating timing delays InterDigital, Inc.
14. [R1-2107740](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107740.doc) Positioning accuracy enhancements under timing errors Apple
15. [R1-2107822](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107822.doc) Mitigation of RX/TX timing delays for higher accuracy MediaTek Inc.
16. [R1-2107858](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2107858.doc) Discussion on mitigating UE and gNB Rx/Tx timing delays NTT DOCOMO, INC.
17. [R1-2108101](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108101.doc) On methods for Rx/Tx timing delays mitigation Fraunhofer IIS, Fraunhofer HHI
18. [R1-2108142](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108142.doc) Enhancements for mitigation of Tx/Rx Delays Lenovo, Motorola Mobility
19. [R1-2108164](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2108164.doc) Techniques mitigating Rx/Tx timing delays Ericsson
20. RP-202900, “New WID on NR Positioning Enhancements”, CATT, Intel Corporation, Ericsson, December 7th – 11th, 2020.
21. [R1-2106339](file:////Users/renda000/Downloads/2021_08_TSGR_106e/docs/R1-2106339.doc), FL Summary #5 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, Moderator (CATT)