3GPP TSG RAN WG1 Meeting #107e R1-2112510

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

**Source: Moderator (CATT)**

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

**Agenda item: 8.5.1**

**Document for: Discussion and Decision**

# Introduction

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

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

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

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

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

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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
  + “No highlights” are used for proposals with low priority
  + “Turquoise highlights” are used for offline consensus/conclusion
  + “Grey highlights” are used for proposals resolved in this meeting.

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

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

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

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

Submitted Proposals

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

FL comments

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

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

### Proposal 2.1

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

Comments

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| **Company** | **Comments** |
| **Nokia/NSB** | Support. As we show with detailed evaluations in our paper the TEG can be invalid if the angular validity region is not taken into account. If RAN1 wants to tackle this issue in Rel-17 we feel this is a very important component to the TEG concept. |
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## Clarification of Rx/Tx/RxTx TEG definitions

*Background*

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

Submitted proposals

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

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

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

FL comments

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

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

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

### Proposal 2.2

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

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

Comments

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| **Company** | **Comments** |
| vivo | For UE RxTx TEG, the association information is unclear based on the following agreement, especially whether UE RxTx TEG can be directly associated with one or more UL SRS resources.  For us, without modification of the UE Rx-Tx time difference measurement definition， RxTx TEG ID or UE Rx-Tx measurement can not be associated with UL SRS resources directly.  Agreement: (RAN1#106-e)  Make the following modification of the previous agreement:  For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE ~~may~~ should support, up to UE capability, either one or both of the following options:   * Option 1: Reporting of UE RxTx TEG ID ~~is supported by the UE~~   + FFS: Further details on how the UE RxTx TEG IDs are related/associated to UE Tx TEG IDs and/or UE Rx TEG IDs and to the UE Rx-Tx measurements. * Option 2: Reporting of ~~UE RxTx TEG ID is not supported by the UE; reporting of~~ UE Rx TEG ID and UE Tx TEG ID ~~is supported~~. * In either option, a UE Tx TEG ID is associated with (downselection needed)   + Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the UE Rx-Tx measurement   + Alt. 2: the Tx timing of the UE Rx-Tx measurement   + Alt. 3: one or more UL SRS resources for positioning * Note: An UE Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement * FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).   FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements   * + ***UE RxTx ‘timing error group’ (UE RxTx TEG):*** *A UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, and one or more UL SRS resources for the positioning purpose~~, which have the ‘Rx timing errors+Tx timing errors’ within a certain margin.~~ The differences in UE RxTx timing errors between any two UE Rx-Tx time difference measurements associated with the same UE RxTx TEG are within the same margin.* |
| Nokia/NSB | Okay with the update to UE/TRP Tx TEG. What is the moitivation to change from within a certain margin to within the same margin in the other definitions? |
| Ericsson | Support.  This should have **high priority** since other proposals rely on this one. Notably the margin will need to be defined somewhere. It may be reported by the UE either semi-dynamically or as a UE capability,  All simulations to show gains have been based on the TEG margins limiting the *difference* in timing error between measurements based on the same TEG, as clarified by the proposal. This is also what RAN4 has replied. There are no results at all showing any gain when the margin limits the timing error itself, and we have seen no arguments for that either. |
| Qualcomm | We agree that it is about timing error differences. RAN4 also has the same understanding. I think also Ran1 is aligned. It may make sense to update the text if there is confusion. |

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

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

Background

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

Submitted Proposal

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

FL comments

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

### Proposal 3.1 (for conclusion)

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

Comments

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| **Company** | **Comments** |
| vivo | We are okay with the FL proposal |
| Nokia/NSB | Okay |
| Ericsson | Support FL proposal |
| Qualcomm | Not sure why such a simple thing needs to be send to RAN2. We prefer to just directly discuss that any UE-based AD should be applicable to both unicast and broadcast. |

## Association information of SRS resources and UE Tx TEGs

Background

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

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

Submitted Proposals and FL comments

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

FL comments

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

### Proposal 3.2a (H)

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

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| vivo | Okay |
| Ericsson | Support |
| CATT | Support. |
| Nokia/NSB | Support. |
| Qualcomm | OK |

FL comments

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

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

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

### Proposal 3.2b (H)

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

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

Comments

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| **Company** | **Comments** |
| vivo | We wonder the yellow highlighted wording is needed because “if the UE supports multiple UE Tx TEGs” seems clear enough and it is difficult to judge whether the UE supports multiple Tx TEGs for Multi-RTT” if only RxTx TEG is reported for Multi-RTT   * For mitigating UE Tx timing errors for UL TDOA, including when UL TDOA is used together with DL-TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA. * For mitigating UE Tx timing errors for Multi-RTT, including when Multi-RTT is used together with DL TDOA and/or UL TDOA, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT. |
| Ericsson | This proposal doesn’t leave the SRS TEG association reporting over RRC/LPP when multiple/hybrid positioning methods are used. If Multi-RTT is used, LPP is mandated by the proposal. As noted by FL multiple companies (e.g. Ericsson, Huawei, ZTE, CMCC, Qualcomm) want this to be under network control. We therefore propose the following change of the WA 3.2a:   * For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.   + The serving gNB should forward the association information provided by the UE to the LMF.     - ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~   + UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB. * For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.   + ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~   + UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF. * For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if a request to do so is received from the gNB and the the UE should provide the association information of UL SRS resources for positioning with Tx TEGs to the LMF if a request to do so is received from the LMF. ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~ |
| CATT | Support. |
| Nokia/NSB | We support removing the FFS on forwarding to neighboring cells.   For the last FFS point on hybrid techniques, in our understanding it is still quite open how the UE will update the TEG association for Tx TEGs to the LMF (e.g., periodic, etc). At least to us it is not clear that the UE will not receive both a request from the gNB and from LMF. For example, in case of batch reporting where the RTOA measurements are transparent to the UE. The UE doesn’t know if it should reply to both. We feel the UE should be able to inform LMF/gNB which way it will report the associations and which way it will continue to update the TEG association. |
| Qualcomm | We don’t think that there is a need to discusss something more. The UE will just report according to a request it will receive. No more specification work is needed. |

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

Background

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

Submitted proposals

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

FL: Further discussion in Proposal 3.3-1.

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

FL: The proposal seems already supported.

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

FL: The proposal seems already supported.

* ***(Qualcomm, R1-2112217[16])Proposal 6:*** *Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs or M different UE RxTx TEGs and report the corresponding multiple UE Rx-Tx measurements.*
  + *N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability*
  + *M=[2, 3, 4, 6, 8], where the maximum value of M depends on UE capability*
  + *The timestamps of the multiple UE Rx-Tx measurements in the same measurement report can be the same or different.*

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

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

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

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

FL: How to support the perform multiple RSTD measurements towards the same TRP may be up to UE. It seems there is no need to further define how the UE made the measurement.

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

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

* *(****Ericsson, R1-2112339[18]) Proposal*** *3: Inform RAN4 with an LS that RAN4 requirements should capture that, subject to UE capability, a UE configured to perform and report multiple RSTD measurements towards the same TRP, utilizing different UE RX TEGs, shall report one RSTD measurement for each UE RX TEG association for which the DL PRS is received with an appropriate configuration and with high enough SINR.*

FL: We may assume we will send all of the agreements to RAN4 in this meeting.

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

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

### Proposal 3.3a (H)

*Make the following modification on the previous agreement made in RAN#106bis-e:*

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| vivo | We agree with the FL proposal, and the maximum number of UE Rx TEGs per band should be 8 in proposal 3.5a |
| Ericsson | Support.  Regarding the DL PRS configurations needed to enable multi-TEG RSTD reporting, we think this needs to be discussed and decided by RAN1. This could, however, be done under a new separate proposal. |
| CATT | Support. |
| Nokia/NSB | Okay |
| Qualcomm | OK |

### Proposal 3.3b (H)

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

Comments

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

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

Backgroud

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

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

Submttted proposals

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

Further discussion in Proposal 3.5-1.

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

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

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

FL: This seems to be already agreed.

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

FL Comments

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

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

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

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

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

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

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

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

### Proposal 3.4 (H)

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | We are supportive of option 2  1. We would like to confirm the difference for trigger reporting based on validity timer and periodicity  2. The “,” after “option 1: “ should be moved |
| Ericsson | We are supportive of option1, but we think one could also consider combinations of option 1 and 2.  **Multi-RTT case**  If the UE reports UE Rx-Tx periodically in multi-RTT reports to the LMF, then the LMF will need the UE Tx TEG association info at the same time. To send UE TX TEG associationinfo inbetween the periodic multi-RTT reports every time a UE TX TEG association changes would waste resources. Note that this can mean that the UE has to start a separate UL transmission just for this purpose so the overhead is very significant. All UE TX TEG associations/changes during the period between multi-RTT reports should be collected and reported in the multi-RTT report itself or at least at the same time. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent.  **UL TDOA case**  Similarly the gNB reports the RTOA periodically to the LMF, then the gNB will need the UE Tx TEG association info at the same time. To send UE TX TEG associationinfo inbetween the periodic RTOA reports every time a UE TX TEG association changes would waste resources. Note that this means that the UE sometimes has to start a separate UL transmission just for this purpose so the overhead is very significant. All UE TX TEG associations/changes during the period between RTOA reports should be collected and reported in one report. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same UL SRS resource need not be sent.  **DL TDOA case**  If the UE reports RSTDs periodically in UL-TDOA reports to the LMF, then the LMF will need the TRP Tx TEG association info at the same time. To send TRP TX TEG associationinfo inbetween the periodic DL-TDOA reports every time a gNB TX TEG association changes would waste resources. All TRP TX TEG associations/changes during the period between multi-RTT reports should be collected and reported in one report. The signaling of the TEG associations could be optimized so that TEG associations that didn’t change since the last reported TEG association for the same DL PRS resource need not be sent. Thus, the basic principle is periodic reporting but signalling can be optimized so that TEG associations that didn’t change since the last reported TEG association for the same DL PRS resource need not be sent.  Thus we make the following compromise proposal based on periodic reporting with signaling optimizations to avoid reporting of TEG associations that didn’t change:   * *For UL TDOA, support the gNB to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*    + *based on a configured periodicity and SFN offset*     - *FFS: the values of the configurable periodicities and offsets*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value* * *For Multi-RTT, support the LMF to request a UE to report the association information between UE Tx TEG IDs and positioning SRS resources, subject to UE capability:*   + *based on a configured periodicity and SFN offset*     - *FFS: the values of the configurable periodicities and offsets*     - *FFS: whether the TX TEG IDs are reported as a part of the multi-RTT report and thus with the same periodicity and offset*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value*   + *The UE TX TEG association is reported for each SRS instance during the configured period*     - *Signaling is optimized by using the last reported UE TX TEG association for the same UL SRS resource as default value* * *For DL-TDOA, support the LMF to request a TRP to provide the association information between TRP Tx TEG IDs and positioning PRS resources:*   + *based on a configured periodicity and offset*     - *FFS: the values of the configurable periodicities and offsets*   + *The TRP TX TEG association is reported for each DL PRS instance during the configured period*     - *Signaling is optimized by using the last reported TRP TX TEG association for the same DL PRS resource as default value* |
| CATT | Support the proposal, and we prefer the Option 2 for all of the three main bullets, i.e., event-triggered reporting of update of the association information in order to reduce the overhead and latency. |
| Nokia/NSB | We support a modified option 3 where the UE/TRP should report the Tx TEG associations after a TRP/UE (respectively) reports a measurement report with corresponding Rx TEGs. This should be the baseline of the feature. It is possible that a modified option 1 can also meet this criteria in which case we could accept that potentially. |
| Qualcomm | Option 2 is the minimal and natural way to consider. |

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

Background

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

Submitted proposals

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

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

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

FL: This seems already covered in UE feature session.

FL Comments

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

### Proposal 3.5a (H)

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

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

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

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | 1. We prefer the TEG capability is per band. And the candidate value of RxTEGs is the same as proposal 3.3 a. So, the candidate values of ‘Maximum number of Rx TEGs for UE-assisted DL-TDOA’ should be modified to [1,2,3,4,6,8] and the values in specification should be changed to 8. Correspondindly, the values for RxTx TEGs in specification should be changed to 64.  2. To define the maximum number per method is redundant since the capability is independent of the methods |
| Ericsson | We share the concern with vivo. We do not agree that the maximum number of UE Rx TEGs should be method specific. So the 2nd row is not needed. |
| CATT | Support. |
| Nokia/NSB | Not sure that this is a high priority topic. |
| Qualcomm | TO E//: For UTDOA/RTT, there needs to be separate capability because different signaling is specified for each one. We cannot assume that a UE supporting reporting of TEGs in RRC, will also do that in LPP, or vice versa.  For DLTDOA/RTT, a UE, in RTT, may only report RxTxTEG, and not RxTEGs, as it has been agreed. And actually we consider it a reasonable implementation for a UE to support RxTEG for DL-TDOA and RxTxTEGs for RTT (and not RxTEG for RTT, since RxTEG doesn’t provide what is really needed to mitigate the timing errors in RTT). |

### Proposal 3.5b (H)

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Support the intention, but we prefer up to 4 RSTD measurements(4 PRS resources) are chosen to be reported in the RSTD measurement, where each RSTD measurement can have multiple values associated with its Rx TEG |
| ericsson | Support. Could alternatively be formulated as:   * The maximum number of reported RSTD measurements per UE RX TEG is 4. * Signaling details left to RAN2 to decide |
| CATT | Support.  For the value of N, we prefer N=32, since Rel-16’s maximum number of RSTD measurements is 4, and the maximum number of UE RX TEGs is 8. |
| Nokia/NSB | Okay. |
| Qualcomm | We prefer the proposal from E//. |

## Configuration of UE TX TEG association

FL Comments

* ***(InterDigital, R1-2111797[11]) Proposal 1:*** *Support the LMF to request the TRP to fix TRP Rx TEG, configure the UE to use N different UE Tx TEGs and report respective RTOA, if the TRP and UE support more than one Rx TEGs and Tx TEGs, respectively.*
* ***(Ericsson, R1-2112339[18]) Proposal 7:*** *The UE can be configured by the gNB with a list of SRS resource sets and SRS resources for which UE TX TEG association reporting should be performed. In case an SRS resource set is listed rather than an SRS resource then the UE should report the UE TX TEG association for all SRS resources in the SRS resource set.*
* ***(Ericsson, R1-2112339[18]) Proposal 10:*** *Support UE TX TEG sweeping over SRS resources for positioning in a SRS resource set configuration.*
* ***(Ericsson, R1-2112339[18]) Proposal 12:*** *It shall be possible to configure a UE with an SRS resource with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS*
* ***(EricssonProposl 13:*** *For UL-TDOA positioning, support LMF to request a gNB to report RTOA measurements separately for each SRS resource in an SRS resource set.*

FL Comments

In [11] and [18], it is proposed to configure a UE to use different UE Tx TEGs for UL transmission of SRS positioning resources or UE TX TEG sweeping over SRS resources for positioning, which allows the TRP uses the same Rx TEG to receive the UL SRS positioning signals, then it may potentially allow the LMF to obtain the time differences between UE Tx TEGs from the UL RTOA measurements.

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

### Proposal 3.6

* *Support the LMF to request the TRP to fix TRP Rx TEG, configure the UE to use N different UE Tx TEGs and report respective RTOA, if the TRP and UE support more than one Rx TEGs and Tx TEGs, respectively.*
* *The UE can be configured by the gNB with a list of SRS resource sets and SRS resources for which UE TX TEG association reporting should be performed. In case an SRS resource set is listed rather than an SRS resource then the UE should report the UE TX TEG association for all SRS resources in the SRS resource set.*
* *Support UE TX TEG sweeping over SRS resources for positioning in a SRS resource set configuration.*
* *It shall be possible to configure a UE with an SRS resource with a restriction for the UE to utilize a certain UE TX TEG when transmitting the SRS*
* *For UL-TDOA positioning, support LMF to request a gNB to report RTOA measurements separately for each SRS resource in an SRS resource set.*

Comments

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

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

Submitted Proposals

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

Comments

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

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

### Proposal 3.7

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support. |
|  |  |
|  |  |

## Positioning SRS with antenna/beam switching

Submitted Proposals

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

FL Comments

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

### Proposal 3.8

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Do not support. |
| Ericsson | We think this is an alternative way of formulating UE TX TEG sweeping (see proposal 3.6). We think, however, that the connection to UE TX TEGs needs to be defined, as in the revised proposal below:   * + *Introduce a new parameter for the positioning SRS resource set indicating "antenna switching", and each positioning SRS resource in the set is associated with a different UE antenna port.*   + *Introduce a new UE capability of antenna switching for positioning SRS resource, indicating the number of UE TX TEGs.*   + *The number of positioning SRS resources in the positioning SRS resource set configured with "antenna switching" should be equal to the number of UE TX TEGs indicated in UE capabilities*   + *The UE should transmit each SRS resource in in the positioning SRS resource set configured with "antenna switching" with a different UE TX TEG*   + *The switching period follows the existing MIMO SRS antenna switching (15us as per R1-1710048).* |
|  |  |

## Association of UE Tx TEGs with the MIMO SRS

Submitted Proposals

* ***(OPPO, R1-2111289[5]) Proposal 1:*** *Rel-17 doesn’t support the association of TEG with MIMO SRS port(s).*
* ***(Ericsson, R1-2112339[18]) Proposal 6****: The UE can be configured by the gNB to send UE TX TEG association reports for all SRS types including SRS for MIMO.*

FL Comments

In previous meetings, there were intensive discussions related to whether to support a UE to provide the association information of UL SRS resources for MIMO with Tx TEGs without conclusion [19]. Given that only two companies have discussed the issue, and one proposes not to support *TEG with MIMO SRS port*, FL would suggest: “*no further discussion on the association of UE Tx TEG with MIMO SRS in Rel-17*”.

### Proposal 3.9 (maybe for conclusion)

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Nokia/NSB | Support the proposed conclusion. |
|  |  |

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

Background

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| Agreement (RAN1#104bis-e)  For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support one of the following alternatives:   * Alt.1: Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a pair of {Rx TEG, Tx TEG} to LMF, where the Rx TEG is used to receive the DL PRS and the Tx TEG is used to transmit the UL Positioning SRS; * Alt.2: Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF according to one of the 2 following options:   + Option 1: the UE RxTx TEG is associated with one or more {DL PRS resource, UL Positioning SRS resource} pairs     - FFS: whether UE provides the association information of DL PRS resources to UE Rx TEG to LMF for UE RxTx measurements specifically   + Option 2: the UE RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs where the Rx TEG is used to receive the DL PRS and the Tx TEG is used to transmit the UL Positioning SRS. * For both alternatives, the UE may provide the association information of SRS resources for positioning to UE Tx TEG to LMF   + FFS: Whether the association information is sent directly from UE to LMF, or is first provided to gNB and then forwarded to LMF * FFS: the details of the signalling, procedures, and UE capability   Agreement: (RAN1#104bis-e)   * For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support one of the following alternatives:   + Alt.1: Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a pair of {Rx TEG, Tx TEG} to LMF   + Alt. 2: Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a TRP RxTx TEG to LMF, if the TRP has multiple RxTx TEGs, according to one of the 2 following options:     - Option 1: the TRP RxTx TEG is associated with one or more {DL PRS resource, UL Positioning SRS resource} pairs       * FFS: whether gNB provides the association information of UL Positioning SRS resources to TRP Rx TEG to LMF, if the TRP has multiple Rx TEGs, for gNB RxTx measurements specifically     - Option 2: the TRP RxTx TEG is associated with one or more {Rx TEG, Tx TEG} pairs where the Rx TEG is used to receive the UL Positioning SRS and the Tx TEG is used to transmit the DL PRS.   + For both alternatives, the gNB may provide the association information of DL PRS resources to TRP Tx TEG to LMF if the TRP has multiple Tx TEGs. * FFS: the details of the signalling, procedures   Agreement: (RAN1#105e)  For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, one or both of the following options:   * Option 1: Reporting of UE RxTx TEG ID is supported by the UE   + FFS: Further details on how the RxTx TEG IDs are related/associated to Tx TEG IDs and/or Rx TEG IDs and to the Rx-Tx measurements. * Option 2: Reporting of UE RxTx TEG ID is not supported by the UE; reporting of Rx TEG ID and Tx TEG ID is supported. * In either option, a Tx TEG ID is associated with (downselection needed)   + Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement   + Alt. 2: the Tx timing of the Rx-Tx measurement   + Alt. 3: one or more UL SRS resources for positioning * Note: An Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement * FFS: How to resolve the potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2). * FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements |
| Agreement: (RAN1#106bis-e)  Make the following modification of the previous agreement:  For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE ~~may~~ should support, up to UE capability, either one or both of the following options:   * Option 1: Reporting of UE RxTx TEG ID ~~is supported by the UE~~   + FFS: Further details on how the UE RxTx TEG IDs are related/associated to UE Tx TEG IDs and/or UE Rx TEG IDs and to the UE Rx-Tx measurements. * Option 2: Reporting of ~~UE RxTx TEG ID is not supported by the UE; reporting of~~ UE Rx TEG ID and UE Tx TEG ID ~~is supported~~. * In either option, a UE Tx TEG ID is associated with (downselection needed)   + Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the UE Rx-Tx measurement   + Alt. 2: the Tx timing of the UE Rx-Tx measurement   + Alt. 3: one or more UL SRS resources for positioning * Note: An UE Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement * FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2). * FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements   Agreement: (RAN1#106bis-e)   * If a Tx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE should also report the association of the Tx TEG ID to the UL SRS resource(s)   + FFS: how the the association of the Tx TEG ID to the UL SRS resource(s) is determined by UE.   + FFS: details of the signalling   Agreement: (RAN1#106bis-e)   * + If a RxTx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE may optionally also report a Tx TEG ID. |

Submitted Proposals

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

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

FL Comments

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

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

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

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

**Supported by**: ZTE

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

**Supported by**: vivo

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

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

### Proposal 3.10

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

Comments

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| **Company** | **Comments** |
| vivo | We can not agree with the proposal, it seems to transmit timing of an uplink subframe contains to UL SRS timing so that “*TUE-TX* ” is different from Rel-16.  We are okay with the following two options   * *Alt 2: A Tx TEG ID of a UE Rx-Tx time difference measurement is associated with* TUE-TX (TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i received from the TP) * *Alt 3:* A Tx TEG ID is associated with one or more UL SRS resources for positioning |
| Nokia/NSB | We are okay with the proposal and would like to highlight that how the UE reports this information (e.g., with UE Rx-Tx time difference report) is a critical step for us to complete this topic for Rel-17. |
| Ericsson | We can’t agree to this proposal. The transmit timing of the UE Rx-Tx time difference is defined by the UL subframe #j closest in time to the subframe #i received from the TP. We are fine with  Alt. 3 A Tx TEG ID is associated with one or more UL SRS resources for positioning |

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

Background

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

Submitted proposals

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

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

* + *If no consensus can be made about this topic, conclude not to specify it in Rel-17.*
* ***(CATT, R1-2111256[4]) Proposal 4:*** *Supporting the following Option 4 related to the UE Rx-Tx time difference:*
  + *Option 4:* 
    - *Subject to UE capability, the UE may report an UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS, instead of original DL Timestamp.*
    - *The nr-TimeStamp field in the IE NR-Multi-RTT-SignalMeasurementInformation in LPP should be redefined to specify the time instance for the uplink subframe of a positioning SRS related to the Tx time of the UE Rx-Tx measurement, instead of the original time instance for which the measurement is performed, related to the Rx time of the UE Rx-Tx measurement*
    - *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):*
    - *If the UE does not transmit SRS in subframe #j, and if the UE reports a timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* *(****CATT, R1-2111256[4]) Proposal 5****: When the UE uses the multiple samples of UE Rx-Tx time difference to calculate the measured value of UE Rx-Tx time difference, the UE should be expected that the transmit timing of SRS-Pos corresponding to all the samples used to calculate one UE Rx-Tx time difference measurement report or one UE Rx-Tx time difference measurement instance, should be subject to either no timing adjustment, or the same timing adjustment.*
* ***(OPPO, R1-2111289[5]) Proposal 6****: Among the three options regarding the UE Rx-Tx time difference, support Option 1, i.e.,*
  + *Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.*
  + *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):* 
    - *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(Nokia, R1- 2111364[6]) Proposal 11:*** *Do not discuss the UE Rx-Tx time difference measurement definition options further in RAN1.*
* ***(CMCC, R1-2111609[9])*** *Proposal 3: Support Option 1 related to the UE Rx-Tx time difference:*
  + *Option 1:* 
    - *Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.*
    - *Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):* 
      * *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(Samsung, R1-2111738[10])Proposal 3****:* 
  + *UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS*
  + *Add the following to the UE Rx-Tx time difference definition:*
  + *If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.*
* ***(LGE, R1-211973[13]) Proposal 3:*** *Regarding TA change for UL positioning measurement, RAN1 should support option 2(reporting Timing Adjustment (TA) change information) to enhance Multi-RTT accuracy enhancement.*
* ***(LGE, R1-211973[13]) Proposal 4:*** *If reporting TA change information from UE is supported, RAN1 needs to consider the measurement report as conveying the TA change information.*
* ***(LGE, R1-211973[13]) Proposal 5:*** *To solve the differentiation problem from TA changes, consider introducing time duration (or window) where UE applies fixed TA.*
* ***(MTK, R1-2112071[14]) Proposal 2-1****: Support UE to report TX timing change information, not to compensate it within the UE report*
* ***Qualcomm, R1-2112217[16])Proposal 1:*** *For the purpose of enhancing the accuracy of RTT method, support Option 1.*
* ***(Ericsson, R1-2112339[18]) Proposal 18:*** *To mitigate transmission timing changes for multi-RTT measurements:*
  + *Support the LMF to configure a UE (with required capabilities) with a list of SRS resource sets and SRS resources for each TRP for reporting of transmission timing compensation.*
    - *In case, an SRS resource set is listed, then that should be interpreted as including all SRS resources in the SRS resource set.*
  + *Given a UE Rx-Tx time difference measurement reported in a multi RTT report, the UE should also report a transmission timing compensation for each SRS resource indicated for transmission timing compensation.*
    - *The transmission timing compensation is signaled together with two timestamps:*
      * *A first timestamp for the UL subframe #j closest in time to the DL subframe #i in which the DL PRS used for the UE Rx-Tx time difference measurement is received*
      * *A second timestamp for the subframe #k where the TX instance of the SRS resource occurs which is closest in time to the reception time of the DL PRS used for the UE Rx-Tx time difference measurement.*
    - *Transmission timing compensation is defined as the difference in transmission timing between the subframe #k and subframe #j.*
    - *Transmission timing is defined as the time between the transmission of UL subframe #i and the first detected path (in time) of the corresponding downlink subframe #i from the reference cell.*
    - *A transmission timing compensation in a multi-RTT report is only coupled to the two timestamps and is thus in the report not tied to a specific SRS resource or UE Rx-Tx time difference measurement.*
* ***(Ericsson, R1-2112339[18]) Proposal 19:*** *The transmission timing compensation should be reported by the UE to the LMF together with a quality estimate, giving a measure of the deviation of the transmission timing compensation from the true difference in transmission timing between UL subframe #k of UL SRS transmission and UL subframe #j closest in time to DL PRS reception.*

FL comments

The feedbacks for the options may be summarised as follows:

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

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

*Intel,*

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

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

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

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

Significant efforts have been spent on the previous two meetings on the issue [19]. From the online/offline discussions in the previous meetings and the contributions submitted in this meeting, it seems that for each of these the options, there are still serious concerns by multiple companies, and possibility of reaching the consensus of accepting either or both of the options are very slim. Based on the consideration that we have many other high-priority issues that need to be resolved for the WI completion in this meeting, and the resolutions of the impact of the timing adjustment on the UE Rx-Tx time difference measurement is not explicitly included in the WI objectives, the FL would suggest making a conclusion that no further discussion of this topic in Rel-17.

### Proposal 3.11 (for conclusion)

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

Comments

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| **Company** | **Comments** |
| vivo | Support |
| Ericsson | In our contribution we have made a compromise proposal caturing components both from option 1 and option 2. It would be nice to hear companies view on this.  The new proposal is based on compensation terms for time intervals between a DL PRS and an UL SRS as in option 1. TA changes at discrete points in time are not reported. The compensation term may consist both of TA changes and clock drifts during the time interval (exactly as in option 1).  The UE Rx-Tx measurements are, however, not compensated with the compensation term by the UE. Instead the compensation terms are sent separately in the same multi-RTT report as the UE Rx-Tx measurement. This separation is similar to the way TA changes are sent in option 2. It allows for sending multiple compensation terms for different UL SRS resources giving the LMF the possibility to match gNB Rx-Tx measurements, UE Rx-Tx measurements and compensation terms correctly.  The proposal looks as follows:  To mitigate transmission timing changes for multi-RTT measurements:   * **Support the LMF to configure a UE (with required capabilities) with a list of SRS resource sets and SRS resources for each TRP for reporting of transmission timing compensation.**   + **In case, an SRS resource set is listed, then that should be interpreted as including all SRS resources in the SRS resource set.** * **Given a UE Rx-Tx time difference measurement reported in a multi RTT report, the UE should also report a transmission timing compensation for each SRS resource indicated for transmission timing compensation.**   + **The transmission timing compensation is signaled together with two timestamps:**     - **A first timestamp for the UL subframe #j closest in time to the DL subframe #i in which the DL PRS used for the UE Rx-Tx time difference measurement is received**     - **A second timestamp for the subframe #k where the TX instance of the SRS resource occurs which is closest in time to the reception time of the DL PRS used for the UE Rx-Tx time difference measurement.**   + **Transmission timing compensation is defined as the difference in transmission timing between the subframe #k and subframe #j.**   + **Transmission timing is defined as the time between the transmission of UL subframe #i and the first detected path (in time) of the corresponding downlink subframe #i from the reference cell.**   + **A transmission timing compensation in a multi-RTT report is only coupled to the two timestamps and is thus in the report not tied to a specific SRS resource or UE Rx-Tx time difference measurement.** |
| Nokia/NSB | Do not support further discussion on this topic. It was clear from the agreement that a decision was supposed to be reached at RAN1#106-b. However, no agreement was reached so we should drop this topic in our view. There are many open issues related to TEG which need to be resolved at this meeting and we feel that this issue should be dropped. |

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

Submitted Proposals

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

FL comments

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

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

### Proposal 3.12

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

Comments

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| **Company** | **Comments** |
| Nokia/NSB | In principle we are okay with the UE/TRP reporting the margin to the LMF. In fact this is a fundamental part of the TEG concept in our view. However, this should be done in UE capability and TRP information request/response in our view. This should be a high priority topic at this meeting. Without reporting of the margins we are not sure there is any benefit to this entire feature. |
| Ericsson | We think this has **high priority** but before agreeing to this, it’s necessary to make sure that we all have the same understanding of what the margin is as discussed in proposal 2.2. Reading company contributions, it still seems that some companies believe the margin puts limits on the timing error of one single measurement. This is not the case. It limits the difference in timing error between different measurements associated to the same TEG. This is the only way to achieve any transmit timing mitigation with the TEG concept. This is also the understanding of RAN4 as expressed in their LS ([R1-2108707](file://Users/renda000/Downloads/2021_11_RAN1_107e/Docs/R1-2108707.doc)),  Once the TEG margin definition is settled we can agree to the proposal with a minor change.The examples in the FFS on signaling details should also include ‘capability reporting’. |
| Qualcomm | We think it is useful to add the capabilities, and let RAN4 decide on the values of timing margins. If this is not agreed, there is a high risk, that Ran4 will just have very loose margins, if there is no capability.  We agree with Ericsson on the meaning of TEGs, its about timing error differences. However, we think it is clear. |

## Reporting of group time delys/errors

Submitted Proposals

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

FL comments

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

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

### Proposal 3.13

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | This isn’t acceptable to us. In fact it’s worse than reporting timing errors separately since UL TDOA measurements are compensated with TX group delays. The UE can’t know beforehand what TRPs will be able to hear the SRS. Thus, the UE doesn’ät know if the UL TDOA will be combined with a RTOA measurement or not. |
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# Reference devices for mitigating UE/gNB Tx/Rx timing errors

Background

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

*Submitted Proposals*

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

FL comments

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

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

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

### Proposal 4

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | We share FL’s view that no discussion is needed in RAN1. |
| Nokia/NSB | Agree with Ericsson. |
|  |  |

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

Background

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

## Measurement time window

Background

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

Submitted Proposals

* ***(Huawei, R1-2110850[1]) Proposal 3:*** *Support both Option 1 and option 2 for MTW configuration of UE and gNB, respectively.*
* ***(Huawei, R1-2110850[1]) Proposal 4:*** *MTW configuration to UE/gNB should include*
  + *MTW starting/offset SFN*
  + *MTW length in the unit of 10msec*
  + *MTW periodicity for the cases of periodic reporting in the unit of 10msec*
  + *The UE/gNB expects MTW periodicity to be configured to a number close to the periodic reporting interval, which is the multiple of PRS/SRS periodicity and can divide or can be divided by 10.24s SFN period.*
* ***(ZTE, R1-2110956[2]) Proposal 8****: There is no need to introduce measurement time window in Rel-17 NR positioning.*
* ***(vivo, R1-2111013[3]) Proposal 9:*** *Support to enable the UE to report PRS measurements derived from the most recent measurement instances in advance of a certain time before the measurement report.*
  + *The certain time before the measurement report is related to PRS processing capability.*
* ***(CATT, R1-2111256[4]) Proposal 7:*** *The configurable measurement time windows should be supported, in which the UE or TRP measurement instances are obtained.*
* ***(CATT, R1-2111256[4]) Proposal 8****: UE measurement time windows and TRP measurement time windows can be configured independently. They can be configured to be the same or different.*
  + *UE measurement time window refers to the time window in which UE measures DL-PRS resources. In this time window, UE obtains at least one UE measurement instance by measuring DL-PRS resources.*
  + *TRP measurement time window refers to the time window in which TRP measures SRS-Pos resources. In this time window, TRP obtains at least one TPR measurement instance by measuring SRS-Pos resources.*
* ***(CATT, R1-2111256[4]) Proposal 9****: UE (or TRP) is not expected to measure DL-PRS (or SRS-Pos) outside of the measurement time window.*
* ***(CATT, R1-2111256[4]) Proposal 11:*** *(Configuration method 1): UE/TRP measurement time window should be configured with the following parameters by LMF:*
  + *For UE measurement time window (via LPP signalling):*
    - *P1: The periodicity of UE measurement time window (for periodic UE MTW).*
    - *T1: The start time of UE measurement time window.*
    - *J: The number of UE measurement instances included in the UE measurement time window.*
    - *Ni: The number of instances of DL-PRS resource set or DL-PRS occasions contained by the i-th UE measurement instance.*
  + *For TRP measurement time window (via NRPPa signalling):*
    - *P2: The periodicity of TRP measurement time window (for periodic TRP MTW).*
    - *T2: The start time of TRP measurement time window.*
    - *K: The number of TRP measurement instances included in the TRP measurement time window.*
    - *Mi: The number of instances of SRS-Pos resource set or SRS-Pos occasions contained by the i-th TRP measurement instance.*
* ***(CATT, R1-2111256[4]) Proposal 14:*** *For configuration method 1 and the periodic DL-PRS, the length of UE measurement time window can be defined as:*
  + - * + *is the periodicity of DL-PRS resource set;*
        + *is the number of UE measurement instances included in the UE measurement time window,* ≥1;
        + *is the number of instances of DL-PRS resource set or DL-PRS occasions contained by the i-th UE measurement instance，*≥1.
* ***(CATT, R1-2111256[4]) Proposal 15:*** *For configuration method 1 and the periodic/semi-persistent SRS-Pos, the length of TRP measurement time window can be defined as:*
  + - * + *is the periodicity of SRS-Pos resource set;*
        + *is the number of TRP measurement instances included in the TRP measurement time window,* ≥1;
        + *is the number of instances of SRS-Pos resource set or SRS-Pos occasions contained by the i-th TRP measurement instance，*≥1.
* *(****CATT, R1-2111256[4]) Proposal 16****: For Configuration method 2, UE/TRP measurement time window can be configured with the following parameters by LMF:*
  + *For UE measurement time window (via LPP signalling):*
    - *P1: The periodicity of UE measurement time window (for periodic UE MTW).*
    - *T1: The start time of UE measurement time window.*
    - *L1: The length of UE measurement time window.*
  + *For TRP measurement time window (via NRPPa signalling):*
    - *P2: The periodicity of TRP measurement time window (for periodic TRP MTW).*
    - *T2: The start time of TRP measurement time window.*
    - *L2: The length of TRP measurement time window.*
* ***(CATT, R1-2111256[4]) Proposal 17****: Configuration method 1 should be adopted to configure the measurement time window, since it will help LMF to more effectively eliminate the influence of timing errors of TRPs and UE.*
* ***(OPPO, R1-2111289[5]) Proposal 10****: Rel-17 doesn’t support the measurement time window (MTW) for the measurement instance.*
* ***(Nokia, R1- 2111364[6]) Proposal 12****: If the MTW is agreed to be supported the UE/TRP is not mandated to use the resources inside the MTW for the positioning measurements*
* ***(CMCC, R1-2111609[9]) Proposal 4:*** *Support both of the following options:*
  + *Option 1: Support LMF to optionally indicate the measurement time window (MTW) for a UE for the measurement instances included in a measurement report.*
  + *Option 2: Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a measurement report.*
* ***(Samsung, R1-2111738[10])Proposal 4:*** 
  + *Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a single measurement report.*
* ***(InterDigital, R1-2111797[11]) Proposal 4:*** *Support Option 1 (“Support LMF to optionally indicate the measurement time window for a UE”) and Option 2 (“Support LMF to optionally indicate the measurement time window for a gNB”) of the measurement time window.*
* ***(LGE, R1-211973[13]) Proposal 10:*** *RAN1 should support configuring MTW for both UE and gNB.*
* ***(LGE, R1-211973[13]) Proposal 11:*** *Regarding configuration of measurement time window (MTW), RAN1 should consider following ways to indicate/configure it.*
  + *Type #1: predefined configuration*
    - *Introducing positioning radio frame (PRF) in which a single or multiple MTW(s) may exist.*
    - *Start timing offset and/or duration and/or repetition factor (and/or including time gap) for detail configuration of MTW(s).*
  + *Type #2:dynamic configuration*
    - *MTW can starts after the message from LMF such as positioning measurement request.*
    - *Start timing offset and/or duration and/or repetition factor (and/or including time gap) for detail configuration of MTW(s).*
* ***(LGE, R1-211973[13]) Proposal 12:*** *RAN1 should allow both UE and gNB to perform positioning measurement regardless of MTW.*
* ***(LGE, R1-211973[13]) Proposal 13:*** *Considering specific use cases that LMF wants to indicate both UE and gNB to perform positioning measurement within MTW, RAN1 also needs to discuss about it in detail such as related signaling, procedure and etc.*
* ***(MTK, R1-2112071[14]) Proposal 3-1****: Instead of indicating MTW by LMF, UE may report its measurement behaviour to LMF and LMF may further forward UE’s measurement behaviours to gNBs so that gNBs may selectively measure SRS to match UE’s behaviour*
* ***(Qualcomm, R1-2112217[16])Proposal 13:*** *Support both the following:*
  + *Support LMF to optionally configure the measurement time window (MTW) for a UE for the measurement instances included in a single measurement report.*
  + *Support LMF to optionally indicate the measurement time window for a gNB for the measurement instances included in a single measurement report.*
* ***(Qualcomm, R1-2112217[16])Proposal 14:*** *The measurement time window (MTW) configuration for a UE/gNB should include*
  + *MTW starting time (e.g., the offset of SFN)*
  + *MTW length, which may be configured with one of the following options* 
    - *Option 1: (explicitly) configured in the unit of 10msec;*
  + *MTW periodicity for the cases of periodic reporting*
* ***(Lenovo, R1-2112323[17]) Proposal 1:*** *Support Options 1 and 2 for indicating the measurement time window for the UE and gNB, respectively.*
* ***(Lenovo, R1-2112323[17]) Proposal 2:*** *The MTW configuration for a UE and gNB should at least include parameters such as time window length and periodicity, where applicable.*
* ***(Lenovo, R1-2112323[17]) Proposal 3:*** *It should be possible to support reporting of timestamps outside the configured MTWs.*
* ***(Ericsson, R1-2112339[18]) Proposal 23:*** *The measurement time window (MTW) configuration for a UE/gNB should include: MTW starting time (e.g., the offset of SFN); MTW length, configured in the unit of 10msec; MTW periodicity for the cases of periodic reporting.*
* ***(Ericsson, R1-2112339[18]) Proposal 24:*** *A UE configured by the LMF to report the UE TX TEG association for an SRS resource should include this reporting in the multi-RTT report. The UE should report the UE TX TEG association of all TX instances of the SRS resource within the MTW configured for the multi-RTT report.*
* ***(Ericsson, R1-2112339[18]) Proposal 25:*** *Support the TEG concept only for single sample measurements.*

FL Comments

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

### Proposal 5.1a (H)

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support |
| CATT | Support.  In our point of view, MTW is very important at least for facilitating the timestamps matching among various measurement instances, e.g., among UE Rx-Tx time difference measurement instances and gNB Rx-Tx time difference measurement instances for multi-RTT positioning method. |
| Nokia/NSB | Our preference is to not introduce this feature but if we need to have it then the notes are necessary in our view. |
| Qualcomm | support |

### Proposal 5.1b (H)

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support. Preference for option 2. |
| CATT | Support.  About the configuration of MTW length, we prefer Option 2. |
| Qualcomm | support |

## Timestamp of measurement instance

Background

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

|  |
| --- |
| (Round 2) Proposal 5-2a (H) *The timestamp for a measurement instance in a measurement report is defined by one of the following options (downselection in RAN1#106b):*   * *Option 1: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource (or the last SRS resource for the positioning purpose) that are used to determining the measurement instance.* * *Option 2: The timestamp of the UE (or TRP) measurement instance corresponds to as a time window indicated by,*   + *A starting time instance corresponds to the reception time of the first instance of the DL PRS (or UL SRS) resources averaged/filtered over to give the reported measurement instance, and*   + *An ending time instance corresponds to a reception time of the last instance of the DL PRS (or UL SRS) resources averaged/filtered over to give the reported measurement instance* * *Option 3: Up to UE implementation.* |

Submitted proposals and FL comments

* ***(ZTE, R1-2110956[2]) Proposal 9:*** *Support of a UE to report multiple measurement instances in a measurement report,*
  + *For PRS processing sample number=1, each measurement instance should be based on a single time instance of corresponding DL PRS resource. UE can report multiple measurement instances based on different time instances of the same DL PRS resource, where different time instances of the same DL PRS resource should be associated with the same UE Rx TEG.*
  + *For PRS processing sample number=4, each measurement value in a measurement instance can be based on a filtered/averaged results from at least four time instances of corresponding DL PRS resource. UE should report a time stamp to indicate the time duration over which the filtering or average is performed, where the time stamp includes,*
    - *A starting time instance corresponds to the reception time of the first instance of the DL PRS resources to obtain the reported measurement instance, and*
    - *An ending time instance corresponds to a reception time of the last instance of the DL PRS resources to obtain the reported measurement instance.*
  + *Note: For both PRS processing sample number=1 and PRS processing sample number=4, UE should always follow the measurement period defined in Rel-16.*
* ***(vivo, R1-2111013[3]) Proposal 10:*** *The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource (or the last SRS resource for the positioning purpose) that are used to determining the measurement instance.*
* ***(CATT, R1-2111256[4]) Proposal 12:*** *When UE reports a measurement instance, it also reports the time stamp of the measurement instance, which corresponds to one certain reception time between the first and last DL-PRS resource sets that are used to determining the measurement instance.*
* *(****CATT, R1-2111256[4]) Proposal 13:*** *When TRP reports a measurement instance, it also reports the time stamp of the measurement instance, which corresponds to one certain reception time between the first and last SRS-Pos resource sets that are used to determining the measurement instance.*
* ***(OPPO, R1-2111289[5]) Proposal 9:*** *For the timestamps for the measurement instances in a measurement report, support either Option 1 or Option 3:*
  + *Option 1: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource (or the last SRS resource for the positioning purpose) that are used to determining the measurement instance. (1st preference)*
  + *Option 3: Up to UE implementation. (2nd preference)*
* ***(Lenovo, R1-2112323[17]) Proposal 4:*** *The timestamp should correspond to the reception time of the last received PRS resource for a single measurement instance.*
* ***(Lenovo, R1-2112323[17]) Proposal 5:*** *The existing UE timing quality indication can be extended to assist the LMF in indicating the quality of the timestamp.*
  + *FL comments: It is unclear why there is need to indicate “the quality of the timestamp”. The timestamp is not a measurement, but just an indication on when the measurement is obtained.*

FL Comments

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

### Proposal 5-2(H)

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

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| vivo | Option 1 |
| Ericsson | Option 1. This is trivial for the UE to implement and having a well defined UE behaviour gives improved accuracy for the timestamp. |
| CATT | Support.  We prefer Option 3. |
| Qualcomm | Option 2 |

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

Background

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

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

Submitted proposals

* ***(ZTE, R1-2110956[2]) Proposal 9:*** *Support of a UE to report multiple measurement instances in a measurement report,*
  + *For PRS processing sample number=1, each measurement instance should be based on a single time instance of corresponding DL PRS resource. UE can report multiple measurement instances based on different time instances of the same DL PRS resource, where different time instances of the same DL PRS resource should be associated with the same UE Rx TEG.*
  + *For PRS processing sample number=4, each measurement value in a measurement instance can be based on a filtered/averaged results from at least four time instances of corresponding DL PRS resource. UE should report a time stamp to indicate the time duration over which the filtering or average is performed, where the time stamp includes,*
    - *A starting time instance corresponds to the reception time of the first instance of the DL PRS resources to obtain the reported measurement instance, and*
    - *An ending time instance corresponds to a reception time of the last instance of the DL PRS resources to obtain the reported measurement instance.*
  + *Note: For both PRS processing sample number=1 and PRS processing sample number=4, UE should always follow the measurement period defined in Rel-16.*
* ***(vivo, R1-2111013[3]) Proposal 11:*** 
  + *Support N=1 and 4 instances of the DL PRS resource set in each measurement instance.*
  + *Support M=1 and 4 SRS measurement time occasions in a TRP measurement instance.*
* ***(CATT, R1-2111256[4]) Proposal 10****: Each UE or TRP measurement instance can be configured with at least one instance of DL-PRS resource set or SRS-Pos resource set.*
  + *Each UE measurement instance can be configured with N instances of the DL-PRS resource set. N = [1, 2, 3, 4], using 2 bits to indicate which value is configured for N.*
  + *Each TRP measurement instance can be configured with M SRS-Pos resource set. M = [1, 2, 3, 4] , using 2 bits to indicate which value is configured for M.*
* ***(Nokia, R1- 2111364[6]) Proposal 13:*** *RAN1 should define a measurement instance.*

FL: It is defined in the previous agreement as “A measurement instance refers to one or more measurements, which can either be the same or different types, which are obtained from the same DL PRS resource(s), or the same UL SRS resource(s).”

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

FL Comments

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

### Proposal 5.3 (H)

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| vivo | Okay |
| Ericsson | Support. Our understanding is that this has already been agreed in the latency AI.  We think the maximum number of measurement instances in a single measurement report should be configurable by the NW to control overhead. The number of instances the UE will succeed to measure may in reality be smaller but still good to be able to limit the number. |
| CATT | Support. |
| Nokia/NSB | Somewhat same view as Ericsson that this seems very similar to the M=1 samples request agreed in the latency AI. Can the proponent explain what is needed on top? LMF can already request the UE to do a single sample measurement. Right now we can’t support this proposal. |
| Qualcomm | This has already been agreed. |

## Tx/Rx TEG for a measurement instance

Submitted proposals

* ***(ZTE, R1-2110956[2]) Proposal 7:*** *When multiple reference signals are used to determine the same Rx timing, support the followings,*
  + *For DL RSTD measurement, if multiple DL PRS resources are used to determine a start of one subframe from a TP, the multiple DL PRS resources should be associated with a same UE Rx TEG ID.*
  + *For UE Rx-Tx time difference measurement, if multiple DL PRS resources are used to determine a start of one subframe of the first arrival path of the TP, the multiple DL PRS resources should be associated with a same UE Rx TEG ID.*
  + *For UL RTOA measurement, if multiple SRS resources are used to determine a beginning of one subframe containing SRS received at a RP, the multiple SRS resources for positioning should be associated with a same TRP Rx TEG ID.*
  + *For gNB Rx-Tx time difference measurement, if multiple SRS resources for positioning are used to determine a start of one subframe containing SRS, the multiple SRS resources for positioning should be associated with a same TRP Rx TEG ID.*

FL Comments

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

### Proposal 5.4

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | Support. |
|  |  |
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## Measurement instances in a measurement report

Background

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| --- |
| Agreement (RAN1#104e)  Support enabling   * A UE to report one or more measurement instances (of RSTD, DL RSRP, and/or UE Rx-Tx time difference measurements) in a single measurement report to LMF for UE-assisted positioning, and * A TRP to report one or more measurement instances (of RTOA, UL RSRP, and/or gNB Rx-Tx time difference measurements) in a single measurement report to LMF, and * Each measurement instance is reported with its own timestamp   + FFS: The measurement instances are within a [configured] measurement time window * FFS: Each UE measurement instance can be configured with N instances of the DL-PRS Resource Set   + FFS: N (including N=1) * FFS: Each TRP measurement instance can be configured with M SRS measurement time occasions   + FFS: M (including M=1) * FFS: details of behavior, procedures, and UE capability if any * FFS: whether and how to consider the additional enhancement related to measurement reporting of multi-paths and quality metric * Note 1: A measurement instance refers to one or more measurements, which can either be the same or different types, which are obtained from the same DL PRS resource(s), or the same UL SRS resource(s). * Note 2: This enhancement has no intention to change the mapping of measurement types to Rel-16 positioning techniques and no intention to introduce new positioning techniques either.   ***Proposal 5-6 (RAN1#106bis-e) [19]***  *Further discuss the association between measurement instances and UE measurement report, at least consider one of the following options,*   * + *Alt.1: For each indicated DL PRS resource in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource.*   + *Alt.2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.*   + *Alt.3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.*   + *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.*   + *Alt.5: Multiple measurement instances are directly associated with a measurement report.* * *FFS: The relationship between the value N and the association between measurement instances and UE measurement report.* |

Submitted proposals

* ***(Qualcomm, R1-2112217[16])Proposal 15:*** *With regards to the association between measurement instances and UE measurement report, at least support the following option:*
  + *Alt.4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.* 
    - *That is, a UE should be able to report, in a single NR-XXX-ProvideLocationInformation, multiple NR-XXX-SignalMeasurementInformation elements for UE assisted positioning, and NR-XXX-LocationInformation for UE-based positioning.*
  + *The Maximum number of measurement instances can be at least 32.* 
    - *Introduce a per-UE capability on the maximum number ofmeasurement instances which can be included with the values {2,4,5,8,10,16,20,32}*

FL Comments

### Proposal 5-5

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

Comments

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| --- | --- |
| **Company** | **Comments** |
| Ericsson | It’s unclear to us what bullet one really means. Better for RAN2 to decide on the measurement reporting structure. When looking at the ASN.1 things become more concrete.  On bullet two, we don’t think this is a well formulated UE capability. The UE capability should be related to how many measurement instances a UE can make in a certain time period, given a DL PRS configuration.  The maximum number of measurement instances is something the NW should configure in order to limit signaling overhead. The UE may in the end be able to measure and report less than the maximum number of measurement instances configured by the NW. |
| **Qualcomm** | We think that this is an important issue. This feature is NOT complete if this is not agreed. For many meetings now, we haven’t been able to make any agreement with regards to this feature.  RAN2 cannot make an agreement here, because each Alternative has a different functionality and these functionalities should be debated/decided in RAN1.  From the alternatives above, we support Alt. 4 |

# Additional proposals

## Multiple reference timings

Submitted Proposals

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

FL comments

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

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

### Proposal 6-1

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Ericsson | Not supportive. The use of one single reference timing is critical. The LMF can change reference timing as it wants by subtracting a suitable DL RSTD measurement. |
|  |  |
|  |  |

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