**3GPP TSG RAN WG1 Meeting #105-e R1-2106156**

**e-meeting, May 19th – 27th, 2021**

**Source: Moderator (CATT)**

**Title: FL Summary #3 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:

 [105-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 May 25, May 27 – Ren Da (CATT)

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

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

The document covers the following aspects related to potential enhancements related to the accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays based on the contributions [1-19]:

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

**Notes:**

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

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

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

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

*Background*

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

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

## Antenna array phase center offset

Submitted Proposals

* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Proposal 1: UE to include reporting of gNB specific SRS-Pos TOD offsets to gNB/LMF for post-compensation of direction specific UE antenna phase center offsets thereby enhancing the positioning accuracy.
* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Proposal 2: UE to signal to gNB/LMF its capabiltiy to compensate for antenna phase center offsets for time based positioning. Note this could apply to both broad beam and narrow beam SRS-Pos transmissions.
* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Proposal 3: Include the impact of antenna PCO in the definition of RX/TX timing errors and associated TEGs
	+ FL: Already considered in the Rx/Tx timing error/TEG definitions in my view.
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 1:
	+ DL-PRS transmitted on the same FL and from the same ARP are associated with the same TEG.
	+ The LMF in UE-Assisted mode and the UE in UE-Based mode can assume that DL-PRS resources transmitted from the same TRP ARP are associated with the same TEG.
* FL: Already considered in the Rx/Tx timing error/TEG definitions in my view.
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 2: For mitigating TRP Rx timing errors:
	+ Support TRP to provide the LMF with ARP information related to the UL-SRS measurements (similar to the DL-PRS ARP information).
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 3: UL-SRS measurements received on the same FL from the same TRP-ARP are associated with the same Rx-TEG.
* FL: Already supported by the Rx/Tx timing error/TEG definitions in my view.
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 5: Support the UE providing the ARP information relative to a UE reference point using a UE coordinate system (UCS).

FL comments

The phase center offsets (PCOs) may be different for different antenna panels and different beam directions, which may result in different timing delays or time of departure (TOD) for different beam directions, and have an impact on the measurement and positioning accuracy. Due to the impact of the PCOs, the true coordinates of the antenna center for the RF signal Tx/Rx may be different from the physical antenna reference point (ARP) for different beams and different positioning frequency layers (PFLs). Similar to the Rx/Tx timing errors, the impact of the PCOs could be compensated if they are known. However, the transmitter and/or the receivers may or may not know the PCOs, and if compensated, there can be remaining errors after the calibration. The impact of PCOs as a part of timing errors and included into the definition of the Rx/Tx timing errors and TEGs (as shown in the definitions of the Tx/Rx timing error, i.e., ‘*The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center.’*). We may further discuss whether to provide additional information related to the PCOs/ARPs from UE/TRP to the LMF as proposed in [14][17].

### Proposal 2.1-1 (suggest to be closed)

* Further study whether there is a need to support the following enhancements related to phase center offsets (PCOs):
	+ UE to include reporting of gNB specific SRS-Pos TOD offsets to gNB/LMF for post-compensation of direction-specific UE antenna phase center offsets.
	+ UE to signal to gNB/LMF its capability to compensate for antenna phase center offsets for time-based positioning.
	+ UE to provide the ARP (Antenna Reference Point) information relative to a UE reference point using a UE coordinate system (UCS).
	+ TRP to provide the LMF with ARP information related to the UL-SRS measurements.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support since it is addressed by Rx/Tx TEG based solutions  In the definition of Tx timing error and Rx timing error, the phase center offsets have been included as below (Highlighted by Yellow):* **Tx timing error**: From a signal transmission perspective, there will be a time delay from the time when the digital signal is generated at baseband to the time when the RF signal is transmitted from the Tx antenna. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Tx time delay for the transmission of the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Tx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Tx time delay after the calibration, or the uncalibrated Tx time delay is defined as *Tx timing error*.
* **Rx timing error**: From a signal reception perspective, there will be a time delay from the time when the RF signal arrives at the Rx antenna to the time when the signal is digitized and time-stamped at the baseband. For supporting positioning, the UE/TRP may implement an internal calibration/compensation of the Rx time delay before it reports the measurements that are obtained from the DL PRS/UL SRS signals, which may also include the calibration/compensation of the relative time delay between different RF chains in the same TRP/UE. The compensation may also possibly consider the offset of the Rx antenna phase center to the physical antenna center. However, the calibration may not be perfect. The remaining Rx time delay after the calibration, or the uncalibrated Rx time delay is defined as Rx timing error.

  |
| Fraunhofer | Support.To OPPO, the comment is not clear because the definition of the TEGs and timing errors are not supposed to be changed with this proposal. In addition, the WI target UE and/or gNB Rx/Tx timing delays: the order of error due to unkown ARP information will exceed Rel-17 accuracy requirements!To calrify: For the first two bullets the phase offsets for the different beams may be compensated by the UE and a common antenna reference point within a margin (as highlighted by OPPO). The capability to compensate this margin and information on the erorr margin can be provided as part of the Tx/Rx timing error.For the third and fouth bullet the offset between the antenna (or beam) reference points from the different ARPs is high. For DL-PRS the TRP-ARP issue is already addressed in Rel-16. |
| CATT | We prefer to treat it as low priority. |
| vivo | Not support |
| Huawei, HiSilicon | We consider it low priority given the PCO of the UE is “direction specific”. There could be no way to know the PCO if UE has no idea from which direction each RP is located. |
| Qualcomm | Low priority |
| Apple | Not support, we share similar view as OPPO and HW/HiSi |
| Nokia/NSB | Support. Especially the 2nd bullet is important in our view. If the network doesn’t know if the UE is taking into account the PCO impact then it may not know if the TEGs are valid for certain measurements. To OPPO, we agree that the definition of timing errors already has PCO impacts included and that the solutions being agreed for TEG can potentially also apply to the PCO problem. However, we feel that some additional care should be taken to make sure that the TEG concept can appropriately take care of this issue. We are open to discussing further. To Huawei, the UE may know the direction of the TRP based on DL signals (e.g., in multi-RTT).  |
| SONY | We don’t support the direction-specific UE antenna PCOs for two reasons. First, we doubt the feasibility of a UE measuring multiple PCOs at different beams. Secondly, the difference of the PCOs at different beams is relatively small because the UE has limited number of RF chain. Hence, all the UE beams typically share the same RF chain. For the panel-specific UE antenna PCOs, we think it can be handled by the Rx/Tx TEG based solutions as OPPO suggested. Firstly if the PCOs are known by UE, the UE can merge it into the TEG. Then, to address the multiple panel PCOs, UE can use association information to identify the TEGs (containing PCOs) at different panels. |
| LG | Not support, we have similar view with OPPO, HW/HiSi and SONY.  |
| Nokia/NSB\_2 | To all, we really feel that we are trending in a bad direction by not addressing the PCO related issues. We have already agreed that they are part of the timing errors but now companies are viewing them as low priority. Can companies that consider this as low priority explain how they plan to overcome the multiple cm of error that are introduced? We have shown detailed simulation results that make it clear that for UEs which are beamforming at mmWave that they will not be able to meet the positioning targets without dealing with this issue. In some cases up to 10 cm of error can be introduce from this impairment in a practical system. At a bare minimum the UE should inform the network if it is performing PCO compensation and to what level it can do so. To Sony, we are not sure we understand the comment on UE beams sharing the same RF chain. The PCO variation that we are discussing is within one beam. The simulation results we provided show that even within a single beam that the PCO variation can be multiple cm over the width of a beam. So, this impairment will clearly lead to the performance not being met and does not have to do with RF chains. We agree that the UE can potentially merge it into the TEG to some degree but the UE is not always aware of the direction of the TRPs a-priori.  |
| FL | From the feedback, it seems the majority of feedbacks are not supportive of the proposal. Based on the feedback, the suggestion is to close the discussion in this meeting with “a consensus cannot be reached for the proposed enhancement”. It does not necessarily mean the proposed enhancement will not be further discussed in future meetings.  |

FL Comments

Due to the lack of majority support, suggest closing the discussion with “*Consensus cannot be reached for the proposed enhancement*”.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CATT | Support to close the discussion. |

## Definition of UE Rx-Tx time difference measurements

Submitted proposals

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 1: Include in the UE Rx-Tx measurement report, at least an UL timestamp which corresponds to the uplink subframe used by the UE to derive the TUE-TX timing in the UE Rx-Tx measurement. Change the TUE-TX UE Rx-Tx definition as follows:
	+ TUE-TX is the UE transmit timing of uplink subframe #j in which the transmission of the associated SRS resource was scheduled according to the UE’s report.

FL comments

With the current definition in TS 38.215, a UE determines the UE Rx – Tx time difference based on the reception time of the DL PRS and UL Tx time of the closest UL subframe, but it does not require UL SRS to be transmitted at the closest UL subframe. If we want to address the concern from Qulacomm, then there is at least to add the mod operation into the definition since the value range of UE Rx – Tx time difference does not exceed 1ms.

### Proposal 2.2-1 (H)

* In the UE Rx-Tx measurement report, include a timestamp that corresponds to the uplink subframe used by the UE to derive the TUE-TX timing in the UE Rx-Tx measurement, and make the following modifications to the UE Rx-Tx time difference definition:
	+ UE Rx – Tx time difference is defined as mod(TUE-RX –TUE-TX, 1ms)

The UE Rx – Tx time difference is defined as mod(TUE-RX –TUE-TX, 1ms)

Where:

TUE-RX is the UE received timing of downlink subframe #*i* from a Transmission Point (TP) [18], defined by the first detected path in time.

TUE-TX is the UE transmit timing of uplink subframe #*j* ~~that is closest in time to the subframe #i received from the~~ ~~TP~~ for the transmission of the associated SRS resource.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Some question for clarification1. In TS 37.355, there is a timestamp associated with UE Rx-Tx measurement. Is the intention of this proposal to introduce an new timestamp, or change the definition of this timestamp (e.g., the time instance for which the measurement is performed -> the uplink subframe used by the UE to derive the TUE-TX timing in the UE Rx-Tx measurement) ? Is there any change regarding timestampe for gNB Rx-Tx Time Difference accordingly?2. If we can agree some update/change on the UE Rx – Tx time difference, would it be better for R16 rather than R17?  |
| Vivo | No needed. From our understanding, UE Rx-Tx time difference measurement is DL measurement independent of actual SRS transmission. For example, there are multiple SRS occasions around one PRS measurement. If the Rx-Tx measurement is associated with the actual SRS ignalingn, which SRS occasion will be selected?  |
| CATT | We prefer to treat it as low priority. |
| Huawei, HiSilicon | Just to clarify if the change discussed here is about changing Rel-16 spec or Rel-17 only. |
| Qualcomm | High priority To vivo: The measurement is still independent of the SRS transmission. The UE includes at which time the “T\_Tx” was derived and used for reporting. It is UE’s responsibility to pick a good UL timestamp. In the worst case, it will pick exactly the same as in rel-16 (aka the subframe that is closest in time to the DL PRS from that TRP). However, we believe, as we explain in the tdoc, that we can enhance the performance if we allow the Ues to include a timestamp that corresponds to when the “T\_Tx” was derived. To OPPO: It is an additional time-stamp. Currently the timestamp is really the time of the PRS reception.We are OK to change it for Rel-17 only, and not go back to rel-16 sicne it is an RRC change. If the UE does not repor the new timestamp, the assumption is that the T\_TX is the same as in Rel-16, so the solution defaults to the rel-16 solution.  |
| Nokia/NSB | We are okay to change this for Rel-17 only.  |
| FL | For the discussion between from OPPO, vivo and QC: I actually have a different understanding for the proposal. My thinking of the proposal was that the UL transmit timing of the SRS (TUE-TX) can be different for different UL subframes (#j) and also different for different SRS resources if they are associated with different TEGs. Thus, when the UE derives the UE Rx-Tx measurement, as defined as TUE-RX –TUE-TX, the UE needs to take the factors into consideration. For example, assume at subframe #*j,* UE transmits SRS resource ID1 and transmit SRS resource ID2, and SRS resource ID1 and SRS resource ID2 belong to different TEGs. Then, the UE Rx – Tx time difference associated with SRS resource ID1 and the UE Rx – Tx time difference associated with SRS resource ID2 can be different because for the UL Tx timings of the same UL subframe #*j* are different for different TEGs.About the timestamp, I assume there is no need to add the new timestamp if we define the it as the UL frame timing of the SRS instead of DL frame timing of the DL PRS. |
| OPPO | To QC: Regarding the existing timestamp, is there any text in the sepc specifying that is the time of the PRS reception? In TS 37.355, the timestamp specifies the time instance on which the measurement is performed. If subframe #*j* is after subframe #*i,* the timestamp should no earlier than subframe#j. |
| vivo2 | Thanks for the discussion, regarding redefining Rx-Tx time difference, we still have some concerns, and there are some questions that need to be clarified.We suppose the SRS transmission timing changes due to TA change (e.g. TA command, UE automatically adjusts TA, etc).* If the TA change information is not reported to LMF, is it meaningful to only report the new timestamp?
* There is another way to solve this problem: do not change the existing definition, and only report the SRS transmission timing change information and the corresponding timestamp. Compared with this way, what are the advantages of changing the definition of Rx-Tx time difference?
* If the definition of Rx-Tx time difference is changed, the measurement period requirement will be changed accordingly, as the UE needs to find a ‘good UL timestamp’ corresponding to each PRS measurement in addition to performing PRS measurement. I think the potential impact on RAN4 is relatively large.
* When the PRS period is large enough and the SRS period is small enough, then there are multiple SRS occasions between two PRS occasion. If there are multiple TA changes between two PRS occasion, whether to include multiple UL time stamps in the Rx-Tx time difference measurement?
 |
| ZTE | We are open to discuss this issue for Rel-17 |
| LG | To clear our understanding. If we understand QC’s intention well , we think that the motivation of the proposal is to change the resolution for TUE-TX from current subframe units to SRS resource units. If it is right, we need to reconsider the definition of TUE-RX  and related description in 38.215 before discussion on TUE-TX. For TUE-RX,  some descriptions regarding multipl DL PRS resources are described in currenet specification. We think multiple SRS resources also can be used for determination even though different Tas are applied. That is, we think it is up to LMF to determine/estimate whether TA values are applied or not. |
| Ericsson | We are supportive to change this definition in Rel-17. However, we would like to discuss the granularity of TUE-TX. We think it is much better of TUE-TX is defined as close as possible to the transmission of the associated SRS resource (to account for UE autonomous adjustments). Hence, we prefer to define TUE-TX in terms of slots or symbols. |
| QC | To OPPO: If the spec says the timestamp is when the measurement is perfmed, and the UE performs a DL measurement, and transmits an UL SRS, which timestamp will the UE report? The one that it measured PRS or then one that it transmitted SRS? The typical understanding is to report a timestamp close/same (up to UE implementation) of the PRS Rx. This can also be concluded by the fact that the UE Tx timing that the UE is using to compute the Rx-Tx is the time the UE has when the PRS is received (or close to that, as the 38.215 says). We need to be able to have the UE report a 2nd timestamp which corresponds to what was the UE Tx Timing used in the Rx-Tx measurement, and not “statically assume” that the UE uses the Tx timing at the time that the PRS is received. This helps a lot with timing errors, especially when the SRS is far away from the PRS. We also have preference to not discus the granularity now, and value range and leave it up for further discussion. For now, we can have a principle agreement. Example: * *In the UE Rx-Tx measurement report, include a timestamp that corresponds to the uplink* ***[subframe/slot]*** *used by the UE to derive the TUE-TX timing in the UE Rx-Tx measurement, and modify the definition accordingly.*
	+ *FFS: Further details*
 |
| FL | Based on the comments from QC, the original proposal from Qualcom intends to add the timestamp that corresponds to the uplink [subframe/slot] used by the UE to derive the TUE-TX timing. Some questions: * Should UE set the timestamp corresponding to the UL SF[/slots] of a) already transmitted SRS, or b) SRS to be transmitted, or c) the SRS closest to the DL PRS time?
* It is unclear how serious is the situation of SRS is far away from DL PRS. In Rel-16, we already have considered avoiding mismatch of DL PRS and UL SRS The periodicity of DL PRS can be set to be the same as SRS the periodicity of DL PRS. The serving gNB has the information of DL PRS setting and can schedule UL SRS to be near to DL PRS.
 |

## Inter-TRP timing error (closed)

Submitted Proposals

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 1: The issues of ‘inter-TRP timing error’ in DL-TDOA/UL-TDOA method should be clarified.
	+ e.g., whether to regard ‘inter-TRP timing error’ as synchronization error beween TRPs.

FL Comments

* My understanding is the enhancement purely for the purpose of network synchronization is not within the scope of this WI. However, we may not want to exclude the enhancements for mitigating UE/TRP Tx/Rx that also have the side benefits of mitigating the impact of the network synchronization errors.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Fraunhofer | Agree with the FL comment |
| CATT | Agree with the FL comments. |
| Ericsson | We object to this proposal. This is out of scope from the work item.  |
| Nokia/NSB | Agree with FL comments.  |
| SONY | Support FL comments |

FL comments

Based on the feedback, suggest no further the discussion on the clarification of ‘inter-TRP timing error’ in DL-TDOA/UL-TDOA.

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

Background

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

Background

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

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

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

Submitted proposals and FL comments (specific for DL positioning)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 2: The UE can be requested to provide the association information of RSTD measurements with UE Rx TEG(s) to LMF.

FL: The proposal seems already agreed in RAN1#104bis-e.

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 4: In DL-TDOA method, to eliminate the positioning error caused by the UE Rx timing errors of more than one UE Rx TEGs, the RSTD measurement report of a certain TRP for more than one UE Rx TEGs needs to be guaranteed if the UE is able to measure PRS(s) associated with different UE Rx TEGs.
	+ FFS the UE reporting rules to guarantee the RSTD measurement report for more than one UE Rx TEGs.

FL: Discussed in previous meeting w/o conclusion. Suggest further discussion in Proposal 3-1.3.

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 3: When the UE is able to measure PRS(s) from a TRP associated with different UE Rx TEGs, support the UE to report original RSTD measurements (uncompensated measurements) and related Rx TEGs information to the LMF, rather than compensating ‘Rx timing error difference’ by UE implementation and then reporting compensated RSTD measurements to the LMF.

FL: Suggest further discussion in Proposal 3-1.3.

* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 11: For UE-assisted DL-TDOA positioning, the following two methods should also be supported to help LMF eliminate the influence of timing errors of TRPs and UE:
* *Provide LMF with the Tx timing errors per Tx TEG.*

|  |  |  |  |
| --- | --- | --- | --- |
| DL-TDOA | From | To | Signalling for mitigating TRP Tx timing errors |
| Option 3 | TRP | LMF | Tx timing errors per Tx TEG of TRP |

* *Provide LMFwith the Tx timing error differences between Tx TEGs.*

|  |  |  |  |
| --- | --- | --- | --- |
| DL-TDOA | From | To | Signalling for mitigating TRP Tx timing errors |
| Option 8 | TRP | LMF | Tx timing error differences between Tx TEGs of the TRP |

FL: The options were discussion in previous meeting w/o conclusion. Suggest further discussion in 3.1-6.

* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 12: For UE-based DL-TDOA positioning, the following two methods should also be supported to help UE eliminate the influence of timing errors of TRPs:
* ***Provide UE with the Tx timing errors per Tx TEG.***

|  |  |  |  |
| --- | --- | --- | --- |
| **DL-TDOA** | **From** | **To** | **Signalling for mitigating TRP Tx timing errors** |
| Option 4 | LMF | UE | Tx timing errors per Tx TEG of TRP |

* ***Provide UE with the Tx timing error differences between Tx TEGs.***

|  |  |  |  |
| --- | --- | --- | --- |
| **DL-TDOA** | **From** | **To** | **Signalling for mitigating TRP Tx timing errors** |
| Option 9 | LMF | UE | Tx timing error differences between Tx TEGs of a TRP |

FL: The options were discussed in the previous meeting w/o a conclusion. Suggest further discussion in 3.1-6.

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 3: For UE-based DL-TDOA, support a UE receiving the Tx-TEG information for each PRS resource in the unicast or broadcast assistance data.

FL: See Proposal 3.1-4 for further discussion

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 2: Rel-17 supports UE to report the grouping of DL TDOA measurement results via LPP for the implicit indication of UE Rx TEG information.

FL: Suggest the details of LPP be discussed in RAN2..

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 3: Rel-17 supports LMF to signal the grouping of DL PRS resources to UE via LPP for the implicit indication of TRP Tx TEG information.

FL: Suggest the details of LPP be discussed in RAN2.

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 4: Rel-17 supports gNB to signal the grouping of DL PRS resources to LMF via NRPPa for the implicit indication of TRP Tx TEG information.

FL: Suggest the details of LPP be discussed in RAN2.

* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 7: For DL TDOA, support the LMF to indicate which Rx TEG(s) to use for the reception of one or more DL-PRS resources.

FL: LMF may not know which UE Rx beam can receive which DL-PRS resources. Suggest further discussion (Proposal 3.1-5).

* (Apple, [R1-2105105](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105105.doc)[10]) Proposal 4: At least for UE-assisted method, UE may be indicated by LMF to perform measurements corresponding to both DL-TDOA and DL-AoD positioning techniques
	+ The measurements at least include DL-RSTD together with DL-PRS-RSRP over a set of (TRPs, antenna panels, PRS configurations, etc)
	+ Additional UE capabilities may be needed

FL: In my opinion, “UE may be indicated by LMF to perform measurements corresponding to both DL-TDOA and DL-AoD positioning techniques” is already supported. TRPs and PRS configurations are already provided in the assistance data. About the antenna panel, LMF may not have the information related to the TRP antenna panel.

* (Sony, [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc)[11]) Proposal 1: In DL-TDOA positioning,
	+ If UE is aware its own Rx timing error, support UE to provide UE Rx timing errors associated with the RSTD measurements to the LMF.
	+ If UE is not aware its own Rx timing error, support UE to provide the ID/index of the UE Rx TEG that is associated with the RSTD measurements to the LMF if the UE has multiple TEGs.
	+ If TRP is aware of its own Tx timing errors, support TRP to provide the TRP Tx timing errors associated with the DL PRS resources to the LMF.
	+ If TRP is not aware of its own Tx timing errors, support TRP to provide the ID/index of the TRP Tx TEG that is associated with the DL PRS resources to the LMF if the TRP has multiple TEGs.
	+ If LMF knows TRP Tx timing errors, support the LMF to provide the TRP Tx timing errors associated with the DL PRS resources to a UE for UE-based positioning.
	+ If LMF doesn’t know TRP Tx timing errors, support the LMF to provide the ID/index of TRP Tx TEG associated with the DL PRS resources to a UE for UE-based positioning.

FL: The options were discussed in the previous meeting w/o a conclusion. Suggest further discussion in 3.1-6.

* (Samsung, [R1-2105310](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105310.doc))[12]) Proposal 1: For DL-TDOA, UE could report the association information of Rx TEGs associated with RSTD measurements to LMF in the IE like NR-DL-TDOA-SignalMeasurementInformation.

FL: It was agreed that UE could report the association information of Rx TEGs associated with RSTD measurements to LMF. Which IE is used may be better discussed in RAN2.

* (Samsung, [R1-2105310](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105310.doc))[12]) Proposal 2: For indication of TEG in DL-TDOA method, one single reference TEG plus the TEG differences (in case of multiple different TEGs) can be considered.

FL: Unclear how the TEG differences work. Maybe it means the measurements without TEG ID have the default TEG ID, and rest has the additional TEG ID. If this is the case, this kind of detail in message formatting can be discussed in RAN2.

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-1: UE may report the DL-RSTD between the observed PRS resources within a same TX TEG of a TRP, to assist the TRP to calibrate the transmission timing offset between resources

FL: Suggest further discussion in Proposal 3-1.3.

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-2: UE may report the DL-RSTD between the observed PRS resources across TX TEGs of a TRP, to assist the TRP to calibrate the transmission timing offset between different TX TEGs of a TRP

FL: Suggest further discussion in Proposal 3-1.3.

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-3: The inter-TRP transmission timing difference could be measured by the reference UE. Same measurement reporting as the normal UEs is expected. LMF may handle the extraction of the inter-TRP transmission timing difference from the measurement reports

FL: Suggest further discussion in Proposal 3-1.3.

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-4: It is subject to UE capability for the reporting of DL-RSTD between a pair of RX TEGs under the measurement of same TRP’s signal

FL: Suggest further discussion in Proposal 3-1.3.

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 1 Support a UE to provide the association information of RSTD measurements with UE Rx TEG(s) for both the target and the reference TRP to the LMF when the UE reports the RSTD measurements to the LMF if the UE has multiple TEGs

FL: This proposal seems to be a simple clarification of the previous agreement. Further discussion in Proposal 3.1-2.

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 2 Support a UE to perform multiple RSTD measurements towards the same TRP utilizing different UE RX TEGs and to report these measurements to the LMF.

FL: Suggest further discussion in Proposal 3-1.3.

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 3 RAN1 to study further under what circumstances the UE should be capable of performing multiple RSTD measurements towards the same TRP utilizing different UE RX TEGs, e.g. if measurements utilizing different UE RX TEGs (i.e. UE antenna panels) can be performed based on 1) different DL PRSs transmitted from the same TRP, 2) different symbols of the same DL PRS, 3) different repetitions of the same DL PRS, 4) different occasions of the same DL PRS, 5) different DL PRSs transmitted from the same TRP, and/or 6) simultaneous reception of the same DL PRS.

FL: Suggest further discussion in Proposal 3-1.3.

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 19 Timing errors per UE/gNB RX/TX TEG should not be ignalin by the UE/gNB to the LMF, nor from the LMF to the UE.

FL: Suggest further discussion in Proposal 3.2-6.

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 20 Timing errors differences between UE/gNB RX/TX TEGs should not be ignalin by the UE/gNB to the LMF, nor from the LMF to the UE.

FL: Suggest further discussion in Proposal 3.2-6.

FL additional comments

It was agreed in RAN1#104bis-e that for DL TDOA, support

* 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;
* TRP to provide the association information of DL PRS resources with Tx TEGs to the LMF if the TRP has multiple TEGs
* 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

In this meeting, there are some additional proposals related to how the association information is provided:

For supporting DL-TDOA, multiple options were agreed to be studied in RAN1#104e, but only some of them were agreed to be supported in RAN1#104bis-e. In this meeting, there are still proposals to support/not support these options. For example, in [3], CATT proposes to support the following Option 3, Option 8, Option 4, and Option 9 for UE-assisted DL-TDOA positioning. In [6], Qualcomm proposes in addition an average timing error associated with a TEG ID for mitigating timing errors in DL-TDOA, UL-TDOA or DL+UL Positioning; in [11], Sony proposes to UE/TRP/LMF to report UE Rx/TRP Tx/LMF timing errors if the information is available; and in [19], Ericsson proposes not to support ignaling timing errors per UE/gNB RX/TX TEG and Timing errors differences between UE/gNB RX/TX TEGs.

In [6], Qualcomm proposes to support a UE receiving the Tx-TEG information for each PRS resource in the unicast or broadcast assistance data for UE-based DL-TDOA.

For a Tx TEG, it seems the common view is that a Tx TEG is associated directly with the PRS/SRS resource(s)/resource set(s). It is also clear that one TRX Tx TEG can be associated with one or more DL PRS resources.

For an Rx TEG, there are different views on how to indicate the association. One approach is to explicitly associate an Rx TEG ID with the measurement. With this approach, there may a need to include Rx TEG ID for each measurement (or a group of the measurements) in each measurement report, and there can be two Rx TEG IDs associated with one RSTD measurement since the UE may use different Rx TEG for receiving the DL PRSs from the reference TRP and target TRPs. Another approach is to provide the association of the received PRS/SRS resources/resource sets with the Rx TEG. The Rx TEG ID of the measurements is then obtained implicitly from the received PRS/SRS resources/resource sets associated with the measurements. In this approach, the UE/TRP does not need to provide the Rx TEG ID for each measurement or in each measurement report. After the association of Rx TEG ID with the received PRS/SRS resources is provided, it does not need to be sent again until there is a need to update or reset.

If UE can use different UE Rx TEGs to measure the same DL PRS resource or different DL PRS resources from the same TRP Tx TEG, the time differences between these UE Rx TEGs may be obtained. If UE can use the same UE Rx TEGs to measure the DL PRS resources from the difference Tx TEG of the same TRP, the time differences between these TRP Tx TEGs may be obtained. This information may be useful for the LMF to improve the positioning performance as proposed in [2][16][19].

Proposal 3.1-1 (H)

* Support one of the following options for DL TDOA if a UE has multiple Rx TEGs:
	+ Option 1:
		- UE provides the association information of DL PRS resources (DL PRS resource sets) with Rx TEGs to the LMF;
		- Note: The association information may not need to be provided for each DL measurement report
	+ Option 2:
		- UE includes two Rx TEG IDs associated with a DL RSTD measurement in each DL measurement report;
			* One Rx TEG ID associated with the DL PRS of the RSTD reference;
			* One Rx TEG ID associated the other DL PRS of the RSTD measurement;
			* Note: The two Rx TEG IDs can be the same.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | We prefer option 2. The sub-bullets of option 2 seem not clear, we suggest to change like this:* + Option 2:
		- UE includes two Rx TEG IDs associated with a DL RSTD measurement in each DL measurement report;
			* One Rx TEG ID associated with the DL PRS of the RSTD reference TRP;
			* One Rx TEG ID associated the other DL PRS of the RSTD ~~measurement~~ neighbor TRP;
			* Note: The two Rx TEG IDs can be the same.
 |
| OPPO | 1. For Option 2, there is no need to report the Rx TEG associated with Reference TRP for each measurement. A Rx TEG associated to reference TRP is sufficient (please refer to Proppsal 3.1-2) 2. what’s the difference between option 1 and option 2? From my understanding, option 2 and option 1 are similar from the perspective of signaling. For example, Rx TEG ID would be an optional field for Option 2. If this filed is not reported and the lastest association of PRS resources and Rx TEGs is assumed to be maintained, then Option 2 is the same as Option 1. 3. Reporting Rx TEG IDs for each PRS resources / RSTD measurement may lead to higher signaling overhead. Another way is to avoid the explicit reporting of Rx TEG IDs and report mupltiple group of the measurements in a report, where each group of the measurement is related to a Rx TEG implicitly. |
| Fraunhofer | Support Option 2, the TEG information in Option2 may be usefull at the LMF for common TEGs with UE-Rx-Tx and RSTD measurments. Is the TEG-ID common over measurements at different times?  |
| CATT | We support Option 1. |
| Vivo | We think it is more suitable to associate Rx TEG ID with DL RSTD measurement. Consider this case: UE has 2 Rx TEGs and different Rx TEGs are associated with different measurements from the same PRS resource, if UE only provides the association information of PRS resources, it is still unclear which measurement corresponds to which Rx TEG.Besides, the following agreement has reached in RAN1 104b-e, it supports providing the association information of RSTD measurements with UE Rx TEG(s) other than the association information of DL PRS resources (DL PRS resource sets) with UE Rx TEG(s)

|  |
| --- |
| Agreement:* 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
 |
| * + - FFS: the details of the ignaling, procedures, and UE capability
 |

In addition, for option2, we don’t think the Rx TEG ID(s) associated with the RSTD reference should be reported for each DL RSTD measurement since the Rx TEG ID(s) of reference PRS for each RSTD is the same and included in the measurement of ‘the reference PRS’ . So some modifications as follows* + Option 2:
		- UE includes ~~two~~ Rx TEG IDs associated with a DL RSTD measurement in each DL measurement report;
			* ~~One Rx TEG ID associated with the DL PRS of the RSTD reference;~~
			* One Rx TEG ID associated the ~~other~~ DL PRS of the RSTD measurement;
			* ~~Note: The two Rx TEG IDs can be the same~~.
 |
| Ericsson | We are supportive of option 2, but think it could be reformulated a bit. A DL TDOA measurement report (i.e. the NR-DL-TDOA-SignalMeasurementInformation IE) contains one reference DL PRS used for all RSTD measurements towards different TRPs in the report. Thus, better to write:* + Option 2:
		- UE includes one reference TRP Rx TEG ID associated with the RSTD reference in a DL TDOA measurement report and one target TRP Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report;
			* One Rx TEG ID associated with the DL PRS of the RSTD reference in the DL TDOA measurement report;
			* One Rx TEG ID for each RSTD measurement in the DL TDOA report, associated with the target DL PRS of the RSTD measurement;
			* Note: The two Rx TEG IDs can be the same.

We note that option 1 doesn’t give any timing error mitigation gains since the TEG of the reference isn’t given. |
| Huawei, HiSilicon | We do not think the Option 2 is necessary as presented in the email discussion last meeting.For the reference TRP, there should be a first Rx TEG reported for the reference timing, and the for the non-reference TRP, there would be a second Rx TEG reported for the RSTD measurement relative to the reference timing associated with the first Rx TEG.For more advanced reporting, if for a TRP (reference or non-reference TRP), multiple Rx timing can be derived using different Rx TEG, which should be fine, it can be supported by enhancing the additional timing reporting adopted in Rel-16, but the principle of a single reference timing based on a single Rx TEG should be followed.Option 1 is already supported in our understanding based on the agreement in RAN1#104b, but why do we need the Note? |
| Qualcomm | The following agreement says that we report RxTEG associated to RSTD measurement, not PRS resources. An RSTD measurement can also be associated with a PRS resource ID (already specified).

|  |
| --- |
| Agreement:* 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
 |

So, not sure what we are trying to clarify here. The above agreement would mean that the UE will report an RxTEG for the reference TRP and then an RxTEG for each RSTD. |
| Apple | Our understanding of what we agreed in 104b, based on “if the UE has multiple TEGs”, is something similar to Option 2, that is UE only reports delta Rx TEG to the reference PRS reception, and UE does not need to report TEG associated to RSTD measurement if there is single RX TEG, OR RxTEG for reference PRS and the other PRS reception is the same. BTW, we need to have a similar proposal for TRP… |
| Nokia/NSB | Same understanding as QC. We are not sure what this agreement brings on top of the prior agreement.  |
| SONY | Same understanding as QC |
| CMCC | We share similar views with QC. |
| ZTE2 | To OPPO: *NR-DL-TDOA-SignalMeasurementInformation* in 37.355 doesn’t contain PRS resources in the reference TRP, because in R16, all PRSs in the reference TRP own the same reference timing, so it is not necessary to report additional PRS information in the reference TRP. Actually in R17, different PRSs in the reference TRP maybe received through different UE Rx TEGs. So we think it is necessary for UE to report its Rx TEG information of reference PRSs in the reference TRP. |
| Samsung  | Similar view as QC, this proposal has been captured before. |
| LG | Agree with QC’s comment. |
| InterDigital | In the last meeting, we agreed that the UE provides the Rx TEG information when the UE reports the RSTD measurement. From our perspective, the UE does not need to always provide TEG information in each RSTD measurement report. For example, when the UE uses the same set of Rx TEGs for RSTD measurement compared to the last measurement report, REG information may not necessary.**Therefore, we support Option 2 with the following modification:*** + Option 2:
		- UE optionally includes ~~two~~ Rx TEG ID(s) associated with a DL RSTD measurement in each DL measurement report;
			* One Rx TEG ID associated with the DL PRS of the RSTD reference;
			* One Rx TEG ID associated the other DL PRS of the RSTD measurement;
			* Note: The two Rx TEG IDs can be the same.
			* FFS when to include Rx TEG information.
 |
| ZTE3 | After a second thought, we agree with VIVO’s modification that only one Rx TEG per RSTD measurement is required. We suggest to add another note based on vivo’s version:* + Option 2:
		- UE includes ~~two~~ a Rx TEG ID~~s~~ associated with a DL RSTD measurement in each DL measurement report;
			* ~~One Rx TEG ID associated with the DL PRS of the RSTD reference;~~
			* ~~One Rx TEG ID associated the other DL PRS of the RSTD measurement;~~
			* ~~Note: The two Rx TEG IDs can be the same~~.
			* Note: the Rx TEG ID is associated with the TRP in each *NR-DL-TDOA-MeasElement*
 |
| Intel | Support option 2 |
| Ericsson | In the agreement cited by QC, it is a high level agreement that UE Rx TEG association information with RSTD measurements are reported from the UE to the LMF. This agreement provides the next level of detail: that is one Rx TEG ID for the reference TRP and one Rx TEG ID for each of the RSTD measurements. We still think that it is good to clarify in the main bullet of Option 1 that the UE includes one Rx TEG ID for the reference TRP and one Rx TEG ID fore each of the RSTD measurements. Please see our suggestion for the main bullet in Option 2 below:“UE includes one reference UE Rx TEG ID associated with the RSTD reference in a DL TDOA measurement report and one target UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report;” |
| FL | It seems there are different views on Option 1 and Option 2.I assume the majority view is that the following agreement is UE Rx TEG is associated with RSTD measurements (Option 2), e.g., as shown in the following: NR-DL-TDOA-SignalMeasurementInformation-r16 ::= SEQUENCE { dl-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,Rx TEG\_ Reference OPTIONAL nr-DL-TDOA-MeasList-r16 NR-DL-TDOA-MeasList-r16, ...}NR-DL-TDOA-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-DL-TDOA-MeasElement-r16NR-DL-TDOA-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL, nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-TimeStamp-r16 NR-TimeStamp-r16, nr-RSTD-r16  nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL, nr-TimingQuality-r16 NR-TimingQuality-r16, nr-DL-PRS-RSRP-Result-r16 INTEGER (0..126) OPTIONAL,Rx TEG\_RSTD OPTIONAL nr-DL-TDOA-AdditionalMeasurements-r16 NR-DL-TDOA-AdditionalMeasurements-r16 OPTIONAL, ...}For Option 1, it does not need to add *Rx TEG\_ Reference* and *Rx TEG\_RSTD* into the *NR-DL-TDOA-MeasElement.* Instead, it can use a new IE for the association of the PRS resources with UE Rx TEG. In this way, there is no need to include Rx TEG\_RSTD into each NR-DL-TDOA-MeasElement.Rx TEG = {nr-DL-PRS-ResourceID1, …, nr-DL-PRS-ResourceID n}Given that the majority’s support Option 2, then let us focus on this option. For Option 2, it seems vivo and ZTE consider there is no need to include the Rx TEG\_ Reference, which I cannot fully understand why. Most other companies seem consider there is a need to have both Rx TEG\_ Reference and Rx TEG\_RSTD. The proposed modification from either InterDigital and Ericsson looks good to me. |
|  |  |

FL Comments

Proposal 3.1-1 is revised as follows based on the comments.

 Proposal 3.1-1 (Revision 1)(H)

* Support UE to include one reference UE Rx TEG ID associated with the RSTD reference in a DL TDOA measurement report and one target UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | We don’t need to introduce more terminologies such as referenced UE Rx TEG ID. It is also preferable to use the same wording as the spce (e.g., 37.355). Thus, we propose to modify the proposal as below* Support UE to include one ~~reference~~ UE Rx TEG ID associated with the “RSTD reference” TRP in a DL TDOA measurement report and one ~~target~~ UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report
 |
| vivo | Same views with OPPO, and some clarificationS as following.It only needs to include ‘Rx TEG’ in NR-DL-TDOA-MeasElement-r16, e.g., as shown in the following, since for RSTD reference, as described in TS37355, the target device includes a value of zero for the *nr-RSTD* and *nr-RSTD-ResultDiff* of the “RSTD reference” TRP in *nr-DL-TDOA-MeasList,* so that ‘Rx TEG’ of RSTD reference can be associated with the ‘zero value’ in NR-DL-TDOA-MeasElement-r16.NR-DL-TDOA-SignalMeasurementInformation-r16 ::= SEQUENCE { dl-PRS-ReferenceInfo-r16 DL-PRS-ID-Info-r16,~~Rx TEG\_ Reference OPTIONAL~~ nr-DL-TDOA-MeasList-r16 NR-DL-TDOA-MeasList-r16, ...}NR-DL-TDOA-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs-r16)) OF NR-DL-TDOA-MeasElement-r16NR-DL-TDOA-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL, nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-TimeStamp-r16 NR-TimeStamp-r16, nr-RSTD-r16  nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL, nr-TimingQuality-r16 NR-TimingQuality-r16, nr-DL-PRS-RSRP-Result-r16 INTEGER (0..126) OPTIONAL,Rx TEG\_RSTD OPTIONAL nr-DL-TDOA-AdditionalMeasurements-r16 NR-DL-TDOA-AdditionalMeasurements-r16 OPTIONAL, ...} |
| ZTE | Support oppo’s modification. In 28.215, it is a common understanding that RSTD is derived through 2 different TRPs |
| LG | We are on the same page with vivo. According to note #3 (The target device includes a value of zero for the nr-RSTD and nr-RSTD-ResultDiff of the “RSTD reference” TRP in nr-DL-TDOA-MeasList) in 37. 355, it seems appropriate that ‘Rx TEG’ of RSTD reference can be associated with the ‘zero value’ in NR-DL-TDOA-MeasElement-r16. |
| FL | For the proposal from vivo and LG may work if we only consider RSTD for DL-TDOA. However, we may need to pay attention to be two potential issues:1. Current definition of the Rx timing errors and Rx TEGs is about the Rx timing error from receiving DL PRS signals, but not the difference of the Rx timing error of receiving DL PRSs;
2. The Rx TEG for RSTD measurement and Rx TEG for UE Rx-Tx time measurement may have different meaning since one of them is the the difference of the Rx timing errors, and another one is the Rx timing error.

For example, if the UE has two Rx antenna panels (having different time error margins) to receive separately the DL PRS from two TRPs to obtain one DL RSTD measurement and two UE Rx-Tx time different measurement. Then, there will be two separate Rx TREGs for UE Rx-Tx time different measurements and one Rx TREG for RSTD measurement. Thus, it may be better to have both Rx TEG\_Reference and Rx TEG\_RSTD. |
| Ericsson | Fine with OPPO’s modification. The details of how to capture this in TS37355 can be left to RAN2. |
| Qualcomm | To FL: OPPO/vivo proposal still have **separate** RxTEGs for reference and target: The way 37.355 is written, as vivo points out, is, such that whenever the UE reports reference TRP information it includes “0” in the RSTD. So, the UE will be reporting RSTD= 0 and adding RxTEG-ID and this will be the RxTEG-ID of the reference TRP. So, it looks good to us also the OPPO’s modification. |
| FL | Thanks for the discussion. The proposal is modified as follows with the consideration of OPPO’s modification for further comments. Proposal 3.1-1 (Revision 1)(H)* Support UE to include one UE Rx TEG ID associated with the “RSTD reference” TRP and one UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report
 |

 Proposal 3.1-1 (Revision 2)(H)

* Support UE to include one UE Rx TEG ID associated with the RSTD reference TRP and one UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Just would like to confirm the understanding here:* RSTD reference TRP: Single Rx timing (*nr-RSTD* and *nr-RSTD-ResultDiff* value set to 0)
* Non-RSTD reference TRP: Rx TEG ID per RSTD measurement, which implied multiple per TRP is possible.

The question is from our side* For the RSTD reference TRP, why should we preclude the case that the Rx timing can be received by multiple Rx TEG, in which one serves as the reference timing for the entire DL-TDOA measurement report.
* For the non-RSTD reference TRP, what is the relationship with proposal 3.1-3 then? Is it to emphasize that the same PRS resource can have different RSTD values due to different Rx TEG?
 |
| CMCC | This proposal says that one UE Rx TEG ID is associated with the reference TRP, while Proposal 3.1-3 proposes that “support a UE to measure *the same* DL PRS resource *(or different* DL PRS resources) from a TRP *with the different UE Rx TEGs*”, which seems contradictory from the reference TRP point of view. |
| ZTE | Support |
| Ericsson | Support |
| OPPO | SupportRegarding Huawei’s understand* we think it is possible to report different Rx TEGs ID in NR-DL-TDOA-AdditionalMeasurementElement

Regarding the Question of Huawei/CMCC on the Proposal 3.1-3A Rx TEG ID seems sufficient for reference TRP. The beneficial to report more Rx TEG IDs for the reference TRP are not clear. Haven’t said that, we are open to the reporting of multiple Rx TEG IDs for the reference TRP. |
| Huawei, HiSilicon | Regarding “The beneficial to report more Rx TEG IDs for the reference TRP are not clear” quoted from OPPO’s comments, we think the case should be the same reference TRP and non-reference TRP. If the non-reference TRP can be received by multiple Rx TEGs, resulting in multiple RSTD measurement per TRP, the same should be applied for the RSTD reference TRP. |
| CATT | Support.Just as this proposal mentioned, since RSTD measurement are calculated from the PRS resources from two TRPs, it is reasonable to include two UE Rx TEG IDs in a DL TDOA measurement report. |
| SONY | We have the same concern as CMCC. We suggest to remove the constraint of only one TEG ID for each TRP measurement. |
| vivo | We have similar problems as Huawei. It is weird for us the RSTD reference TRP needs to be supported separately if the nr-RSTD and nr-RSTD-ResultDiff value set to 0 is a DL RSTD measurement and includes in a DL TDOA measurement report, can the proponent provide more information for that?Besides, it seems to imply: for the same PRS resource received by 2 Rx TEGs, UE can report 2 RSTD measurements each associated with a Rx TEG. However, we don’t think the following case should be excluded: for the same PRS resource received by 2 Rx TEGs, the 2 Rx TEGs can be associated with a RSTD measurement, e.g. via different paths.So, we propose * Support UE to include ~~one UE Rx TEG ID(s) associated with the RSTD reference TRP and~~ ~~one~~ UE Rx TEG ID(s) for each DL RSTD measurement in a DL TDOA measurement report.
 |
| Nokia/NSB | Feels like we are overcomplicating something simple here. The UE for N RSTD measurements should report N+1 UE Rx TEG ID(s) where the 1 is for the reference of the RSTD measurements. What are we discussing? We don’t need to fight in RAN1 about the specific wording as RAN2 will anyways design the signalling.  |
| Intel | Support |
| Apple | Not sure if our previus comment is addressed. The proposal assumes regardless whether or not the RX TEGs are the same or not UE needs to report the associated Tx TEG IDs to reference and the other PRS. This is our suggestion:* Subject to UE capability, support UE to include one UE Rx TEG ID associated with the RSTD reference TRP and one UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report, if the two Rx TED IDs are different.
 |
| Ericsson | SupportThe exact way in which the target and reference TRP TEG associations are signaled isn’t very important as long as they are reported and a single reference is used in the measurement report. The signaling proposal made by VIVO would work assuming it’s mandatory for the UE to include the RSTD for the reference TRP. This could be captured e.g. as* Support UE to include one UE Rx TEG ID associated with each DL RSTD measurement in a DL TDOA measurement report
* Support UE, subject to capability, to mandatorily include the DL RSTD measurement corresponding to the reference TRP in a DL TDOA measurement report

One might , however, argue that this kind of details is up to RAN2 to decide and thus the current proposed wording is preferable. It allows for VIVOs solution as one signaling option for RAN2 to consider. This isn’t a big issue for us and we are happy to compromise if that can help to reach an agreement. |
| LG | In our understanding, it seems the proposal is related to proposal 3.1-3 directly as some companies concerns. Even though we understand the intention of the proposal, we don’t need to discuss proposal 3.1-3 if ‘one’ is allowed to be used. We think that the revision of vivo is a neat solution for the smooth progress. |
| FL | By looking at the comments, it seems we all have the understanding that Rx TEG ID(s) are needed for RSTD measurements and they can be different for different TRPs. It seems more companies are fine with vivo’s suggestion. Since there can muximumly two UE Rx TEG IDs for each DL RSTD measurement, and the UE Rx TEG IDs can be the same, I would suggest make it clear based on vivo’s suggestion.  |

###  Proposal 3.1-1 (Revision 3)(H)

* Subject to UE capability, support UE to include two UE Rx TEG IDs for each DL RSTD measurement in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Did I miss something? I interpret the proposal as “single RSTD value” associated with multiple Rx TEG IDs, but what is the use case here, and how would LMF use such information?Is it the intention to say “two UE Rx TEG IDs for the DL RSTD meausrements in each TRP”? |
| ZTE | We want to make sure that one of the two UE Rx TEG IDs is what UE uses it to receive DL PRS from “RSTD” reference TRP.In other words, one of the two UE Rx TEG IDs is what UE uses to determine RSTD=0 in “RSTD” reference TRP (the global reference timing). To avoid ambiguity, we would like to add a note,Note: Two UE Rx TEG IDs include at least one UE Rx TEG ID that is used to determine RSTD=0 in “RSTD” reference TRP. |
| Apple | Proposal and intention still needs clarification. Let’s assume we have RSTD1 and RSTD2, where target PRS1 and target PRS2, respectively for RSTD1 and RSTD2, are measured by Rx TEG ID 1 &2. If this is what proposal saying, what about the Rx TEG for reference PRS in RSTD1 & 2. What’s the advandage of this proposal? Why 2 Rx TEG IDs? |
| FL | To Huawei, ZTE, and Apple:Will the following modification address the comments:* Subject to UE capability, support UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement in a DL TDOA measurement report. The two UE Rx TEG IDs can be the same or different.

I tried to use RSTD reference time instead of RSTD reference TRP to avoid opening up the discuss of the same TRP or different TRP issue. |

###  Proposal 3.1-2 (closed)

* Support a UE to provide the association information of RSTD measurements with UE Rx TEG(s) for both the target and the reference TRPs to the LMF when the UE reports the RSTD measurements to the LMF if the UE has multiple TEGs

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE |  ‘target TRP’ is not clear. If it describes the TRPs involved in the measurement, we think this proposal is almost the same as proposal 3.1-1 option 2. |
| OPPO | In our understanding, the proposal is to report an Rx TEG for *dl-PRS-ReferenceInfo* and an Rx TEG for each NR-DL-TDOA-MeasElement. If it is the correct understanding, Proposal 3.1-2 is the same as Option 2 of Proposal 3.1-1, and they can be merged.  |
| Fraunhofer | Agree with Oppo, this can be achieved with Option2 in Proposal 3.1-1.  |
| CATT | Support. |
| Ericsson | We are supportive of this proposal but this is captured by proposal 3.1-1 option 2. See also our comment to that proposal. |
| Huawei, HiSilicon | Unclear about the relationship between this proposal and Option 1 in Proposal 3.1-1. |
| Qualcomm | This is Related to Proposal 3.1-1 and can be treated together. Yes our understanding is that the UE will report an RxTEG for the reference TRP, and an RxTEG for each RSTD.  |
| Apple | The intention of proposal needs further clarification, given that we have P3.1-1, which is more complete for discussion to us. |
| Nokia/NSB | Same understanding as QC.  |
| CMCC | We have the same understanding as other companies that this proposal can be merged with Proposal 3.1-1 |
| Samsung | We suggest discussing this proposal with Proposal 3.1-1 together. |
| LG | We are also supportive of the proposal. We prefer to merge the proposal into proposal 3.1-1 and discuss all the issues together.  |
| InterDigital | We are supportive of the proposal. However, similar to Ericsson and OPPO, we think that this proposal can be merged to Option 2 of Proposal 3.1-1. |
| Intel | Propose to merge this Proposal with Proposal 3.1-1 (Option 2)  |
| FL | The discussion is merged with Proposal 3.1-1. |

Proposal 3.1-3 (H)

* Subject to UE’s capability, support a UE to measure the DL PRS resources from the same TRP with the same or different UE Rx TEGs, and report multiple RSTD measurements from the same pair of TRPs.
* FFS: details of the ignaling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support in principle. ‘report multiple RSTD measurements from the same pair of TRPs’ is already supported in the spec, so this description may not be needed. |
| OPPO | This proposal should be postponed untile some agreement is achieved for Proposal 3.1-1 or 3.1-2. The reasons are as below1. If option 1 of Proposal 3.1-1 is agreed, LMF cannot know the association of measurement results for the same pair of TRP and the TEGs. How does Option 1 and Proposal 3.1-3 work together? 2. If option 2 of Proposal 3.1-1 or Proposal 3.1-2 is agreed, each measurement result will associated with a Rx TEG for the target TRP and UE can report multiple measurement results for the same target TRPs. In this sense, Proposal 3.1-3 can be supported without any additional agreement. Whether UE will use the same Rx TEG or different Rx TEGs for the same pair of TRPs, it depends on UE implementation and the location/environment of UE. |
| Fraunhofer | Support |
| CATT | Support. |
| Vivo | Support |
| Ericsson | Support. This is very important since ignaling TEG association in itself isn’t sufficient to fully mitigate timing errors and to reach Rel. 17 target requirements. This technique is needed (see simulation results below)!Chart  Description automatically generatedFigure Utilization of antenna panel (or UE RX TEG) info is seen to give a very big improvement but still fails to fully mitigate the UE RX timing errors and to fulfill Rel. 17 positioning accuracy requirements in the InF-SH scenario. However, the combination of two techniques, 1) utilization of antenna panel (or UE RX TEG) info, and 2) sequentially performing one TOA estimate for each antenna panel towards the same TRP, result in complete mitigation of the UE RX timing errors and fulfillment of Rel. 17 positioning accuracy requirements. |
| Huawei, HiSilicon | Support. This can be easily achieved by enhancing the multiple measurements per TRP pair in Rel-16. |
| Qualcomm | We already have multiple RSTD reporting per pairs of TRPs, so the proposal needs to be clarified further. Also, similar to what OPPO is saying, if the RxTEG is associated with the RSTD (which is our understanding also based on previous ignaling), a UE, up to implementation, if it has multiple RxTEGs, could report multiple RSTDs for the same set of TRPs. This will happen automatically by using the feature of multiple measurement reporting (which now supports up to 4 RSTDs). If we just add an RxTEG in each “additional measurement”, which I assume would be the case already based on previous agreement. NR-DL-TDOA-AdditionalMeasurementElement-r16 ::= SEQUENCE { nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL, nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-TimeStamp-r16 NR-TimeStamp-r16, nr-RSTD-ResultDiff-r16 CHOICE { k0-r16 INTEGER (0..8191), k1-r16 INTEGER (0..4095), k2-r16 INTEGER (0..2047), k3-r16 INTEGER (0..1023), k4-r16 INTEGER (0..511), k5-r16 INTEGER (0..255), ... }, nr-TimingQuality-r16 NR-TimingQuality-r16, nr-DL-PRS-RSRP-ResultDiff-r16 INTEGER (0..61) OPTIONAL, nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL,RxTEG-ID...}Therefore, a more specific/clear proposal would be: * Subject to UE’s capability, support a UE to be able to report a separate RxTEGID for each of the RSTD measurements per pair of TRPs, including those in the *NR-DL-TDOA-AdditionalMeasurements.*
 |
| MTK | The wording seems a little vague to us. In our views, the significant measurement needs to contain the following two cases, otherwise the timing error can’t be mitigated.1, A RSTD is measured by a RX TEG of UE between two resources of a TRP. This TRP could be reference TRP, or a neighbour TRP. This is to measure whether there is extra timing error during TX beam switching2, A RSTD is measured by two RX TEGs of UE under same resource of a TRP. This TRP could be reference TRP, or a neighbour TRP. This is to measure the RX TEG difference To FL, we want to make sure the above two cases are contained. Then we support |
| Apple | Questions for clarification: is it subject to multiple Rx TEGs at UE? Otherwise multiple RSTD reports is already specified. We also think better to postpone after we agree on 3.1-1 (and 3.1-2)  |
| Nokia.NSB | Agree with QC that the FL proposal is not clear. The version from QC seems better to us.  |
| CMCC | If I remembered correctly, in the last meeting, it was proposed that by supporting a UE to measure the RSTD from the same TRP pair using different UE Rx TEGs can help the LMF to estimate the timing error difference between different UE Rx TEGs, so that the Rx timing errors can be further compensated. However, in our view, this solution relies on the assumption that the propagation delay between the same TRP and different Rx TEGs are the same, which we believe cannot be guaranteed all the time and therefore the benefits would be limited.  |
| Samsung  | Maybe a silly question, how to exactly “measure” the RSTD with a given Rx TEG? Does it like tracking the first arrival path time and then plus the timing error value? |
| LG | Support. |
| InterDigital | Support |
| Intel | Support. In our uderstading it is supported if Proposal 3.1-1 (Option 2) is agreed. |
| Ericsson | Regarding CMCC’s question, we analysed this issue in our previous contribution R1-2103735 and observed that the lag between paths does not change when observed from different RxTEGs. Two peaks identified with both RxTEGs with the same lag between them are very likely to correspond to the same propagation paths. Using this temporal structure, you can identify the delay caused by the different Rx TEGs. Please see discussion around Figure 20 of our contribution R1-2103735.Regarding questions from Qualcomm and Nokia/NSB, in current spec, the UE may report multiple RSTD measurements per pair of TRPs. But this is up to the UE. What we would like is to be able to configure the UE to report multiple RSTD measurements per pair of TRPs using separate RxTEG IDs for each of the RSTD measurements per pair of TRPs. So we have the following modification to the suggestion from Qualcomm.* Subject to UE’s capability, support a UE to be configured ~~able~~ to report a separate RxTEG ID for each of the RSTD measurements per pair of TRPs, including those in the *NR-DL-TDOA-AdditionalMeasurements.*
 |
| FL | Based on the comments, it seems most companies are supportive to the proposal with some clarification. We may take the modified version from Ericsson for further discussion. |

Proposal 3.1-3 (Revision 1)(H)

* Subject to UE’s capability, support a UE to be configured to report a separate RxTEG ID for each of the RSTD measurements per pair of TRPs, including those in the *NR-DL-TDOA-AdditionalMeasurements*.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| vivo | We are not sure whether the following case is included in this proposal, as MTK’s previous comments* A RSTD is measured by two RX TEGs of UE under same resource of a TRP. This TRP could be reference TRP, or a ignalin TRP. This is to measure the RX TEG difference

From our understanding, ‘NR-DL-TDOA-AdditionalMeasurements’ is used for additional RSTD measurement from additional PRS resources; whether RSTD measured by two RX TEGs of UE under same resource can be supported by this element is unclear, maybe the element ‘nr-AdditionalPath’ can be supported for the above case. Therefore, we suggest to modify Proposal 3.1-3 as follows* Subject to UE’s capability, support a UE to be configured ~~able~~ to report a separate RxTEG ID for each of the RSTD measurements per pair of TRPs, including those in the *NR-DL-TDOA-AdditionalMeasurements*.
* Subject to UE’s capability, support a UE to be configured to report a separate RxTEG ID for each of additional detected paths associated with each RSTD measurement, including those in the *nr-AdditionalPath*.
 |
| ZTE | Whether a Rx TEG is associated with multiple RSTDs or a Rx TEG is associated with one RSTD, we think it is more like a ignaling design issue related to RAN2. We suggest to discuss the issue in RAN2 |
| LG | In our understanding, the original intention of the proposal is whether the different RxTEG IDs in measurement for each TRP is supported or not. We have a similar view with vivo. To cover the problem, we suggest to modify ‘separate RxTEG ID’ to ‘multiple RxTEG IDs’ for more intuitive description. |
| Ericsson | Support.@ZTE: although the ignaling will be specified by RAN2, this is still RAN1 functionality. So RAN1 can discuss and make an agreement. We can leave the exact ignaling detail to RAN2.Regarding comment from vivo, we think it is better to discuss issue related to ‘nr-AdditionalPath’ as a separate dedicated proposal. |
| Qualcomm | Unfortunately we are confused now. Seems vivo is saying that the same PRS resource can be received with 2 RxTEGs? E.g. like 2 Rx antennas, and the UE reports for each antenna what are the TOAs? Was that really the intention? Its better to start talking about PRS resources instead of TRPs, because in the UE’s report, the measurements are associated with a PRS resource.So, if my understanding of the comments are correct, the UE is measuring a single PRS resource with X antennas/panels and reports TOA multiple measurements associated with each antenna/panel?  |
| FL | To QC: The original proposal “*Subject to UE’s capability, support a UE to measure the DL PRS resources from the same TRP with the same or different UE Rx TEGs, and report multiple RSTD measurements from the same pair of TRPs”* support the following two cases:* *measure the same or different DL PRS resources from the same TRP with the different UE Rx TEGs, and report the corresponding RSTD measurements*
* *measure the same or different DL PRS resources from the same TRP with the same UE Rx TEG, and report the corresponding RSTD measurements*

Both of the above could be supported once the RxTEG-ID is added into R-DL-TDOA-AdditionalMeasurementElement, as QC suggested, when UE reports * two AdditionalMeasurementElements with the different nr-DL-PRS-ResourceID/ nr-DL-PRS-ResourceSetID but the same RxTEG-ID,
* two AdditionalMeasurementElements with the same nr-DL-PRS-ResourceID/ nr-DL-PRS-ResourceSetID but the different RxTEG-IDs

I was assuming that is the common understanding of original proposal, and also that is the reason that QC proposed the revision of the previous proposal.About the discussion between ZTE and Ericsson on the ignaling part, my personal preference is not to define RAN1’s agreement for specific LPP Ies, e.g., *DL-TDOA-AdditionalMeasurementElement,* but let RAN2 to work on it.  |
| MTK |  To FL: As your revision* two AdditionalMeasurementElements with the different nr-DL-PRS-ResourceID/ nr-DL-PRS-ResourceSetID but the same RxTEG-ID,
* two AdditionalMeasurementElements with the same nr-DL-PRS-ResourceID/ nr-DL-PRS-ResourceSetID but the different RxTEG-IDs

For “two AdditionalMeasurementElements”, why not say “a RSTD”? |
| FL | To MTK:I would agree that it would be better to let RAN2 discuss with the IE, e.g., AdditionalMeasurementElements.Proposal 3.1-3 is revised as follows that only describe what RAN1 wants, but let RAN2 work on the details on the Ies.  |

Proposal 3.1-3 (Revision 2)(H)

* Subject to UE’s capability, support a UE to measure *the same* DL PRS resource *(or different* DL PRS resources) from a TRP *with different UE Rx TEGs*, and report corresponding RSTD measurements.
* FFS: details of the Signaling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Just to echo the question from 3.1-1Can the TRP here be the RSTD reference TRP. |
| CMCC | As replied by Ericsson, we believe that “helping the LMF to estimate the timing error difference between different UE Rx TEGs” is at least one benefit by enabling this proposal. Then one question would be that, if the RSTD measurement is measured by different DL PRS resources from a TRP, these DL PRS resources should be within the same TRP Tx TEG; otherwise the estimated UE Rx TEG difference would be biased. |
| ZTE | Support UE to measure different DL PRS resources from a TRP with different UE Rx TEGs, do not support the same PRS measured with different UE Rx TEGs to generate RSTD measurements.We assume that PRS1→Rx TEG1, PRS2→Rx TEG2. In proposal 3.1-1, PRS1 and PRS2 belong to reference TRP and neighbor TRP, respectively; in proposal 3.1-3, PRS1 and PRS2 comes from one TRP, and this TRP can neither be called reference TRP nor the neighbor TRP according to current spec. |
| Ericsson | Regarding Huawei/HiSilicon’s question, our understanding is that the TRP here refers to the non-RSTD reference TRP. Assume the UE reports RSTDTEG1 and RSTDTEG2 for the same DL PRS resource from a TRP for UE Rx TEG ID1 and UE Rx TEG ID2, respectively. Then, the LMF can estimate the timing error difference between the two UE Rx TEGs as (RSTDTEG1 – RSTDTEG2). Since the UE would report RSTD=0 for reference TRP, we do not think having RSTD reference TRP as TRP in the above proposal makes much sense.In the above proposal, the same DL PRS resource can be measured with different UE Rx TEGs. So supporting same DL PRS resource is important in Proposal 3.1-3. |
| MTK |  To FL,Just want to know why the below term is gone at the revision 2? In our view, to measure different resources under a same TRP by a same RX TEG could let know whether there is potential timing offset during beam switching.  Can you put it back?* two AdditionalMeasurementElements with the different nr-DL-PRS-ResourceID/ nr-DL-PRS-ResourceSetID but the same RxTEG-ID,

  |
| OPPO | We prefer to keep “*NR-DL-TDOA-AdditionalMeasurements*” in the proposal as Revision 1 to avoid confusion in future work (e.g., whether the multiple Rx TEGs are associated with different paths or not? ) |
| Huawei, HiSilicon | To Ericsson/OPPO:For the RSTD reference TRP, there should be the case that UE receives the reference TRP with multiple Rx TEG, but decides to only use one as the reference, and report others in the *NR-DL-TDOA-AdditionalMeasurements* for the RSTD reference TRP. In Rel-16, this should be a mistake by restricting *nr-RSTD-ResultDiff* to 0 for RSTD reference TRP, and we think it is important to fix that in Rel-17. |
| CATT | Support.We think this proposal just try to let a UE to measure the DL PRS resource from a TRP with the different UE Rx TEGs can help LMF to use the estimated timing error differences to compensate the TE differences of the UE. |
| vivo | Support |
| Nokia/NSB | In our understanding the “(or different DL RPS resources)” doesn’t need to be in the proposal as it has already been agreed. Otherwise we are okay with the proposal. |
| Intel | Support |
| ZTE2 | We don’t support a same PRS resource is measured by different UE Rx TEGs and UE reports corresponding RSTD measurements. Firstly, in current spec, a same pair of TRP can generate up to 4 RSTD measurement, they come from different pair of PRSs; Secondly, if a PRS is used to measure time difference of different UE Rx TEGs, there is no need to report another RSTD with the same pair of PRSs, UE just compensate by itself. |
| FL | To Huawei and Ericsson’s discussion on reference TRP:* The proposal, as it is written, does no exclude the reference TRP. In my opinion, the reference TRP should not be excluded. In general, the DL PRS power level for the reference TRP is stronger than others, and thus, can have more reliable estimation of UE Rx time differences.

To CMCC:* If the same DL PRS from TRP, then obviously it is the same TRP Tx TEG. If not from the same DL PRS from TRP, it will be up to LMF to decide if they are from the same TRP Tx TEG.

To ZTE:* Yes, I assume the UE may also calibrate the time difference between Rx TEGs if the UE can receive the same DL PRS resource with two Rx TEGs. However, the reliability may be in question if the UE receives the same DL PRS resource arrives the UE in different path, which could be the case since two Rx TEGs may be linked to two UE Rx antenna panels toward different directions. LMF may have more information to make the use of the information correctly.

To MTK:* I was thinking to first make the agreement in UE side. Once it is agreed, it would be much easier to work on TRP side.

To Huawei and OPPO’s discussion on *NR-DL-TDOA-AdditionalMeasurements*:* My thinking is that RAN1 should avoid working directly to LPP IEs. RAN2 should be in much better position to decide how in include RAN1’s decision into RAN2’s LPP signalling. I also share the similar view as Huawei that reference TRP should be included. It will then up to RAN2 to work on the details.

To Nokia/NSB:* I assume using the same TEG to measure different DL RPS resources may be a nature extension of R16 RSTD measurements. I guess it may not hurt to emphasize that we support using, e.g., Rx TEG1 and Rx TEG2 to measure DL PRS 1 and DL PRS2 to generate RSTD related to {Rx TEG1, DP PRS1}, {Rx TEG2, DL PRS1} , {Rx TEG2, DL PRS2}
 |
| Qualcomm | Why do we add the “**the** different UE Rx TEGs”? What if the UE has 4 Rx TEGs, wouldn’t be able to report using just 2 of those? Ie. Will it either be 1 or 4 RSRD, or intermediate values will be there? I assume the UE should be able to report measurements with fewer Rx TEGs. Suggest to remove the word “the”. Similar proposal should be there for Rx-Tx measurement reporting, will that be discussed in a later stage?* Subject to UE’s capability, support a UE to measure *the same* DL PRS resource *(or different* DL PRS resources) from a TRP *with ~~the~~ different UE Rx TEGs*, and report corresponding RSTD measurements.
* FFS: details of the Signaling, procedures, and UE capability
 |
| FL | To Qualcomm:* Obviously, it may not make sense to request UE to report the measurements associated with all UE Rx TEGs. Rx-Tx measurement reporting will be discussed in Section 3.3.
 |
| ZTE3 | to FL:Thanks for the response. However, we're confused with the intention to report two RSTD measurements with different UE Rx TEGs based on a single DL PRS resource. Some companies say this is for deriving timing error difference (can be measured by the difference of the two RSTD values) between different UE Rx TEGs, which we assume the transmission time over the air (or the path delay) should be the same. Because the transmission time over the air is determined by the locations of UE and TRP, which is irrelevant of UE Rx TEGs. As we commented in last round, if UE is aware of the timing error difference, UE can simply compensate it. There is no need for UE to report both RSTD values.In your reply, it seems that the same DL PRS resource received by one UE with different UE Rx TEGs may experience different transmission time over the air (or the path delay) , which conflicts with the former assumption. So, the difference of the two RSTD values may not only include timing error difference, but also time difference measured by different UE Rx TEGs because of different transmission time over the air. Our question is: how LMF can use such information to improve positioning accuracy? |
| Huawei, HiSilicon | Just reply to ZTE3:Different TOA measurements on different Rx TEGs based on the same DL PRS resource is possible. One source could be that the direct (LOS) path may be attenuated on one Rx chain and thus not observed because UE antenna may not be omni-directional, in which case TOA measurement based on Rx TEG 1 corresponds to the first path, but TOA measurement based on Rx TEG 2 corresponds to a reflecting path. UE using such information to estimate and “compensate” the TEG error will result in even worse performance. Even for the case when the two TOA measurements from different Rx TEGs correspond to the same first arrival path, we would like to note that TOA measurement may not be accurate due to TOA measurement algorithm. UE estimation and compensation on the Rx timing difference between two Rx TEGs and report them as a single TEG may be problematic, since the residual compensation error may compromise the integrity of “single TEG” in the report.How LMF could use such information to improve the accuracy? Our understanding is that when UE reports two TOA measurements based on the same PRS resource from different Rx TEGs, it gives some **estimate of the timing error** between different TEGs, which can be useful when LMF may determine the UE location and inter Rx TEG error jointly. |
| ZTE4 | To Huawei:Regarding your view that ‘compensation may not be a good idea no matter the PRS has same path or different path’, we think it is reasonable. However, if a single DL PRS resource is received by 2 Rx TEGs with different first arrival paths, **estimate of the timing error** may be perturbed by path delay and it is no longer valid. Also, supporting a PRS measured by different Rx TEGs and reporting corresponding RSTD measurements may lead to more number of RSTDs per TRP pair (now it is up to 4), which may have more spec impacts. |
| Apple | Question for clarification, RSTD for the same TRP? |
| Ericsson | SupportRegarding the potential problem with unhearable paths, simulation results from Ericsson as well as fromVivo show very strong benefits despite the fact that it can’t be guaranteed that the same path is identified using different TEGs. Clearly the same path is detected often enough to give good benefits.We analysed this issue in more detail in our previous contribution R1-2103735 and observed that the lag between paths does not change when observed from different RxTEGs. Two peaks identified with both RxTEGs with the same lag between them are very likely to correspond to the same propagation paths. Using this temporal structure, you can identify the same path using different Rx TEGs. This method wasn’t used in our simulations but could be used to futher improve the results. Please see discussion around Figure 20 of our contribution R1-2103735. Note, however, that such methods where not needed to give the results shown in our contribution. Generally, all measurements don’t have to be correct. Outlier rejection methods can be used to reject faulty ones. |
| OPPO | One minor comment: is there any special indication or intension for the brackets? If the answer is no, we suggest to remove the brackets.*(or different* DL PRS resources) |
| LG | We have a question for clarification. Is the “same DL PRS resource” means DL PRS resources that have the same DL PRS resource ID in different periodicity. If it is right, some related detail description should be added. If it is not, sholud we accept that the UE receives PRS by using different Rx TEG at the same time?. For the principal of the proposal, we agree with it. |
| Nokia/NSB\_2 | Given the FL explanation we are okay with the proposal.  |
| FL | To ZTE4:I share the similar view as some other companies, it will be up to LMF’s implementation on determine and exclude the measurements of “a single DL PRS resource is received by 2 Rx TEGs with different first arrival paths, **estimate of the timing error** may be perturbed by path delay and it is no longer valid”. For the impact on the specs, yes, it could lead to more number of RSTDs per TRP pair. We may need to have follow-up discussion on the issue once the proposal is agreeable.To Apple:Yes. Here, we means RSTD for the same TRP. E.g., UE uses UE Rx TEG1 to measure a DL PRS to obtain the TOA1, and used UE Rx TEG2 to measure the same DL PRS to obtain TOA2. UE will reports RSTD=TOA1-TOA2. The RSTD may indicate the time difference between Rx TEG1 and RX TEG2. To OPPO:I assume the brackets because supporting *different DL PRS resources* may have larger impact on the specs and also deserves a lilltle more discussions on the potential benefits. I assume the brackets can be removed once we reach the consensus about the intention and benefit of measuring the DL PRS resource with the different UE Rx TEGsIn addition, I will we may need to send the LS to keep RAN2 informed on the  |

### Proposal 3.1-3 (Revision 3)(H)

* Subject to UE’s capability, support a UE to measure *the same* DL PRS resource *~~or different~~* ~~DL PRS resources~~ from a TRP *with different UE Rx TEGs*, and report corresponding RSTD measurements.
* FFS: details of the Signaling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| FL | I removed *~~or different~~* ~~DL PRS resources~~  due to the comments in online discussion. However, in my view, using *different UE Rx TEGs* to measure the *different DL PRS resources* may serve the similar purpose as using *different UE Rx TEGs* to measure the the same DL PRS resources in terms of the estimation of the timing difference of UE Rx TEGs, if the DL PRS resources from the same Tx TEG of the TRP, i.e., the *different DL PRS resources* are transmitted at the same time from the TRP, although the estmation accuracy of the timing difference of UE Rx TEGs may be not as good as using the same DL PRS resource. |
| MTK | When a same PRS resource is measured by 2 different RX TEGs, there is chance, depending on the probability, UE can learn the RX timing delay difference between 2 RX TEGs. And actually UE can compensate. In our view, to report the measured delay difference between 2 RX TEGs and report it may not always needed, since UE can do the compensation. Note that, the RX TEG delay difference is UE specific and each UE can actually handle it.When two PRS resources belonging to a TRP are measured by a same RX TEG of UE, UE can learn whether there is potential timing offset between PRS resources transmission to prevent UE from doing the combining among resources. We already show the gain in Rel-16 when timing offset between resources is not present. And this is why we propose to report one RSTD for a pair of TRPs, not to report multiple RSTDs for some pair of resources under a pair of TRPs.\The timig offset between PRS resources could happen, and this is system-specific issue. Reporting such offset to LMF is more valuable than reporting UE specific error to LMF. LMF can provide the timing offset measurement by UEs to TRP for further calibrating the timing for beam transmission.For the measurement of 2 different PRS resource by 2 RX TEGs, the would be two timing errors, which is between PRS reousrces transmission, and between RX TEGs reception. So, we see less value for doing such measurement and reporting.We suggest the following proposal, because we don't quite understand the value to report UE specifc error to LMF. UE can compensate it when the error is measured.* Subject to UE’s capability, support a UE to measure *the same* DL PRS resource *~~or different~~* ~~DL PRS resources~~ from a TRP *with different UE Rx TEGs*, and to measure different DL PRS resources from a TRP with a same UE RX TEG, and report corresponding RSTD measurements.
* FFS: details of the Signaling, procedures, and UE capability
 |
| Huawei, HiSilicon | To my understanding, the following could be the case in the MTK’s revised proposal.* RSTD#0 PRS#0 RxTEG#0
* RSTD#1 PRS#1 RxTEG#0
* RSTD#2 PRS#0 RxTEG#1
* RSTD#3 PRS#1 RxTEG#1

Then automatically RSTD#0 and RSTD#3 (or RSTD#1 and RSTD#2) belong to the case with different PRS resource and different Rx TEG.To MTK, we disagree with the following argument as discussed with ZTE before:When a same PRS resource is measured by 2 different RX TEGs, there is chance, depending on the probability, UE can learn the RX timing delay difference between 2 RX TEGs. And actually UE can compensate.I would assume the post-compenstation will treat the two Rx TEGs as signle one, but to our understanding, this should not be the case. The OTA TOA measurement may be subject to TOA measurement accuracy impact and NLOS impact. This OTA compenstation and the resultant single TEG may not be complied with a real single TEG in our mind. |
| ZTE | We want to make sure that we have the same understanding. Let’s take an example: we have two TRPs (TRP1 is reference TRP and TRP2 is neighbor TRP).Then DL PRS from TRP1 is received by UE with UE Rx TEG 1( the TOA is denoted by TOA\_11). Meanwhile, a single DL PRS from TRP2 are received by UE with UE Rx TEG 1 and UE Rx TEG 2 simultaneously (the TOAs are denoted by TOA\_12 and TOA\_22). Finally, the timing error for UE Rx TEG 1 and UE Rx TEG 2 are represented by Rx\_1 and Rx\_2 respectively.We assume that the above proposal will report following two RSTD valuesRSTD\_1= （TOA\_12+Rx\_1)-(TOA\_11+Rx\_1)RSTD\_2= （TOA\_22+Rx\_2)-(TOA\_11+Rx\_1)If LMF wants to get timing error difference between UE Rx TEGs, which can be acquired by (assume TOA\_12=TOA\_22)RSTD\_2-RSTD\_1=Rx\_2-Rx\_1This is why we commented in GTW that the intra-TRP RSTD {i.e. IntraTRP\_RSTD=（TOA\_22+Rx\_2)-(TOA\_12+Rx\_1)=Rx\_2-Rx\_1} is not necessary.In current spec, intra-TRP RSTD is only supported for reference TRP, we don’t need to extend to neighbor TRPs.With analysis above, we want to add the note we have discussed during GTW:Note:All RSTD measurements are relative to a single reference timing. |
| OPPO | Compared to the measurements of the different PRS resource with different Rx TEGs, association of the same PRS with different Rx TEGs are less useful. The main reasons is that there are less chance for a UE to measure the same PRS with different Rx TEGs with satisfied quality. From this perspective, the new proposal is updated by removing the most valuable part. We suggest to keep the part of different DL PRS resource.  |
| Huawei, HiSilicon | To ZTE:Why should we assume TOA\_12 = TOA\_22? What if TOA\_22 is the NLOS link? Even if TOA\_22 is LOS link, the BB TOA corresponding to the TOA\_22 could have TOA estimation error, due to SINR, BW, etc. then the Rx\_2 – Rx\_1 will contain the double TOA measurement error. Of course UE can do the compenstation if they want, and report the result as a single Rx TEG to the LMF, but we have doubt whether this can be complied with requirement of a single TEG.In addition, in the current spec, intra-TRP RSTD is supported where up to three additional RSTDs can be reported each associated with a different PRS resource, but it is only applicable for the non-reference TRP, NOT the reference TRP. |

|  |  |
| --- | --- |
| MTK |  To ZTE: Quite similar view. Using your example, if UE can measure TRP2 simultaneouly by its own 2 RX TEGs, and UE has confidence on the receving RSRP level in the 2 RX TEGs, UE can actually setup reference TRP to TRP2, if CIR observed from 2 RX TEGs has similar profile. Then any RSTD measured in each RX TEG could be based on TRP2 as reference TRP, and then there wont be issue of RX TEG delay difference.No matter what, this is UE specific error. If UE has confidence on the measurement, UE can compensate the delay difference. We are also open to have RAN4, and in-house test for this. We are not to completely objecting the proposal by FL. Of course, under NLOS condition, it could be challaneing to learn the delay difference between RX TEGs. We don't think the problem could be solved by reporting it to LMF. So why not admit that, the measurement of 2 RX TEGs for a same DL PRS resource is not always reliable? We slightly modify our proposal by adding a note, after some “offline” discussion with Huawei,* Subject to UE’s capability, support a UE to measure *the same* DL PRS resource *~~or different~~* ~~DL PRS resources~~ from a TRP *with different UE Rx TEGs*, and to measure different DL PRS resources from a TRP with a same UE RX TEG, and report corresponding RSTD measurements.
* Note: UE may indicate whether the measured RX TEG timing difference has been compensated at UE side.
* FFS: details of the Signaling, procedures, and UE capability

  |

Proposal 3.1-4

* + For UE-based DL-TDOA, support a UE to receive the Tx-TEG information for each PRS resource in the unicast or broadcast assistance data.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | OK |
| CATT | Support. |
| vivo | We think the previous agreement is reached on the condition that if TRP has multiple TEGs, the proposal also should be discussed in the condition. |
| Qualcomm | Support. Clearly fine to add that condition; it is understood.  |
| Apple | Support (and suggest to change the text to “at least” for UE-based…) |
| Nokia/NSB | Unclear that we need to be so specific in “unicast or broadcast”. We are okay with UE receiving this information and RAN2 can decide how the UE gets that information.  |
| Sony | Support. The details whether unicast or broadcast assistance data should be discussed in RAN2. |
| ZTE | Support. Suggest to remove ‘in the unicast or broadcast assistance data’. |
| LG | We have similar view with Nokia/NSB and Sony. |
| InterDigital | Support |
| FL | Based on the comments, it seems the majority of companies support the proposal, but some companies consider the details of “unicast or broadcast” should be discussed in RAN2. In the last meeting, RAN1 agrees 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. RAN1 has agreed on the support in unicast assistance data. If we want to add the support of broadcast, then there is a need for the LMF to provide the information of the neighboring gNBs to the serving gNB. Maybe we could change the wording to “from RAN1’s perspective”, and let RAN2/RAN3 consider the signalling support. |

### Proposal 3.1-4 (Revision 1)

* + For UE-based DL-TDOA, from RAN1’s perspective, it should be supported for a UE to receive the Tx-TEG information for each PRS resource in broadcast assistance data if the TRP has multiple TEGs.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Some modification:* + For UE-based DL-TDOA, ~~from RAN1’s perspective, it should be~~ support~~ed for~~ a UE to receive the Tx-TEG information for each PRS resource/PRS resource set in broadcast assistance data if the TRP has multiple TEGs.
 |
| Ericsson | We already have the following agreed in last RAN1 meeting:* + “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”

The above agreement does not specifically say unicast assistance data. Hence, we do not need to discuss ‘unicast assistance data or broadcast assistance data’ and leave these signalling details to RAN2. |
| OPPO | OK |
| CATT | Support. |
| SONY | We have a similar view as Ericsson. We think we need to send an LS to RAN2 so that they can discuss whether unicast assistance data or broadcast assistance data. |

### Proposal 3.1-5 (suggest to be closed)

* + For DL TDOA, support the LMF to indicate which Rx TEG(s) to use for the reception of one or more DL-PRS resources.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support. How does LMF know which Rx TEG should be used for a given PRS resource?  |
| CATT | Support. We think this proposal just try to let LMF to recommend the proper Rx TEGs to UE for the reception of DL-PRS, in order to facilitate the mitigation of the timing error. |
| Qualcomm | Not support |
| Apple | Support the intention, as long as indication is taken as suggestion to UE. |
| Nokia/NSB | We think there needs to be more clarification how this would work and what would be gained. TEGs by definition can vary over time so how is the network to know which Rx TEG is best for the UE to use for positioning measurements?  |
| Sony | Do not support, we prefer it is up to the UE to decide. |
| ZTE | Do not support. DL-TDOA already has a real-time report configuration through LPPa, so there is no need to restrict UE’s behaviour. |
| LG | Not support. We think the decision on which RX TEG is used is up to UE. So, it is not necessary to discuss additional restrictions. |
| InterDigital | Support. In our view, LMF can recommend the UE to use the same of different Rx TEG(s) for two or more DL-PRS resources. If the UE uses the same Rx TEG for one RSTD measurement, Rx timing error can be canceled out. On the other hand, if the UE uses different Rx TEG(s), the LMF can know the timing error difference between two TEGs.  |
| FL | From the feedback, it seems the majority of feedbacks are not supportive of the proposal. Based on the feedback, the suggestion is to close the discussion in this meeting with “a consensus cannot be reached for the proposed enhancement”. It does not necessarily mean the proposed enhancement will not be further discussed in future meetings.  |

FL Comments

Due to the lack of majority support, suggest closing the discussion with “*Consensus cannot be reached for the proposed enhancement*”.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |

Proposal 3.1-6

* For UE-assisted DL-TDOA positioning, support
	+ TRP to provide the LMF with the Tx timing errors per Tx TEG (Option 3)
	+ TRP to provide the LMF with the Tx timing error differences between Tx TEGs (Option 8)
	+ LMF to provide UE with the Tx timing errors per Tx TEG (Option 4)
	+ LMF to provide UE with the Tx timing error differences between Tx TEGs (Option 9)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support1. Option 3/8: If TRP knows the errors, why doesn’t TRP do a calibration?2. Option 4/9: If LMF konow the time errors, why doesn’t LMF indicate this information to TRP for compensation?  |
| CATT | Support.In our point of view, if TRP compensate the Tx timing errors, it means TRP have to adjust the timing of transmission of DL-PRS, which may lead to some interference to other DL signals.  |
| vivo | At least, we think option 3 and option 4 are hard to get and unreasonable. |
| Nokia/NSB | We don’t think Options 3 and 4 are technically feasible. We are open to discussing Option 8 and 9 further but it should be lower priority than other proposals in our view.  |
| SONY | Support. Do we intend to down-select later? (e.g. Option 3 versus Option 8) |
| ZTE | Do not support as we suggested in the last meeting |
| LG | Not support. We need to consider the original intention of defining TEG.  |
| InterDigital | Support. In our view, if the LMF and TRP have such information (i.e., timing error of each TEG and timing error differences between Tx TEGs), they should provide such information to the UE to improve the accuracy positioning methods. However, Option 4 and 9 are for UE-B positioning. Therefore, we propose to modify the proposal as follow:* For UE-assisted DL-TDOA positioning, support
	+ TRP to provide the LMF with the Tx timing errors per Tx TEG (Option 3)
	+ TRP to provide the LMF with the Tx timing error differences between Tx TEGs (Option 8)
* For UE-based DL-TDOA positioning, support
	+ LMF to provide UE with the Tx timing errors per Tx TEG (Option 4)
	+ LMF to provide UE with the Tx timing error differences between Tx TEGs (Option 9)
 |
| FL | Based on the feedback, at least for Options 3 and 4, the majority of the feedbacks are NOT supported. For Option 8 and 9, more companies are either supportive or open for further discussion. The proposal is revised with Option 3 and 4 being deleted for further discussion. |

### Proposal 3.1-6 (Revision 1)

* For UE-assisted DL-TDOA positioning, support
	+ TRP to provide the LMF with the Tx timing error differences between Tx TEGs (Option 8)
	+ LMF to provide UE with the Tx timing error differences between Tx TEGs (Option 9)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Do not support |
| Ericsson | We note that if the UE/gNB knows the timing error differences then it can compensate for the timing error differences by correcting measurements or adapting the TX time of RSs. Thus, there is no need to signal the timing error differences to the LMF. Hence, we do not think Options 8 and 9 need to be supported. So we do not support the above proposal. |
| OPPO | Not support Option 9 since LMF can compensate the error difference for UE-assisted DL-TDOA positioning  |
| CATT | Support both Option 8 and Option 9. |
| SONY | Do not support |

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

Background

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

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

Agreement (RAN1#104bis-e):Support the following for mitigating UE Tx timing errors and/or TRP Rx timing errors for UL TDOA* Support a TRP to provide the association information of RTOA measurements with TRP Rx TEG(s) to the LMF when the TRP reports the RTOA measurements to the LMF if the TRP has multiple Rx TEGs
* Support a UE to provide under capability the association information of UL SRS resources for positioning with Tx TEGs to the LMF if the UE has multiple Tx TEGs
	+ FFS: Whether to support a UE to provide the association information of UL SRS resources for MIMO with Tx TEGs to the LMF if the UE has multiple Tx TEGs
	+ FFS: Whether the association information is sent directly from UE to LMF, or is first provided to gNB and then forwarded to LMF;
* FFS: the details of the Signaling, procedures, and UE capability
 |

Submitted Proposals and FL comments

* (Huawei [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc)[1]) Proposal 1: Support UE to be requested to report TEG information for MIMO SRS.
	+ Note 1: This is an optional UE feature.
	+ Note 2: The request of TEG information can serve as the functionality of informing UE of MIMO SRS used for positioning.
	+ Note 3: Associating MIMO SRS with TEG in Rel-17 does not affect/restrict UE implementation of MIMO SRS transmission, i.e., legacy UE implementation of MIMO SRS can be inherited

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (Huawei [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc)[1]) Proposal 2: Support gNB to report the associated SRS resource ID and port ID of the RTOA measurement..
* FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)
* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 5: The UE can be requested to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF.
	+ Including positioning accuracy requirement information in Tx TEG request

FL: I assume the main bullet is already supported, but including the accuracy requirements is not discussed before. Suggest further discussion (3.2-3)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 6: Support the UE to directly provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF via LPP message.
	+ Note: The way the UE provides Tx TEG association information to the LMF should be consistent with the way the LMF requests UE Tx TEG association information

FL: It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 9: Support the gNB to provide information related to SRS resource(s) ID to the LMF in RTOA measurement result, to help the LMF obtain the relationship between the RTOA measurement result and the Tx TEGs of SRS resource(s).

FL: It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 10: In UL-TDOA method, to eliminate the positioning error caused by the UE Tx timing errors of more than one UE Tx TEGs, the RTOA measurement report for more than one UE Tx TEGs needs to be guaranteed if the gNB is able to measure SRS resoures associated different UE Tx TEGs.
	+ FFS the gNB reporting rules to guarantee the RTOA measurement report for more than one UE Tx TEGs

FL: Discussed in previous meeting w/o conclusion. Suggest further discussion (Proposal 3.2-4)

* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 13: For UL-TDOA positioning, the following two methods should also be supported to help LMF eliminate the influence of timing error of TRPs and UE:
* *Provide LMF with the Tx timing errors per Tx TEG.*

|  |  |  |  |
| --- | --- | --- | --- |
| UL-TDOA | From | To | Signalling for mitigating UE Tx timing errors |
| Option 3 | UE | LMF | Tx timing errors per Tx TEG |

* *Provide LMF with the Tx timing error differences between Tx TEGs.*

|  |  |  |  |
| --- | --- | --- | --- |
| UL-TDOA | From | To | Signalling for mitigating UE Tx timing errors |
| Option 4 | UE | LMF | Tx timing error differences between Tx TEGs |

FL: These options were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-5)

* (ZTE, [R1-2104590](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104590.doc)[4]) Proposal 2: Whether Tx TEG is associated with SRS resource, SRS resource set or SRS port depends on different SRS usages and UE capability, e.g. UE antenna coherent capability, UE antenna switching capability, etc.

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (ZTE, [R1-2104590](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104590.doc)[4]) Proposal 3: Support to include UE Tx TEG information in location measurement report.

FL:It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 4: Support TxTEG-to-SRS association reporting as part of the LPP signaling framework:
	+ A UE should be able to report capability information related to Tx TEGs
	+ A UE should be able to report association of Tx TEGs to SRS resources for positioning together with a timestamp (e.g. in a Provide Location Information message) to the LMF

FL:It is elated to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 5: Do not support Tx TEGs reporting for MIMO SRS.

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 1: Rel-17 doesn’t support the association of TEG with MIMO SRS port(s).

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 5: Rel-17 doesn’t support the association of TEGs with MIMO SRS resources.

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 6: For the association information of TEGs and SRS resources for positioning, Rel-17 supports UE to report it to gNB and gNB to forward it to LMF via NRPPa.

FL:It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 6: 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

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 8: For UL TDOA, support the LMF to indicate which Tx TEG(s) to use for transmission in one or more UL PRS resources.

FL: Unclear how LMF knows which Tx TEG(s) the UE should use for the transmission of UL PRS resources. Suggest further discussion (Proposal 3.2-6)

* (Sony, [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc)[11]) Proposal 2: In UL-TDOA positioning,
	+ If a TRP is aware of its own Rx timing errors, support TRP to provide TRP Rx timing errors associated with the RTOA measurements to the LMF.
	+ If a TRP is not aware of its own Rx timing errors, support TRP to provide the ID/index of TRP Rx TEGs associated with the RTOA measurements to the LMF if the TRP has multiple Rx TEGs.
	+ If UE is aware of its own Tx timing errors, support UE to provide the UE Tx timing errors associated with the UL SRS resources to the LMF.
	+ If UE is not aware of its own Tx timing errors, support UE to provide the ID/index of UE Tx TEGs associated with the UL SRS resources to the LMF if the TRP has multiple Rx TEGs.

FL: These options were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-5)

* (Samsung, [R1-2105310](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105310.doc))[12]) Proposal 4: Support that the association information is sent directly from UE to LMF when the calculation of UL-TDOA is done at LMF. Otherwise it can be provided to the gNB first if the calculation is done at the gNB side.

FL: It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (DOCOMO, [R1-2105699](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105699.doc) [15]) Observation 1: Regarding mitigating UE Tx timing errors for UL-TDOA, the mitigation enhancements should be introduced for UL positioning using SRS resources for MIMO

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 4 The UE TX TEG association of UL SRS transmissions should be sent by the UE to the gNB and then forwarded to the LMF.

FL: It is related to one of the FFS in the previous agreement. Suggest further discussion (Proposal 3.2-1)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 5 The UE can be configured to send TX TEG association reports for all SRS types.

FL: Issues related to MIMO SRS were discussed in the previous meeting w/o a conclusion. Suggest further discussion (Proposal 3.2-2)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 6 The UE can be configured with a list of SRS resource sets for which UE TX TEG association reporting should be performed.

FL: The association of SRS resource sets and TX TEG should be determined by UE. It is unclear how and why the LMF/gNB to configure it Suggest further discussion (Proposal 3.2-6)

FL additional comments

In RAN1#104bis-e, there was an intensive discussion related to whether to support a UE to provide the association information of UL SRS resources for MIMO with Tx TEGs. In this meeting, it seems there are still quite different views on this issue. A number of companies (e.g., [1][4][5][8][19]) are supportive for UE to provide the association information of UL SRS resources for MIMO with Tx TEGs. However, some other companies propose not to support it (e.g., [6][7][8]). Suggest having a further discussion in this meeting.

For the remaining issue “Whether the association information is sent directly from UE to LMF, or is first provided to gNB and then forwarded to LMF”, it seems the majority of companies support UE to provide the association information directly to LMF (e.g., [2][4][6][11][12]), but there are some companies propose the association information is first provided to gNB and then forwarded to LMF (e.g., [7][19]).

In [3][11], it was proposed to support UE to provides LMF with the Tx timing errors per Tx TEG; In [3], it was proposed to support UE to provides LMF with the Tx timing error differences between Tx TEGs; and in [11], it was proposed TRP to provide TRP Rx timing errors associated with the RTOA measurements to the LMF.

 Proposal 3.2-1 (H)

* For mitigating UE Tx timing errors and/or TRP Rx timing errors for UL TDOA, support one of the following options:
	+ Option 1:
		- Subject to UE’s capability, support a UE to provide the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.
		- Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs
	+ Option 2:
		- Subject to UE’s capability, a UE should support providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.
		- Support the *serving* gNB to forward the association information provided by the UE to the LMF
		- Support LMF to forward the association information from the *serving* gNB for the UE to the neighboring gNBs
* UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support option 2 |
| OPPO | We prefer Option 2 since the SRS configuration/triggering are all controlled by gNB |
| Fraunhofer | The TEG information is needed at the LMF for UL-TDOA position estimation. For Option1: the motivation for supporting LMF to forward the association information is unclear, the LMF can provide the gNB with SRS configuration information.On Option2, the third subbullet why is should TEG information be helpful to determine an RTOA? |
| CATT | Support option 1. Option 1 is sample and introduce less signalling overhead. About the SRS configuration, maybe it can be informed to LMF by gNB. |
| vivo | Support option1.Firstly, in the current spec, direct UL capability interaction between UE and LMF already exists, and Tx TEG request/report can also use a similar way. Secondly, different with SRS configuration, the UE Tx TEG information is determined by the UE and there is no use for the serving gNB to obtain this information before other neighboring gNB. |
| Ericsson | We support Option 2. The serving gNB is controlling the SRS radio resources and should have access to all information that can be useful in controlling interference. In a single gNB multi TRP scenario (e.g. in indoor IIOT), this reduces the latency and amount of NRPPa signalling. We also note, that if the information is sent ‘directly’ to the LMF over LPP it’s of course still passing the serving gNB. The only difference is that the gNB doesn’t have access to the LPP message content. |
| Huawei, HiSilicon | We do not see the need to expose TEG info to the non-serving gNB, and from gNB measurement perspective, the UL RTOA measurement can be associated with the SRS resource set/SRS resource/SRS port, and LMF may further link the results with TEG reported from the UE.In addition, we would like to emphasize that in order the complete the loop of associating UE Rx TEG with RTOA measurement, there should be a crucial procedure to allow the measuring gNB to provide the RTOA measurement with* Option 1: SRS resource set ID, and/or SRS resource ID, and/or SRS port ID (if supported)
	+ LMF will link the RTOA measurement with the UE Tx TEG information based on the IDs
* Option 2: UE Tx TEG ID
	+ Note: This Option would require LMF to provide the UE Tx TEG ID to the measuring gNB along with the SRS configuration

Our following proposal is trying to resolve this issue, not necessarily associated with MIMO SRS used for TEG reporting, and it should also be applicable for positioning SRS, in which case the port ID reporting is not necessary.* Proposal 2: Support gNB to report the associated SRS resource ID and port ID of the RTOA measurement.
 |
| Qualcomm | Option 1. Support a single solution for both UTDOA and RTT. LPP is the right protocol to do so.  |
| Apple | Support Option 1, given that positioning estimation is anyway done by LMF |
| Nokia/NSB | We support Option 2 without the third subbullet. We have the same understanding as Huawei that this information is not useful at neighboring gNB.  |
| SONY | Support Option 1 |
| CMCC | Support Option 1, and for the 2nd bullet, we think that there is no need for the LMF to forward this association information to serving and neighboring gNBs. The gNBs will report the RTOA measurements associated with UL SRS resources (sets) to the LMF, which can have the complete information about the relationship with measurements/resources (sets) and TEGs. |
| Samsung  | Option 1 is preferred.Indeed the signalling will be transferred from serving gnb anyway, the difference is the serving gnb is allowed to decoded it or not. If the calculation is done at LMF, it seems not necessary, but if it is done at gNB side, it could be helpful. Considering mostly there could be multiple RSTD measurement to form the final results, we see the option1 may be more likely to happen. |
| LG | Support Option 1. |
| InterDigital | Support Option 1 since it is simpler and less signalling overhead then Option 2. |
| vivo | To Huawei, we support for providing TEG info to the non-serving gNB is based on the following consideration: to obtain the RTOA measurements of a SRS resource, the gNB may derive SRS measurements from multiple SRS occasions/instances for joint processing (e.g. averaging). However, without the information of the UE Tx TEG(s), it is possible for the gNB to perform joint processing on multiple SRS occasions associated with different UE Tx TEGs, which will introduce unnecessary errors. |
| FL | Based on the feedback, it seems Option 1 may be supported with more companies (CATT, vivo, Qualcomm, Apple, Sony, CMCC, Samsung, LG, InterDigital), while Option 2 is also supported by multiple companies (ZTE, OPPO, Ericsson, Nokia/NSB). Obviously, both options will work. Suggest making the decision in online meeting. About providing the Tx TEG information from LMF to the serving gNBs (in Option 1) and to the neighboring gNBs (Option 1 and Option 2), there are different views. It seems this may not be a critical issue. Suggest adding “FFS” for the moment for further discussion.In addition, it was proposed that gNB should report associated SRS resource ID with the RTOA measurement, which was proposed by both vivo [2] and Huawei. Based on the discussion, the suggesrion is to revise the proposal as forllows: Proposal 3.2-1 (H)* For mitigating UE Tx timing errors and/or TRP Rx timing errors for UL TDOA, support one of the following options:
	+ Option 1:
		- Subject to UE’s capability, support a UE to provide the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.
		- FFS: Support LMF to forward the association information provided by the UE to the serving and neighboring gNBs
	+ Option 2:
		- Subject to UE’s capability, a UE should support providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.
		- Support the *serving* gNB to forward the association information provided by the UE to the LMF
		- FFS: Support LMF to forward the association information from the *serving* gNB for the UE to the neighboring gNBs
* UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling
* Support gNB to report the associated SRS resource ID of the RTOA measurement to LMF
 |
| Intel | Support option 1 |
| Nokia/NSB | Suggest the following revision: * For mitigating UE Tx timing errors and/or TRP Rx timing errors for UL TDOA, support one of the following options:
	+ Option 1:
		- Subject to UE’s capability, support a UE to provide the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE has multiple Tx TEGs.
	+ Option 2:
		- Subject to UE’s capability, a UE should support providing the association information of UL SRS resources for positioning with Tx TEGs to the *serving* gNB if the UE has multiple Tx TEGs.
		- Support the *serving* gNB to forward the association information provided by the UE to the LMF
* FFS: Benefit and need of LMF forwarding the association information to the neighboring gNBs
* UE should be able to report capability information related to Tx TEGs to LMF via LPP signaling
* Support gNB to report the associated SRS resource ID of the RTOA measurement to LMF
 |
| vivo | We prefer the version of FL based on our previous reply.For the benefit of the FFS, we think it is beneficial for the neighboring gNBs to derive SRS measurements from multiple SRS occasions/instances for joint processing. For example, the neighboring gNBs may average SRS measurements from 4 sample measurements, but if the TEG is changed for some SRS resource at the second sample, the neighboring gNBs may need to know and filter from the second sample. |

FL Comments

Proposal 3.2-1 is revised as follows based on the comments.

### Proposal 3.2-1(Revision 1) (Closed)

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

FL Comments

The following agreement was made in online session. We will continue the discussion on which of the options will be adopted in the next meeting.

Agreement:

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

### Proposal 3.2-2 (H)

* Subject to UE’s capability, support a UE to provide the association information of Tx TEGs with UL SRS resources for MIMO and port IDs to the LMF for UL-TDOA if the UE has multiple Tx TEGs.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE  | Considering the association between Tx TEG and SRS port/SRS resource/SRS resource set, we suggest to modify the main bullet and add a FFS:* Subject to UE’s capability, support a UE to provide the association information of Tx TEGs with UL SRS resources or SRS resource sets for MIMO and port IDs to the LMF for UL-TDOA if the UE has multiple Tx TEGs.
* FFS: Whether Tx TEG is associated with SRS resource, SRS resource set or SRS port.
 |
| OPPO | Not support. In Rel-16, it is transparent to UE whether MIMO SRS is used for positioning purpose or not. This proposal will break Rel-16 principle of transparency.  |
| Fraunhofer | Ok with the proposal with following changes: * Subject to UE’s capability, support a UE to provide the association information of the Tx TEGs transmited over multiple ports with UL SRS resources for MIMO ~~and port IDs~~ to the LMF for UL-TDOA ~~if the UE has multiple Tx TEGs~~.
 |
| vivo | According to Huawei’s Tdoc, the relationship between Tx TEG and SRS seems different for different usages. For example, the beam usage is associated with the SRS set, and the non-codebook usage is associated with the SRS resource. But it doesn’t reflect in this proposal.We propose to first discuss whether extending Tx TEG to SRS for MIMO . If agreed, the association information of Tx TEGs with which SRS can be discussed. |
| Ericsson | Support the proposal. UL SRS resources are scarce. The possibility of re-using the same UL SRS resources for multiple purposes is very important. |
| Huawei, HiSilicon | Support. We would like to emphysize the Note 3 in our paper to address OPPO’s concern.* + Note 3: Associating MIMO SRS with TEG in Rel-17 does not affect/restrict UE implementation of MIMO SRS transmission, i.e., legacy UE implementation of MIMO SRS can be inherited
 |
| Qualcomm | Not support. SRS for MIMO is not intended for Positioning. Reusing it for UL-TDOA is supposed to be a transparent/backward-compatible feature. Enhancements should be targeted for SRS for Positioning.  |
| Apple | Do not support. We share similar view as OPPO and Qualcomm. Using MIMO SRS for positioning is not transparent to UE in currents specification. Besides, PosSRS is designed and specified for this purpose. No need to specify TEG for MIMO SRS where the use-case, and pros/cons are not well studied.  |
| SONY | Similar view as QC. As of now, SRS for MIMO is not designed for positioning. |
| ZTE2 | MIMO SRS can already be used in the current spec in UL-TDOA and UL-AoA, if Tx TEG can be associated with pos SRS, it is reasonable to associate Tx TEG with MIMO SRS for consistency. Maybe this requires another UE capability. |
| Samsung  | Not support. As vivo suggests, we can first discuss whether to enhance MIMO SRS in this release.  |
| InterDigital | Support the proposal.  |
| NTT DOCOMO | Support. We think it's better not to restrict the feature to SRS for positioning, since Rel-16 already supports positioning using SRS for MIMO. |
| FL | It seems multiple companies (OPPO, QC, Apple, SONY, Samsung) have the concern that the proposal will break the rule that the use of MIMO SRS for positioning is transparent to UE. Suggest further discussion to see if the concerns of these companies can be addressed.   |
|  |  |

### Proposal 3.2-3

* The UE can be requested to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF, including positioning accuracy requirement information in the Tx TEG request.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | What does “positioning accuracy requirement information in the Tx TEG request” refer to? Is it related to the current discussion?  |
| vivo | Support |
| Qualcomm | Clearly there is going to be a request to the UE, otherwise why would the UE start reporting it? Is this proposal about the “positioning accuracy requirement”?  |
| Nokia/NSB | What does this proposal bring over proposal 3.2-1? |
| SONY | FFS. The purpose of positioning accuracy requirement information is unclear. |
| ZTE | Do not support. Supporting TEG is a UE capability. If UE has the capability, UE can always report Tx TEG information rather than being requested. |
| LG | Before discuss it, could you gie us the motivation of the proposal.  |
| InterDigital | Support |
| vivo2 | First, we can agree with the first half of the proposal and FFS with other part* The UE can be requested to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF.
	+ FFS the signaling including positioning accuracy requirement information.

The further explanation of FFS in the proposal is as follows:Firstly, we believe UE Tx TEG information only works when high-precision positioning is required. Therefore, when the accuracy requirement is low, the UE does not need to provide this information; when the accuracy requirement is high, the LMF can request the UE to provide Tx TEG information.Secondly, providing accuracy requirements can assist UE grouping Tx TEG. For example, when the accuracy requirement is strict, UE can provide finer TEG grouping; when the accuracy requirement is not so strict, UE only needs to provide rough TEG grouping |
| ZTE | Towards vivo’s view, we think it is RAN2’s work to determine when the LMF requires Tx TEG report. |
| FL | My understanding is that “UE can be requested to provide the association information of SRS resources for positioning with UE Tx TEG(s) to LMF” is already supported based on the previous agreement. The motivation of “the signaling including positioning accuracy requirement information” is unclear to most of the companies, for which vivo has provided some explanation. Suggest continuing the discussion to see if there can be more supporters for including positioning accuracy requirements in the request. |

### Proposal 3.2-4

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support FL’s proposal |
| OPPO | Is it a counterpart of Proposal 3.1-3 for UL-TDOA? If so, “different UE Tx TEGs from a UE” should be “different Rx TEGs”. |
| vivo | Support |
| Nokia/NSB | Unclear what this means. The gNB doesn’t have or need UE Tx TEG information for RTOA measurements in our view.  |
| SONY | We do not suppot because it is still unclear how does gNB know the association information between the RTOA measurement and UE Tx TEGs. |
| LG | Support. |
| FL | To OPPO’s comments:The intention of the proposal is for a gNB to measure the SRS resources with different UE Tx TEGs from a UE. The gNB may use one Rx TEG. To Nokia’s comments:I assume the intention of the proposal is for the estimation of the time difference of the UE Tx TEGs based on measuring the SRS resources with different UE Tx TEGs from a UE.  |
| Ericsson | Support |
| CATT | Support.We think this proposal just try to let a gNB measures and reports the SRS resources with different UE Tx TEGs can help LMF estimates and eliminate the time difference of the UE Tx TEGs. |

### Proposal 3.2-5 (suggested to be closed)

* For UL-TDOA positioning, support
	+ UE provides LMF with the Tx timing errors per Tx TEG
	+ UE provides LMF with the Tx timing error differences between Tx TEGs
	+ TRP to provide TRP Rx timing errors associated with the RTOA measurements to the LMF

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support. Similar comment as Proposal 3.1-6 |
| CATT | In our point of view, if UE compensate the Tx timing errors, it means UE have to adjust the timing of transmission of SRS-Pos, which may lead to some interference to other UL signals. |
| Nokia/NSB | Same comments as in proposal 3.1-6.  |
| SONY | Support sub-bullet 1. |
| ZTE | Do not support as we suggested in the last meeting |
| LG | Not support. We have the same view in proposal 3.1-6. |
| InterDigital | Support |
| FL | From the feedback, it seems none of the options has the support of the majority. Based on the feedback, the suggestion is to close the discussion in this meeting with “a consensus cannot be reached for the proposed enhancement”.  |

FL Comments

Due to the lack of majority support, suggest closing the discussion with “*Consensus cannot be reached for the proposed enhancement*”.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |

Proposal 3.2-6

* For UL TDOA, support the LMF to configure which Tx TEG(s) to use for transmission in one or more UL PRS resources.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support. How does LMF which Tx TEG is suitable for the a given SRS resources for positioning? The Tx beam is controlled by gNB |
| CATT | Support. We think this proposal just try to let LMF to recommend the proper Tx TEGs to UE for the transmission of SRS-Pos, in order to facilitate the mitigation of the timing error. |
| SONY | Do not support |
| ZTE | Support FL’s proposal. The reason is, if Tx TEG can be indicated to UE, UE will need no Tx TEG report, which requires much less spec impact. We are not sure the Tx TEG should be configured by LMF or serving gNB, so maybe we can change the proposal like this:* For UL TDOA, support UE to receive the configuration that which Tx TEG(s) to use for transmission in one or more UL ~~PRS~~SRS resources.
* FFS: whether the configuration comes from LMF or serving gNB.
 |
| LG | It seems that some clarifications are needed. Actually, we think that the recommendation from LMF is okay for gNB. But, the subject of decision must be a gNB. |
| InterDigital | Support for the similar reason as Proposal 3.1-5. |
| FL | Based on the feedback, it seems the majority of the feedbacks are supportive of the proposal. To address LG’s comment, we may change “support the LMF to configure” to “support the LMF to recommend”. The proposal is revised based on ZTE and LG’s comments. |

### Proposal 3.2-6 (Revision 1)

* For UL TDOA, support the LMF to recommend which Tx TEG(s) to use for transmission in one or more UL SRS resources.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | 2 questions:1. If we use the word ‘recommend’, it means UE can adopt the Tx TEG, or the UE can also use another Tx TEG and report. From UE side, it is purely UE’s choice to determine Tx TEG, that is to say, it is UE’s implementation, UE do nothing towards the recommendation. If this is the case, then what is the usage of ‘recommend’ for a UE?
2. We still think gNB can also play a role on indicating SRSs with Tx TEGs, not only LMF.
 |
| Ericsson | We are supportive of the UE receiving a Tx TEG configuration to use for transmission of UL SRS. But further discussion is needed on whether it is the gNB or LMF that provides this information to the UE. Hence, we suggest to revised the proposal as follows:* For UL TDOA, support the UE ~~LMF to recommend~~ to receive which Tx TEG(s) to use for transmission in one or more UL SRS resources.
* FFS: Whether Tx TEG(s) are configured by serving gNB or LMF
 |
| OPPO | Not support. How does LMF which Tx TEG is suitable for the a given SRS resources for positioning? The Tx beam is controlled by gNB |
| CATT | Support. The changes in the above Revision 1 proposal are fine for us, since SRS-Pos is scheduled by gNB and LMF should recommend the proper Tx TEGs for the transmission of SRS-Pos. |
| SONY | Do not support. It is still unclear what is the benefit of this proposal. To our understanding, the TEG doesn’t reflect the quality of the propagation channel. Timing error only reflect the property of the RF chains.  |

## UE/gNB Rx/Tx timing errors in DL+UL positioning

Background

The following agreements were made in RAN1#104e and RAN1#104bis-e, related to the option(s) for mitigating UE Rx/Tx timing errors in DL+UL positioning. In this meeting, there is a need to decide which alternative (option) should be supported.

|  |
| --- |
| 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 the 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 alterntives, 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 the 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
 |

Submitted Proposals and FL comments

* (Huawei [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc)[1]) Proposal 3: Support
	+ A UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF.
	+ 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.

FL:Related to the remaining issues in previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2, 3.3-3)

* (Huawei [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc)[1]) Proposal 4: Support reporting association of UE Rx – Tx time difference, UE RxTx TEG and UE Tx TEG in the multi-RTT measurement reporting.
	+ Note: this implies that a RxTx TEG is associated with multiple pairs of Rx TEG and Tx TEG, where the Rx TEG is not explicitly reported

FL:Related to the remaining issues in previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2, 3.3-3)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 11: Support UE to provide the association information of DL PRS resources to UE Rx TEG to LMF for UE RxTx measurements under capability.

FL:Related to the remaining issues in previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2, 3.3-3)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 12: Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG under capability.
	+ The UE RxTx TEG is associated with one or more {DL PRS resource, UL Positioning SRS resource} pairs

FL:Related to the remaining issues in previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 13: The SRS resource(s) in the most recent SRS instance in advance of the Rx-Tx time difference measurement can be used to derive RxTx TEG or Tx TEG in { Rx TEG, Tx TEG } pairs for Rx-Tx time difference measurements.

FL: Suggest further discussion (Proposals 3.3-4)

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 14: Support UE to provide Tx TEG information of SRS resources for positioning along with Rx-Tx time difference measurements via ‘NR-Multi-RTT-SignalMeasurementInformation’.

FL: Which IE to use can be discussed in RAN2.

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 15:
	+ Support 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.
	+ Support gNB to provide 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.

FL: Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 14: For DL+UL positioning methods, the following Alt.1 should be supported to help LMF eliminate the influence of timing error of UE:
	+ 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.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 15: For DL+UL positioning methods, the following Alt.1 should be supported to help LMF eliminate the influence of timing error of TRPs:
	+ 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.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (ZTE, [R1-2104590](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104590.doc)[4]) Proposal 1: For DL+UL positioning, 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.
	+ Support an additional UE capability to indicate which {Rx TEG, Tx TEG} pairs are in a same RxTx TEG.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (CMCC, [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc)[5]) Proposal 4: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF:
	+ 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.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (CMCC, [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc)[5]) Proposal 5: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a TRP RxTx TEG to LMF, if the TRP has multiple RxTx TEG:
	+ 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.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 6: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, support Alt. 2
* A UE should be able to provide an association of each UE RxTx measurement to an RxTx TEG ID.
* Irrespective of Opt. 1 or Opt. 2, the association of RxTx-TEGs to {PRS ID, SRS ID} (Opt. 1), OR to {RxTEG ID, TxTEG ID} (Opt.2) should be optionally provided in addition to the RxTx-TEG IDs.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2, 3.3-3)

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 7: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, Rel-17 NR support Alt.1, i.e.,
	+ UE provides 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

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 8: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, Rel-17 NR support Alt.1, i.e.,
	+ gNB to provide the association information of a gNB Rx-Tx time difference measurement with a pair of {Rx TEG, Tx TEG} to LMF

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 9: For TEG for DL+UL positioning, support Option 2 of Alt. 2 for both UE and gNB cases.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2, 3.3-3)

* (Intel, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[9]) Proposal 1: For mitigating UE/gNB RX/TX timing errors for the DL+UL positioning, support the following:
	+ Support a UE to provide the association information of a pair of {TX TEG ID, RX TEG ID} with a UE Rx-Tx time difference measurement to LMF, where TX TEG ID is used to transmit the UL Positioning SRS and RX TEG ID is used to receive the DL PRS
	+ The UE may provide the association information of the UE TX TEG ID with the UL Positioning SRS resources to LMF, if the UE has multiple TX TEGs
		- Note: if association information of the TX TEG ID with the UL Positioning SRS resources is provided, then a UE may report the RX TEG ID only associated with the UE Rx-Tx time difference measurement

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Intel, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[9]) Proposal 2: For mitigating UE/gNB RX/TX timing errors for the DL+UL positioning, support the following:
	+ Support a gNB to provide the association information of a pair of {TX TEG ID, RX TEG ID} with a gNB Rx-Tx time difference measurement to LMF, where TX TEG ID is used to transmit the DL PRS and RX TEG ID is used to receive the UL Positioning SRS
	+ The gNB may provide the association information of the TRP TX TEG ID with the DL PRS resources to LMF, if the TRP has multiple TX TEGs
		- Note: if association information of the TX TEG ID with the DL PRS resources is provided, then a gNB may report the RX TEG ID only associated with the gNB Rx-Tx time difference measurement

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (Apple, [R1-2105105](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105105.doc)[10]) Proposal 5: For mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, “subject to UE capability” support the following
	+ the UE RxTx TEG is associated with the cumulative TEG for DL PRS resource Rx and UL Positioning SRS Tx
	+ the association information is sent from UE to LMF on LPP message
	+ UE is not expected to additionally provide the association information of DL PRS resources to UE Rx TEG for m-RTT technique

 FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Samsung, [R1-2105310](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105310.doc))[12]) Proposal 5: For Multi-RTT, UE provides the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG , which is associated with one or more DL PRS resource and UL Positioning SRS resource pairs.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Proposal 5: Support Alt. 2, Option 1 in the prior agreement on UE Rx-Tx time difference measurements.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Propsoal 6: Don’t support UE providing association of PRS resources and Rx TEG to LMF for UE Rx-Tx measurements.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Propsoal 7: Support Alt. 2, Option 1 in the prior agreement on gNB Rx-Tx time difference measurements.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (Nokia, [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc)[14]) Propsoal 8: Don’t support TRP reporting the association information of SRS resource to TRP Rx TEG for gNB Rx-Tx measurements.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-3)

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 2-1: Support option 2 of Alt. 2, which is
	+ 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 the one of the 2 following options:
		- 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.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-6: Support TRPs to report RX+TX group delay measurement to solve the inter-TRP transmission and receiving timing difference mathematically at the location server

FL:Discussed in previous meeting w/o conclusion. Suggest further discussion (Proposals 3.3-5)

* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-7: Support UE to report RX+TX group delay measurement for each pair of {RX TEG, TX TEG} to solve transmission timing difference between TX TEGs and receiving timing difference between RX TEGs mathematically at the location server.

FL: Suggest further discussion (Proposals 3.3-5)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 10 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. 1 in the agreement for mitigating UE/TRP Tx/Rx timing errors for DL+UL positioning, at RAN1#104bis\_e)

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 11 Support a UE RX TEG indication and an optional UE TX TEG indication in the UE RX-TX time difference measurement report. If the UE TX TEG indication is not present in the UE RX-TX time difference measurement report, the UE TX TEG is given through a one-to one relation by the UE RX TEG indication.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 12 Support a coupling between the UE RX-TX time difference measurement and an UL SRS transmission as given by an SRS ID and SRS occasion indication in the UE RX-TX time difference measurement report.

FL:Related to the remaining issues in the previous agreement. Suggest further discussion (Proposals 3.3-1, 3.3-2)

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 13 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: Suggest further discussion (Proposals 3.3-6)

FL additional comments

Based on the feedback, it seems there are diversed opinions on the alternatives (options) from the interested companies [1-19], which can be summarized in the following. In my view, all these alternatives (options) should work as discussed in [21]. In this meeting, we may need to decide which of them should be supported.

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

* 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;
	+ **Supported by:** *CATT, ZTE, OPPO, Intel, Ericsson*
* 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 the 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
		- **Supported by:** *vivo, Qualcomm, Apple, Samsung, Nokia*
		- FFS: whether UE provides the association information of DL PRS resources to UE Rx TEG to LMF for UE RxTx measurements specifically
			* **Supported by:** *vivo*
			* **Not Supported by:** *Apple, Nokia*

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.

* + - **Supported by:** *Huawei, CMCC, Qualcomm, InterDigital, MTK*

**For mitigating TRP Tx/Rx timing errors for DL+UL positioning:**

* 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
	+ - **Supported by:** *CATT, OPPO, Intel, Ericsson*
* 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 the 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
		- **Supported by:** *vivo, Qualcomm, Nokia*
		- 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
			* **Supported by:** *vivo*
			* **Not supported by:** *Nokia*
	+ 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.
		- **Supported by:** *Huawei, CMCC, Qualcomm, InterDigital*

In this meeting, it seems we will need to a further discussion before making the decision on which one to support. To make it easier to collect the opinions from the companies and online discussion, Proposal 3.3-1 lists the Alt1, Alt1 (OP1), and Alt.2 (OP2) as three separate options in parallel.

Proposal 3.3-1 (H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, adopt one of the following options:
	+ Option 1:
		- Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a pair of UE {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;

Supported by: ZTE, OPPO, CATT, Ericsson, SONY, LG(slightly support)

* + Option 2:
		- Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. 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 specificall
		- Supported by: Qualcomm, Apple, Nokia/NSB, Samsumg (preferred)
	+ Option 3:
		- Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. The UE RxTx TEG is associated with one or more UE {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.
		- Supported by: vivo(with modification), Qualcomm, Apple, Huawei, HiSilicon, CMCC, InterDigital
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support option 1. Whether 2 pairs of {Rx TEG, Tx TEG} can be assumed in a same RxTx TEG requires UE capability. There are two cases:1. If UE can not calibrate the round trip delay, UE doesn’t know how to group x {Rx TEG, Tx TEG}pairs into y RxTx TEGs, so option 2 and option 3 can not work;
2. If UE has the calibration capability, UE can group x {Rx TEG, Tx TEG} pairs into y RxTx TEGs in advance, and report this information as UE capability. Then option 1 can still be adopted, LMF will know how to combine the measurement results according to the previous UE capability report.
 |
| OPPO | Ok to further discuss it. Option 1 is preferred. |
| CATT | Support option1. In our point of view, it will make the signalling for mitigating UE Rx/Tx timing errors more complicated and increase the overhead, if RxTx TEGs are introduced for DL+UL positioning methods. |
| vivo | Option 3 and with a small modification. We support UE to provide the association information of DL PRS resources to UE Rx TEG to LMF for UE RxTx measurements under capability. Considering UE providing Rx TEG information in option2 is still listed as FFS, so option3 is preferred.But UE Rx-Tx time difference measurement is DL measurement independent of actual SRS transmission. So we propose the Tx TEG is used to transmit in the timing of uplink subframe #j that is closest in time to the subframe #i received from the TP. Otherwise, if the current definition of Tx TEG is used, which SRS is selected also is a problem. And LMF also needs to replace the selected SRS for different receiving SRS in gNB Rx-Tx time difference. Note: from the definition of Rx-Tx time difference, the reference point for TUE-TX measurement shall be the Tx antenna/antenna connector of the UE. Therefore, the Tx TEG is associated with Tx antenna/antenna connector for TUE-TX measurement.So some modifications as follows * + Option 3:
		- Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. The UE RxTx TEG is associated with one or more UE {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~~ in the timing of uplink subframe #j that is closest in time to the subframe #i received from the TP.
 |
| Ericsson | We support Option 1.Having said that, we think it’s hard to agree on something here without seeing the whole concept. We note that a given TRP doesn’t listen to all SRSs transmitted by the UE. It’s therefore necessary to specify how the UE selects the SRS used for TX timing for a given UE RX-TX time difference measurement. This could be based either ona) An explicit coupling of each DL PRS to an UL SRS signalled in assistance datab) The spatial relation of the UL SRS towards a DL PRS or towards the SSB of the TRP from which the DL PRS is sent.Regarding RxTx TEG we have understood from the proponents that UE self calibration could make RX+TX timing error differences small so that a UE Rx-Tx measurement using antenna panel 1 for both RX and TX could be in the same RxTx timing error group as a UE Rx-Tx measurement using antenna panel 2 for both RX and TX. If this is so, to our understandiung we don’t need TEGs at all. All UE Rx-Tx time difference measurements will be in the same RxTx TEG. It would be good if the proponents could explain this point. |
| Qualcomm | Option 2 or 3. Option 1 is NOT enough for some scenarios. To E//: it is not true that a UE will ALWAYS have panels calibrated. Maybe it depends on the time distance of the measurements, their bands, etc. So, a UE, at a first instance may be able to quarantee that 2 panels have similar errors, and in another instance may not be able to quarantee that.  **Can the proponents of Option 1 please tell me how will the UE report that the following 2 Rx-Tx measurements have the same RxTx timing error?** * The UE cannot assign the 2 measurements the same TxTEG because the Tx Timing changed
* The UE cannot assign them 2 measuremens the same RxTEG because the Rx Timing drifted.

**So, how will the LMF know that the RxTx Errors are similar between those measurements if the RxTEG-IDs and TxTEG-IDs are different?**We don’t see any signaling complexity. It can just be an additional RxTxTEG-ID in the RTT report: NR-Multi-RTT-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL, nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-UE-RxTxTimeDiff-r16 CHOICE { k0-r16 INTEGER (0..1970049), k1-r16 INTEGER (0..985025), k2-r16 INTEGER (0..492513), k3-r16 INTEGER (0..246257), k4-r16 INTEGER (0..123129), k5-r16 INTEGER (0..61565), ... }, RxTxTEGID INTEGER (0..X) OPTIONAL, ...} |
| Apple | Support Option 2 and OK with Option 3 as well. |
| Nokia/NSB | We support option 2.  |
| SONY | We prefer option 1 |
| Huawei, HiSilicon | Although we support Option 3 in our contribution, we felt that both Option 1 and Option 2/3 can be supported subject to UE/network capability. For example, we can have the following ASN.1 structure.NR-Multi-RTT-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16 OPTIONAL, nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-UE-RxTxTimeDiff-r16 CHOICE { k0-r16 INTEGER (0..1970049), k1-r16 INTEGER (0..985025), k2-r16 INTEGER (0..492513), k3-r16 INTEGER (0..246257), k4-r16 INTEGER (0..123129), k5-r16 INTEGER (0..61565), ... }, ... [[ nrTEG-r17 CHOICE { RxTEGID-r17 INTEGER (0..X1-1), RxTxTEGID-r17 INTEGER (0..X2-1) } OPTIONAL ]]}BTW, we still think that TxTEG info should anyway be needed. |
| CMCC | We support Option 3 |
| Samsumg | Option 2 is preferred. |
| LG | We slightly support option 1. |
| InterDigital | We support support Option 3. In our view, RxTx TEG is not necessary the same as the Rx +Tx TEG. Providing RxTx TEG associated with Rx-Tx time difference can help the LMF to accurately get rid of the timing error at the UE side. |
| ZTE2 | To QC: Firstly, your example shows the TEG varies with time. However, we believe that TEG can be determined through the dimension of panel and frequency, not time. Timing error shift over time can be solved according to the definition of measurement instance. Secondly, regarding your question ‘**So, how will the LMF know that the RxTx Errors are similar between those measurements if the RxTEG-IDs and TxTEG-IDs are different?’**, we think UE can report its RX TEG, Tx TEG combinations to LMF as a UE capability in advance. So LMF will know which Tx TEGs and which Rx TEGs can be seen as a combination and has the same Rx+Tx timing error. |
| QC | To ZTE: Thanks for the reply. OK, so i can draw the corresponding issue with regards to “panel/antenna/RF-path” or “band” as shown below.In your reply above, * “UE can report its RX TEG, Tx TEG combinations to LMF as a UE capability in advance. So LMF will know **which Tx TEGs and which Rx TEGs** can be seen as a combination and has **the same Rx+Tx timing error**.”

you are effectively saying that **there will be RxTxTEGs** that are reported associated with {RxTEG, TxTEG}. Then why don’t you support Option 3? Option 3 says: the UE provides RxTxTEG association with {RxTEg, TxTEG}, which is what you are saying also above with your statement.  |
| FL | For vivo’s comment, I assume there is a need for the UE to provide Tx TEG information to the LMF, similar to the case of UL-TDOA. In this way, the LMF can link the Tx TEG in UE Rx-Tx time measurements with the gNB UE Rx-Tx time measurements where the information of the SRS resources are included.For Ericsson’s comment, I assume the UE may not be able to select the SRS used for TX timing for a given UE RX-TX time difference measurement, since the UE does not know which SRS will be received by the TRP. It could happen that there is a mismatch the UE indicates the UE Rx-Tx time measurement is associated with UE Tx TEG1 (e.g., with SRS resource ID 1) while the TRP receives SRS resource ID 2 which is associated the UE Tx TEG2. This issue may be alleviated but not resolved with the methods suggested by Ericsson, e.g., spatial relation of the UL SRS towards a DL PRS or towards the SSB of the TRP from which the DL PRS is sent in my view.For HW’s comments, I basically share the similar view that all these three options should work, as I also commented in the previous meeting [21].For the discussion of the issue related to the TEG changes with time (or the SRS transmitted in different times) as mentioned in vivo, Qualcomm, ZTE’s comments, I assume the issue can be addressed with the time stamps to the Tx TEG or other approaches, as discussed in Proposal 3.4-5.The following is a summary of the supporting companies for each of the options. I would suggest we resolve the issue in online session:* Option 1:
	+ Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a pair of UE {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;

**Supported by:** ZTE, OPPO, CATT, Ericsson, SONY, LG(slightly support)* Option 2:
	+ Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. 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

**Supported by:** Qualcomm, Apple, Nokia/NSB, Samsumg (preferred)* Option 3:
	+ Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. The UE RxTx TEG is associated with one or more UE {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.

**Supported by:** vivo(with modification), Qualcomm, Apple, Huawei, HiSilicon, CMCC, InterDigital |
| QC | To FL and this comment: “For the discussion of the issue related to the TEG changes with time (or the SRS transmitted in different times) as mentioned in vivo, Qualcomm, ZTE’s comments*, I assume the issue can be addressed with the time stamps* to the Tx TEG or other approaches, as discussed in Proposal 3.4-5.”The time-stamps are used to “differentiate” TEGs, not to report that 2 measurements have the same Rx+Tx error. In ZTE’s reply, they suggest that the UE will report capability of which {RxTEG, TxTEG} are mapped to the same Rx+Tx timing error. This is a solution within Option 3, and NOT option 1. How are the remaining companies supporting Option 1 addressing the issues that we present above?  |
| Intel | Option 1 |
| vivo | Sorry, I am also confused by the current description of” Tx TEG is used to transmit the UL Positioning SRS”, whether the description means we need to redefine the UE Rx – Tx time difference and like in proposal 2.2-1. |
| FL | To QC’s comments: My understanding for Option 1 is that there is still a need to indicate the group of {Rx TEG, Tx TEG} pairs that have the same RxTx timing errors, although it may not be necessary to attach an RxTx ID to each group.To vivo’s comment: The wording “the Tx TEG is used to transmit the UL Positioning SRS” is used in the agreement in the last meeting. Yes, we may need to consider the change of the UE Rx-Tx time measurement definition (Proposal 2.2-1), since the UE needs to know which Tx TEG is used for the measurement. |
| Huawei, HiSilicon | We think Option 3 can be worded by* + Option 3:
		- Support a UE subject to capability to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. The UE RxTx TEG is associated with one or more UE {Rx TEG, Tx TEG} pairs where the Rx TEG is used to determine the Rx time of the measurement and the Tx TEG is used to determine the Tx time of the measurement.

Since Option 3 does not particularly address Tx TEG reporting, which I believe is to be resolved by 3.3-2, we would be concerned if we only agree to Option 3 without agreeing 3.3-2 at the same time, because there would be problem as discussed in our paper.On the other hand, we consider Option 1 as a complete solution since at least Tx TEG is reported, so we can support the following modified Option 1.* + Option 1:
		- Support a UE to provide the association information of a UE Rx-Tx time difference measurement with a pair of UE {Rx TEG, Tx TEG} to LMF, where the Rx TEG is used to determine the Rx time of the measurement and the Tx TEG is used to determine the Tx time of the measurement.;
 |
| OPPO | One clarification question for Option 3: Is RxTx TEG always associated with Rx/Tx TEG, or optionally associated with Rx/Tx TEG? In other words, does it allow UE to only support RxTx TEG but not support Rx/Tx TEG for Option 3?  |
| vivo | We also have a question whether” the Tx TEG is used to determine the Tx time of the measurement” is equal to Tx TEG is associated with the current definition of TUE-TX  in UE Rx-Tx timing errorIf yes, can we modify it as follows* + Option 3:
		- Support a UE subject to capability to provide the association information of a UE Rx-Tx time difference measurement with a UE RxTx TEG to LMF. The UE RxTx TEG is associated with one or more UE {Rx TEG, Tx TEG} pairs where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG is associated with the Tx time of the measurement.
 |
| ZTE | Based on today’s GTW discussion, we think a compromised proposal is:* + Option 1:
		- For mitigating UE Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with one or more of UE RxTx TEG, Rx TEG or Tx TEG to LMF.
		- Note 1: the UE RxTx TEG is associated with one or more UE {Rx TEG, Tx TEG}pairs where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG is associated with the Tx time of the measurement.
		- Note 2: Whether RxTx TEG can be reported subject to UE capability.
 |
| FL | For OPPO’s comments, my understanding is that providing the UE {Rx TEG, Tx TEG} pairs can be optional. If the information is not provided, the LMF knows which UE Rx-Tx measurements are in the same UE RxTx TEGs, but the LMF may not have the information related the Rx TEG and Tx TEG, which can be potentially used for further improving the positioning accuracy.For the suggested modification from Huawei, vivo, ZTE, my thiking is that Rx/Tx TEGs do not termine the Rx/Tx time, but are related to the Rx/Tx time determined by the UE. Thus, use “associated with” may be better. |
| Ericsson | Regarding the following comment from FL summary:“*For Ericsson’s comment, I assume the UE may not be able to select the SRS used for TX timing for a given UE RX-TX time difference measurement, since the UE does not know which SRS will be received by the TRP. It could happen that there is a mismatch the UE indicates the UE Rx-Tx time measurement is associated with UE Tx TEG1 (e.g., with SRS resource ID 1) while the TRP receives SRS resource ID 2 which is associated the UE Tx TEG2. This issue may be alleviated but not resolved with the methods suggested by Ericsson, e.g., spatial relation of the UL SRS towards a DL PRS or towards the SSB of the TRP from which the DL PRS is sent in my view.*”Our point is that it would be important to avoid or minimize this mismatch. In the example that you provide, the UE indicates the UE Rx-Tx time measurement is associated with UE Tx TEG1 (e.g., with SRS resource ID 1) while the TRP receives SRS resource ID 2 which is associated the UE Tx TEG2. As different Tx TEGs are associated with the UE Rx-Tx time measurement and the gNB Rx-Tx time measurement, the LMF may not be able to combine these two measurements to derive RTT. So we think it is important to resolve this mismatch. Among the two approaches we provided above, we would be fine with either (a) or (b) below.a) An explicit coupling of each DL PRS to an UL SRS signalled in assistance datab) The spatial relation of the UL SRS towards a DL PRS or towards the SSB of the TRP from which the DL PRS is sent.If usin spatial relation based solution is an issue, how about we go with explicit coupling based solution? Would companies be ok to add signalling of explicit coupling of each DL PRS to an UL SRS in assistance data? If this concern is addressed, we can compromise and accept Option 3. Regarding Option 3, we prefer the modified Option 3 suggested by Huawei. |
| Qualcomm | What about the following?* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with one or more of UE RxTx TEG, Rx TEG or Tx TEG to LMF.
* Note 1: the UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG is associated with the Tx time of the measurement.
* Note 2: Whether any of RxTx TEG, Rx TEG, Tx TEG can be reported are subject to UE capability.
 |
| MTK | We would like to modify the QC’s proposal slightly:* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with one or more of UE RxTx TEG, Rx TEG or Tx TEG to LMF.
* Note 1: the UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs, or can be associated with one or more UE TX TEGs, where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG is associated with the Tx time of the measurement.
* Note 2: Whether any of RxTx TEG, Rx TEG, Tx TEG can be reported are subject to UE capability.

If a UE has the capability to perform RX+TX group delay measurement and compensate it, then the RX delay has been cancelled. The TX delay has been pre-included at the UE RX-TX time difference measurement report. The actualy TX delay happens for the gNB RX-TX time difference measurement, then after UE and gNB measurement combining, the UE TX delay term is cancelled. So we need TX TEG for pairing the UE and gNB measurement report for cancallation. The purpose of RXTX TEG is to indicate the achieved performance. Each RXTX TEG ID should also be associated with a error range, for example RXTX TEG ID = 0 is associated with 0.5ns error rangeFor on-the-fly RX+TX group delay measurement of UE, it may also rely on the device is external or internal. Basically, the measurement inside chip is easier to do. If the PA is external, for example. the effort would be larger. We can actually send LS to RAN4 for checking the feasibility..If a UE doesn't have the capability to perform RX+TX group delay measurement and compensate it, then, the RX delay is present in the UE RX-TX time difference measurement report. After combining with gNB RX-TX time difference measurement report, the error contributed by UE is the RX delay + TX delay. In our view, it can be associated with a RXTX TEG ID with larger error range. For example RXTX TEG ID = 1, which is associated with 15ns error range, since RF RX+TX delay are not compensated.If the supporters don't want RXTX TEG for the case without the capability to perform RX+TX group delay measurement, and want to use {RX TEG, TX TEG}, that is fine. But the question would be, how LMF can differentiate the UEs? Some UEs report {RX TEG, TX TEG}, and some UEs report {RXTX TEG, TX TEG}. In our view, UE may not perform RX TEG and TX TEG measurement (estimation) on-the-fly. We can just run circuit simulation to learn about the potential mean delay, and the variance of the delay due to temperature, frequency, and the fab process.One question to all companies and FL, can we say, if a UE report {RX TEG, TX TEG}, it means this UE doesn't have on-the-fly RX+TX group delay measurement capability? Because it requires to design some hardware, and design the preamble signal, to measure the delay from DAC to RF to ADC. And if a UE report RXTX TEG, it actually indicate to LMF that UE has the on-the-fly RX+TX group delay measurement capability. If we don't have clear understanding on the difference of reporting RXTX TEG, RX TEG and TX TEG, then LMF may just receive these stuff and ignore most of it |
| FL | Thanks for the interesting discussions.  Based on the comments from Huawei, vivo, Ericsson (seems fine with Huawei’s modified OP3, Qualcomm and MTK, it seems the main issue is the clarification of Rx TEG and Tx TEG. About the wording of “the Rx TEG is used to determine the Rx time of the measurement” and “the Tx TEG is used to determine the Tx time of the measurement”, my thinking is that the UE may not know the values of the Rx/Tx timing errors, and thus not use Rx/Tx TEGs to determine Rx/Tx times. Using the wording “is associated with” might be better.  |

Proposal 3.3-1 (Revision 1) (H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with one or more of UE RxTx TEG, Rx TEG, or Tx TEG to LMF.
* Note 1: the UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs, or can be associated with one or more UE TX TEGs, where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG is associated with the Tx time of the measurement.
* Note 2: Whether any of RxTx TEG, Rx TEG, Tx TEG can be reported are subject to UE capability.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CMCC | Not sure if I fully understand MTK’s comment or not. It seems that for a UE with the capability to perform RX+TX group delay measurement and compensate it, the RX delay can be cancelled and therefore no Rx TEG reporting is needed. But when we taking about Rx/Tx TEGs, it can be some remaining errors after calibration, so I’m wondering why after UE performs Rx+Tx group delay measurement, the Rx delay can be completely deleted and no remaining error is considered? |
| ZTE | support |
| Ericsson | The issue that we raised in the previous round regarding the mismatch (i.e., when UE indicates the UE Rx-Tx time measurement is associated with UE Tx TEG1 (e.g., with SRS resource ID 1) while the TRP receives SRS resource ID 2 which is associated the UE Tx TEG2) remains unaddressed in the above proposal. Addressing the issue of how to avoid the mismatch is our condition to compromising to Option 3. We suggest to add the following subbullet to the above proposal:* for DL+UL positioning, an explicit coupling of each DL PRS to an UL SRS is signaled in the assistance data.
 |
| MTK |  To CMCC:If UE has the capability to perform RX+TX group delay measurement, then the remaining error would be ΔtTX\_ue\_panelA + ΔtRX\_ue\_panelA – ($∆\hat{t}\_{RX\\_ue\\_panelA}$ + $∆\hat{t}\_{TX\\_ue\\_panelA} )$, where the first two terms are the actual delays, and the last two terms are the estimated delays. In our view, the error range could be defined in RXTX TEG. For example, RXTX TEG ID = 0 is related to a UE with good self-calibration capability so that RXTX TEG ID = 0 is associated to (remaining) error range <= 0.5ns. This is what UE claim its capability, and it can be verified by RAN4 test or any in-house testTX TEG is used for pairing UE RX-TX time measurement and gNB RX-TX time measurement in order to cancel the unwanted terms |
| Sony | Support |
| vivo | Some clarifications may be needed.1. For the first bullet, regarding the description of ‘one or more of UE RxTx TEG, Rx TEG, or Tx TEG to LMF’, it seems that there are many combinations/understandings of TEGs for a UE Rx-Tx time difference measurement:* UE provides RxTx TEG separately.
* UE provides Rx TEG separately. We wonder in which case UE only provide Rx TEG to LMF?
* UE provides Tx TEG separately. Is this the case that UE compensating ‘Rx+Tx group delay’?
* UE provide {Rx TEG, Tx TEG}.
* UE provide {RxTx TEG, Tx TEG}, or {RxTx TEG, Rx TEG}, or { RxTx TEG, Rx TEG, Tx TEG}. It is observed in Note1, the UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG} pairs, should we assume these combinations are excluded?

2. For Note1, regarding the description of ‘or can be associated with one or more UE TX TEGs’, does it duplicate with the description of Tx TEG in the first bullet?In addition, since we also have a concern whether” the Tx TEG is used to determine the Tx time of the measurement” is equal to Tx TEG is associated with the current definition of TUE-TX  in UE Rx-Tx timing error, could we add a note as followingNote 3: This does not imply that the definition of UE Rx-Tx time difference measurement needs to be modified.  |
| Nokia/NSB | Our understanding of the agreement from RAN1#104-b was that we will either have a UE RxTx TEG or we will have pairs of UE Rx TEG, UE Tx TEG. I guess we want to support both options in order to progress? That does not seem captured in the current proposal wording which seems to say a UE can report just a Rx TEG or just a Tx TEG as options but those are not good options in our view. So we feel this needs clarification.  |
| Intel | We support for mitigating UE Tx/Rx timing errors for DL+UL positioning, support a UE to provide the association information of a UE Rx-Tx time difference measurement with one or more of UE RxTx TEG to LMF. RxTx TEG is associated with a pair of UE (Rx TEG, Tx TEG). |
| FL | For Ericsson’s comments on the potential mispatching of Tx TEGs in UE and gNB Rx-Tx measurements, we may consider adding an FFS for further investigation.For vivo’s comments on the potential impact of definition of UE Rx-Tx time difference measurement, we may also consider the impact once we have the agreement on the structure for reporting the RxTx TEGs.From vivo’s and Nokia’s comments on the main bullet, it seems the confusion comes from including (Rx, Tx) TEGs in the main bullet. The proposal is revised as following by removing the (Rx, Tx) TEGs from the main bullet.  |
|  |  |

Proposal 3.3-1 (Revision 2) (H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, subject to UE’s capability a UE should support providing the association information of a UE Rx-Tx time difference measurement with one UE RxTx TEG to LMF.
* The UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs, where the Rx TEG is associated with the Rx time of the measurement and the Tx TEG ID is the is associated with the Tx time of the measurement.
* FFS: Whether the Rx TEG, Tx TEG, or both Rx and Tx TEGs need to be reported
* 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: potential impact on the definition of the UE/gNB Rx-Tx time difference measurement

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| vivo | Some clarifications may be needed.1. Whether the second bullet is the sub-bullet of the first bullet？
2. Whether the meaning of “UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs” is equal to report the mapping table of UE RxTx TEG and{Rx TEG, Tx TEG}pairs to LMF?
3. Why the proposal will impact the definition of the UE/gNB Rx-Tx time difference measurement? That is, is there any problem with the existing definition supporting this proposal?
 |
| FL | To vivo:* Yes. The second bullet can be the sub-bullet of the first bullet？
* To me, “UE RxTx TEG can be associated with one or more UE {Rx TEG, Tx TEG}pairs” is equal to report the mapping table of UE RxTx TEG ID and{Rx TEG ID, Tx TEG ID}pairs to LMF.
* vivo suggested to add “Note 3: This does not imply that the definition of UE Rx-Tx time difference measurement needs to be modified.” At this moment, I assume there is a need to first discuss it, before we conclude no impact. That is why “FFS” is added.
 |
| CATT | Support. Although we support Option 1 in original Proposal 3.3-1, we can compromise to accept this proposal. |
| Ericsson | As this proposal is related to Proposal 3.3-1b, we assume this proposal will also be discssed in the next RAN1 meeting. |
| Intel | Support in principle, Before agreeing we would like to clarify the case for asscociation of RxTx TEG ID with **more than one** UE {Rx TEG, Tx TEG}pairs. |

FL Comments

During the online discussion, it seems we need to consider the issues indicted as “FFS” together, namely which of the Rx TEG, Tx TEG, or both Rx and Tx TEGs need to be reported, how to match Rx TEG with Tx TEG in UE and gNB Rx-Tx time difference measurements, how to define the Tx time of the Rx-Tx time difference, etc.

1. **The relations of the DL PRS, Rx TEG and Rx time of Rx-Tx measurement**

It seems the common understanding is that Rx time of Rx-Tx measurement is obtained from the DL PRS resources. For the association of the Rx TEG with the DL PRS resources, it can be provided with explicitly or implicitly. The implicit approach by simply adding Rx TEG ID with the Rx-Tx measurements. In this case, the Rx TEG ID is associated with DL PRSs that is already included in the Rx-Tx measurements. The explicit approach uses a separate report of the association of RxTEG with the DL PRS resources.

1. **The relations of the UL SRS, Tx TEG and Tx time of Rx-Tx measurement**

There seem different considerations on how they are connected:

* + 1. **Approach 1:** UL SRS, Tx TEG and Tx time of Rx-Tx measurement are all connected. For example, the Tx time of Rx-Tx measurement is determined by the Tx time of the UL SRS resources, and the UL SRS resources are associated with Tx TEG.
		2. **Approach 2**. UE can provide a separate report of the association of the Tx TEG with the UL SRS resources. But, the Tx time of Rx-Tx measurement is determined by the nearest UL subframe (as Rel-16 definition), but not by UL Tx time of the UL SRS resources.

For Approach 1, when the UE provides the UE Rx-Tx time difference measurement, it needs to decide which SRS resources is used as UL Tx reference. It may also have the matching issue, since the UE does not know which SRS sources that the gNB is going to receive. E.g., if a UE uses a SRS resource to determine Tx time for Rx-Tx time difference measurement, but gNB does not receive the SRS resource.

For Approach 2, since the UE determines the UL Tx based on the nearest UL subframe, there is no need to consider which SRS resource is used to derive the Tx time of UE Rx-Tx measurement, and no need to worry which SRS resources are received by the gNB.

1. **The relations of the Rx TEG, Tx TEG and RxTx TEG**

Assume the UE provides the association of UE RxTx TEG ID with one or more UE {Rx TEG ID, Tx TEG ID} pairs. With the information available LMF will know which UE Rx-Tx measurements and gNB Rx-Tx measurements are associated with the same UE RxTx TEG ID, or different UE RxTx TEG IDs based on the mapping of {Rx TEG ID, Tx TEG ID} pairs to UE RxTx TEG ID.

In summary, it seems the following procedure (actually a combination of Option 1 and Option 3) may resolve the three “FFS” issues of the Proposal 3.3-1 (Revision 2) (H):

* + UE determines the UE Rx-Tx time difference measurements as defined in Rel-16 (no impact on the definition)
	+ UE reports the association information of a UE Rx TEG (ID) with DL PRS resources implicitly by including the UE Rx TEG ID in the UE Rx-Tx time difference measurements (similar to DL-TDOA)
	+ UE provides the association information of UL Tx TEG (ID) with UL SRS resources in a separate IE (similar to UL-TDOA)
	+ UE provides the mapping of UE {Rx TEG ID, Tx TEG ID} pairs to UE RxTx TEG IDs. LMF determines which UE Rx-Tx measurements have the same Rx+Tx timing errors based on the mapping information (resolving the mismatch problem)

Proposal 3.3-1b (H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, subject to UE’s capability a UE should support:
	+ in each UE Rx-Tx time difference measurement reporting an Rx TEG ID that is associated with the DL PRSs that are used to determine the Rx time of the measurement;
	+ providing the association information of UE Tx TEG(s) with all UL Positioning SRS resources in the UE Rx-Tx time difference measurement report
		- Note: The association information does not assume which UL Positioning SRS resources will be received by TRPs.
	+ providing the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs.
		- Note: The {Rx TEG ID, Tx TEG ID} pairs maps to the same UE RxTx TEG ID have the same Rx+Tx timing error margin.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Just would like to check the understanding of the comments from the FLThe implicit approach by simply adding Rx TEG ID with the Rx-Tx measurements. In this case, the Rx TEG ID is associated with DL PRSs that is already included in the Rx-Tx measurements. The explicit approach uses a separate report of the association of RxTEG with the DL PRS resources.I wonder why do we need to consider the so-called “explicit approach”? I would rather interpret “explicit” means that UE reports the Rx TEG in the RTT report, and “implicit” means that UE reports the RxTx TEG in the RTT report without reporting any Rx TEG ID at all.FL: Okay. It might be better to say there is three ways to provide the Rx TEG information to LMF: 1. Rx TEG ID is included in Rx-Tx measurements;
2. Separate report of the association of RxTEG with the DL PRS resources
3. UE does not report Rx TEG ID
	* I assume in this case, UE needs to associate Tx TEG (or SRS resource ID) with the Rx-Tx measurements, then LMF may derive the Rx TEG associated with Rx-Tx measurements from the mapping of RxTx TEG to {Tx TEG, Rx TEG} and the Tx TEG (or the association of the SRS resource IDs with Tx TEG)
		1. **Approach 2**. UE can provide a separate report of the association of the Tx TEG with the UL SRS resources. But, the Tx time of Rx-Tx measurement is determined by the nearest UL subframe (as Rel-16 definition), but not by UL Tx time of the UL SRS resources.

My understanding is that even in Rel-16, UE may still predict the (virtual) UL subframe boundary (by offsetting a couple of ms) based on subframe boundary corresponding to the actual SRS transmission. The “closest in time” in 215 is used to restrict UE Rx – Tx time difference measurement to [-0.5ms, 0.5ms] while in reality the nearest actual UL subframe based on TDD configuration could be larger than 0.5ms away from the DL subframe that UE receives the PRS.Our understanding why 215 used UL subframe in general is a way of forward compatible so that in case UE Rx – Tx time difference measurement can also be measured through other RS (e.g. SSB/PRACH for Type 2 TA), there is no need to change the “core part” of the definition. This should be clear that UL subframe timing used for calculating the UE Rx – Tx time difference measurement for Multi-RTT positioning can and should only be determined by the positioning SRS, otherwise all the discussion to include/exclude MIMO SRS for RTT does not make much sense.FL: Yes, UE could use predict the (virtual) UL subframe boundary (by offsetting a couple of ms) based on subframe boundary corresponding to the actual SRS transmission if the UE can predict the potential time drafts from the time when the UE provides the UE Rx-Tx measurement to the time when the UE transmits the SRS. I assume UE UL subframe timing is the same for all UL RS, thus from UE point of view, it does not need to determine the Tx time in UE Rx-Tx measurement by the positioning SRS.Assume the UE provides the association of UE RxTx TEG ID with one or more UE {Rx TEG ID, Tx TEG ID} pairs.I am not sure whether this should be a valid assumption. However, to our understanding based on the discussion in the previous meetings and this meeting, I would consider either Rx TEG + Tx TEG or RxTx TEG + Tx TEG should be useful. The necessity of providing a full association table of RxTx ID with Rx TEG ID and Tx TEG ID is still in question.FL: If UE provides the association of UE RxTx TEG ID with {Rx TEG ID, Tx TEG ID} pairs, then with the information available LMF will know which UE Rx-Tx measurements and gNB Rx-Tx measurements are associated with the same UE RxTx TEG ID, or different UE RxTx TEG IDs based on the mapping of {Rx TEG ID, Tx TEG ID} pairs to UE RxTx TEG ID. Getting back to the proposal, my understanding of combining Option 1 and Option 3 is different from what the FL is proposing.FL: By combination, here I mean we take Option 1’s way for UE to report the Rx TEG associated with DL PRS (similar to DL-TDOA), Tx TEG information (also similar to UL-TDOA), and Option 3, the association of the UE RxTx TEG with UE {Rx TEG, Tx TEG} pairs. |
| OPPO | Some comments as below1. Regarding the “explicit” or “implicit” issue, we share the same feeling as Huawei FL: see my response to Huawei’s comment.2. With the second bullet, UE cannot report the Rx-Tx timing difference measurement report until it can determine the association information of UE Tx TEG(s) with all UL Positioning SRS resources. Not sure whether it is aligned with the intentionFL: The intention is to decouple the report the Rx-Tx timing difference measurement from the Tx TEG. UE derives Tx timing for the Rx-Tx timing difference measurement report based on the expected UL Tx time. The real UL Tx timing errors for UL trasnmissino of the SRS resource will be provided by the UE through Tx TEG information. In this way, LMF can determine the UL Tx timing errors based on the received SRS resource ID to avoid mismatching. 3. One question for clarification: Is “the mapping information of UE {Rx TEG ID, Tx TEG ID} to UE RxTx TEG IDs” fixed after the reporting, or can be updated via different reporting? FL: In my view, there is no need to include in every report if UE reports the measurement periodically. The UE needs to update the mapping information when it is needed. |
| MTK |  The wording of 3.3-1b doesn't say RXTX TEG ID needs to be included in UE RX-TX measurement report. Instead, RX TEG ID is included.FL: Yes. It needs to be included in the report, but it may not need to be in every report. The UE needs to update the mapping information when it is needed. Our understanding to contain RX TEG ID in the UE RX-TX measurement report may be used for differential RTT solution to cancel the UE RX group delay. If so, why not just TDOA?FL: The question is unclear to me. For DL-TDOA, we have agreed to include Rx TEG ID.Besides using differential RTT, we would appreciate that whether any company can provide the benefit of reporting RX TEG ID?If a UE has the capability to calibrate the RX+TX group delay and pre-compensate it, there is no need to report RX TEG ID. The remaining error is related to RX+TX, not respective RX and respective TX. Then for a UE having such capability, report RXTX TEG ID, and the ID should also be linked with an error range.FL: I think the concern is that RXTX TEG ID alone may not be good enough unless all Rx+Tx combinations are one RxTx TEG. For example, after calibration, we have RXTX TEG ID1 = { RX1+TX1}, { RX2+TX2}. A UE measures the UE Rx-Tx measurement with RX1, and assume UE reports RXTX TEG ID1. However, the TRP does not receive the SRS transmitted from TX1, but TX2. In this case, the reported RXTX TEG ID1 may no longer valid.LMF should pair a UE RX-TX report with a gNB RX-TX report in order to cancel unwanted terms (R1-2103600). Since during UE RX-TX measurement, UE doesn't actually transmit SRS, UE may indicate within the measurement report that the pre-compensation of RX+TX group delay is based on which TX TEG for SRS transmission for gNB RX-TX measurement. Then besides RXTX TEG ID, a TX TEG ID also needs to be included within the report. The main reason not to use SRS resources for pairing is because multiple SRS resources could be transmitted from a TX TEG under FR2, and during the UE RX-TX measurement, there is not actual SRS transmission.  LMF may pair a UE RX-TX report which indicate using which TX TEG for potential SRS transmission, with a gNB RX-TX report which indicate using which actual SRS receiving for measurement. The SRS resources association with any TX TEG could be provided outside the report to facilitate the pairing.Therefore we don't see the strong need that a RXTX TEG ID needs to be associated with any pair of {RX TEG ID, TX TEG ID}, when differential RTT is not applied. The association between RXTX TEG ID and TX TEG ID is quite needed.FL: Consider that RxTx timing error = Rx timing error + Tx timing error, why it woud be difficult for UE to provide the assocaitin of RXTX TEG ID with {RX TEG ID, TX TEG ID} if UE can provide the association between RXTX TEG ID and TX TEG ID?Based on the above, in our view, there are 3 potential reporting contents related to TEG IDs within a UE RX-TX report:* a RXTX TEG ID + a TX TEG ID, for a UE with self RX+TX calibration capability
* a RX TEG ID + a TX TEG ID, for a UE which may rely on differential RTT at LMF. (If so, why not just DL-TDOA+UL-TDOA?)
* a RXTX TEG ID + a RX TEG ID + a TX TEG ID. The supporters can explain what is the use case to mitigate group delay? For example, to consider a UE with self RX+TX calibration capability and also expect LMF to perform differential RTT?

 So we suggest the following wording:* For mitigating UE Tx/Rx timing errors for DL+UL positioning, subject to UE’s capability a UE should support:
	+ Report a UE RXTX TEG ID within a UE RX-TX measurement report
		- Report a associated UE TX TEG ID, or
		- Report a associated pair of {RX TEG ID, TX TEG ID}
* If RXTX TEG ID is not reported
	+ Report a pair of {RX TEG ID, TX TEG ID}

FL: The intention of Proposal 3.3-1b is to decouple Tx TEG ID with a particular UE Rx-Tx time measurement to avoid the case of mismatching, i.e., the UE indicates the UE Rx-Tx time measurement is assicated with a TX TEG ID, but the gNB only receives the SRS associated with other UE Tx TEGs. |
| vivo | We can support this proposal for the progress to report all the mapping informationRegarding Approach1 and Approach 2 related to the relations of the UL SRS, Tx TEG and Tx time of Rx-Tx measurement, we share the similar understanding with FL. We also tend not to change the R16 definition of ‘Tx time’ in Rx-Tx time difference measurement, considering the ‘Tx time’ is irrespective of SRS resource, so the UE can provide a separate report of the association of the Tx TEG with the UL SRS resources.In addition, in the proposal, we suggest that we should clarify that ‘UE determines the UE Rx-Tx time difference measurements as defined in Rel-16 (no impact on the definition)’, so an additional note may be needed.FL: I assume could add the clarification if we reach the same understanding after the discussion. |
| ZTE | It is an intensive discussion, it may not settle down which options we should finally take in this meeting(report RxTx TEG/Rx TEG /Tx TEG and/or their combinations). So base on the discussion in last GTW, we propose to make some changes on the proposal listed in Chairman note, which also incorporates MTK’s view above. Hope this proposal can be a compromised solution that can be acceptable to all companies.For mitigating UE Tx/Rx timing errors for DL+UL positioning, ~~subject to UE’s capability a~~ UE should support at least one of the following options:* Option 1: For mitigating UE Tx/Rx timing errors for DL+UL positioning, ~~subject to UE’s capability,~~ a UE may support providing the association information of a UE Rx-Tx time difference measurement with one UE RxTx TEG ID to LMF.
	+ FFS: whether the RxTx TEG ID can be associated with one or more {Rx TEG ID, Tx TEG ID} pairs, or can only be associated with one Tx TEG ID.
* Option 2: For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support providing the association information of a UE Rx-Tx time difference measurement with one Rx TEG ID and one Tx TEG ID to LMF.
* 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).
* Note 1: the Rx TEG ID is associated with the DL PRS corresponding to the Rx time of the measurement and the Tx TEG ID is associated with the UL SRS corresponding to the Tx time of the measurement
* Note 2: This does not imply any modification to the definition of the UE/gNB Rx-Tx time difference measurement
* Note 3: whether UE supports Option 1 or Option 2 is subject to UE capability

FL: ZTE’s suggestion to have multiple options may be one wayforrd if we cannot resolve the issue in this meeting. |

|  |  |
| --- | --- |
| Qualcomm | We agree with ZTE’s proposal to leave it up to the UE what to report, and seems also related to what MTK is suggesting on the different options. Also, the proposal from CATT or ZTE do not address that there are still different views on what the Tx TEG are associated with (an SRS resource or the Tx Timing used in the measurement). There is no time to resolve this now. We suggest the companies to regroup and finalize it next meeting. We think it’s a technicality that can be resolved later. *For mitigating UE Tx/Rx timing errors for DL+UL positioning, ~~subject to UE’s capability a~~ UE* ***may*** *support at least one of the following options:** *Option 1: Provide association of a UE Rx-Tx time difference measurement with one UE RxTx TEG ID to LMF.*
	+ *A UE may also provide association of the UE Rx-Tx time difference measurement to a {Rx TEG ID, Tx TEG ID} pair, or a Tx TEG ID.*
* *Option 2: Provide association of a UE Rx-Tx time difference measurement with a {Rx TEG ID, Tx TEG ID} pair to LMF.*
* *Whether UE supports Option 1 or Option 2 or both is subject to UE capability*
* *Note 1: The Rx TEG ID is associated with the DL PRS corresponding to the Rx time of the measurement*
* *Note 2: The Tx TEG ID is associated with (downselection needed)*
	+ *Alt. 1: an UL SRS resource corresponding to the Tx timing of the measurement*
	+ *Alt. 2: the Tx timing 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).*
 |
| Nokia/NSB | Generally okay with the revision from QC. One question for clarification: if a UE reports only RxTx TEG ID how should the LMF understand the relation between that RxTx TEG ID and the resources used for multi-RTT?  |
| Qualcomm  | Reply to Nokia: The LMF would only understand whether the measurements are “affected” by a same error or not. So, a LMF could do differential RTT (subtrack out the measurements to remove the common bias). The UE already supports PRS resource IDs. A UE may also report the (RxTEG, TxTEG) in this case also as Option 1 says. Either way, the feature of reporting allt his information will be optional; a UE would always be able to just report what is in rel-16.  |
| Ericsson | We are fine to keep both options on the table for now and discuss further on which option to support in the next meeting. |
| CATT | We support FL’s original proposal to solve the three FFS in Proposal 3.3-1 (Revision 2) (H). We prefer the Approach 2 in FL’s comments. And we support to keep the original definition of UE Rx-Tx time difference measurement, and the Tx time of UE Rx-Tx time difference is determined by the nearest UL subframe.About ZTE’s proposal containing two options, we think it is a compromised progress for this issue, if we cannot achieve final consensus in this meeting, we are also fine to keep both options in this meeting. Maybe we can down-select one opition in next meeting. |
| Intel | We are open to discuss both options suggested by Qualcomm in the modified proposal, the 2 Option is prefered for us. |
| FL | I would like to check with the group on the understanding of how the UL Tx time of the UE Rx-Tx time difference will be determined with the introduction of the Tx TEG. For simplicity, let us assume a UE will derive two UE Rx-Tx time difference measurements that have the same Rx time. Assume the UE will transmit SRS resources that belong to two Tx TEGs at the same UL subframe. The question is: will the UE determine the UL Tx times for two UE Rx-Tx time difference measurements with the consideration that the SRS resources are transmitted in different Tx TEGs? If yes, it may make sense to associate the UE Rx-Tx time difference with Tx TEG; on the other hand, if UE determines the UL Tx timings is based on the timing of the UL subframe without considering the SRS resources are transmitted in different Tx TEGs, then it seems that there is no need to associate UE Rx-Tx time differences with Tx TEG. Then, the Tx TEGs are associated with SRS resources but not with individual UE Rx-Tx time difference measurements. Any view on this? |
| Huawei | Regarding the question below:I would like to check with the group on the understanding of how the *UL Tx time* of the UE Rx-Tx time difference will be determined with the introduction of the Tx TEG. For simplicity, let us assume a UE will derive two UE Rx-Tx time difference measurements that have the same Rx time. Assume the UE will transmit SRS resources that belong to two Tx TEGs at the same UL subframe. The question is: will the UE determine the *UL Tx times* for two UE Rx-Tx time difference measurements with the consideration that the SRS resources are transmitted in different Tx TEGs? If yes, it may make sense to associate the UE Rx-Tx time difference with Tx TEG; on the other hand, if UE determines the *UL Tx timings* is based on the timing of the UL subframe without considering the SRS resources are transmitted in different Tx TEGs, then it seems that there is no need to associate UE Rx-Tx time differences with Tx TEG. Then, the Tx TEGs are associated with SRS resources but not with individual UE Rx-Tx time difference measurements. Any view on this?For this one, I assume that the Rx time corresponds to **the both RF Rx time (antenna connector) and BB Rx time (Baseband) for a single TRP** if the PRS is receive with the same Rx antenna?For this one, I am not sure if we assume that we are talking about the same BB time or the same RF time.* Case 1: BB time. Then the RF time could be different if the ***calibrated*** Tx chain group delay is different, which results in different UE Rx – Tx time difference measurements for different SRS resources and different SRS RF Tx time. The measurement then is resource-specific/TEG specific. There is necessity to report TEG ID for the measurement, and TEG association with SRS.
* Case 2: RF time (UE may do Tx group delay compensation). UE will only report a single UE Rx – Tx time difference because the measurement derived based on either SRS should be the same (Same Rx RF time and Same Tx RF time). Then the measurement is not necessarily associated with any SRS resource. There is no necessity to report TEG ID for the measurement, but there is need to report TEG association with SRS, so that SRS in the same TEG has a common post-compensation error (similar to UL-TDOA)

To us, the key issue is whether subframe boundary in the RF is aligned for different chains.Of course, to our understanding, this condition is not that typical for multi-RTT if UE can do Rx+Tx RTT group delay compensation. I do not think that I should overcomplicate the discussion here. |
| FL | To Huawei:Thanks for the discussion. In my example in previous email, the Rx time is the TUE-RX that the UE is used for calculating UE Rx – Tx time difference = TUE-RX –TUE-TX In my understanding, the TUE-RX and TUE-TX refer to RF Rx/Tx time (antenna). My interest is the TUE-TX(RF Tx time). What I am hoping for is that UE derives TUE-TX independent of the UE Tx REG/the SRS resources (Case 2 in Su’s email). If this is the case, we will have, as also stated in Su’s email,  “the measurement is not necessarily associated with any SRS resource. There is no necessity to report TEG ID for the measurement.” This will make the matching of the UE/gNB Rx – Tx time difference much easier. Also, UE can have the same UE Tx TEG association with SRS to support both Multi-RTT and UL-TDOA. Similarly, TRP can used the same TRP Tx TEG association with PRS to support both Multi-RTT and UL-TDOA. |
| MTK | Since in Rel-16, we have defined the reference point at RF,  then TUE-TX would be dependent on TX TEG, unless we change the reference point to BB. Again, UE measures at BB. UE needs to conduct RX+TX group delay measurement to learn the RX+TX RF group delay and compensate it so that the reporting could satisfy using reference point at RF. If we consider to move the reference point to BB, then the remaining error would be RX+TX group delay at both UE and TRP side. Relying on differential RTT is a solution to cancel UE side RX and TX group delay. If Rel-17 M-RTT for group delay mitigation is simply to rely on differential RTT which performs differential (cancellation) at LMF, we can simply do DL-TDOA+UL-TDOA. |
| Huawei | To FL,Based on the reply, let me complicate this to see if we can be further aligned.For UE supporting Rx+Tx RTT group delay calibration, it should be possible that the **Tx RF time of SRS transmitted through different Tx chains are different**. UE knows that they are different, but UE does not know the difference. Likewise for the Rx RF chains. However, UE knows the Rx group delay + Tx group delay for chain 1 and Rx delay delay + Tx group delay for chain 2.To MTK,I think the introduction of RxTx TEG is to facilitate differential Multi-RTT, which seems equivalent to DL-TDOA+UL-TDOA if RxTx TEG and tight coupling beween DL-PRS and UL-SRS are also supported DL-TDOA+UL-TDOA. However, I wonder whether the group delay error (instead of the group delay error difference) between Rx+Tx chains in the same RxTx TEG can be sufficiently small via calibration, so that the ranging benefit of RTT can be exploited rather than seeking differential methods. |
| FL | To MTK,Thanks for the discussion. Yes, I think we have the same understanding that the reference point is at RF time (Case 2 in Su’s email). But, I could not understand you view that TUE-TX is dependent on TX TEG. Go back to my question,  if two UE Rx – Tx time differences have the same TUE-RX, and two SRS resources of different Tx TEGs are transmitted in the same UL subframe, will UE provide two different UE Rx – Tx time difference measurements? If yes, how does UE provide the two UE Rx – Tx time difference measurements differently (just keep in mind that the Tx timing errors in the Tx TEGs are unknown). UE Rx – Tx time difference = TUE-RX –TUE-TX |
| MTK | In our view, we actually don't know TX timing error in each TX TEG, and RX timing error in each RX TEG. What UE can do is to design some signal with additional circuit to measure RX+TX group delay of each antenna/panel. We have done this in WiFi product. We also believe it could be more challenging for NR since the band combination is complicated so that RF part is complicated for the internal round-trip group delay measurement. But we also think, for IIOT scenario, if the band combination is simpler, it is still feasible for the internal measurement. Back to your question “how does UE provide the two UE Rx – Tx time difference measurements differently  “ . We think UE could report 2 different UE RX-TX measurements, the value of UE RX-TX time difference is different in the two reports, since UE already pre-compensate the RX+TX group delay to satisfy using reference point at RF. UE also needs to indicates in the report which TX TEG to consider for the “pre-compensation”. The “pre-compensation” actually is equivalent to include the estimate of RX+TX group delay. The purpose is to cancel the UE TX group delay which actually happens in gNB RX-TX measurement because UE DOES transmit SRS for gNB to measure. This needs to go back to the equation in my contribrion, but I feel that less companies seem to take a look. |
| vivo |  Thanks for the discussion. Sorry, we are confusing about the two cases from HuaweiWhether the two cases means that:1. BBtime: UE RX-TX timing difference=*t2-t1* 2. RF time: UE RX-TX timing difference=*t*2+*e*2-*(t*1*-e*1*)*From my aspect, I cannot sure the reporting UE RX-TX timing difference can include the Tx TEG error (that is *e*2). And then I cannot understand that “the measurement derived based on either SRS should be the same (Same Rx RF time and Same Tx RF time), Then the measurement is not necessarily associated with any SRS resource”. We think if reporting UE RX-TX timing difference is *t2-t1* , the result is independent of the Tx TEG and SRS. And the SRS Tx TEG will impact on the gNB RX-TX timing difference=*t3-t0*. So, come back to the one or more RxTx TEG(s) that are associated with UE RX-TX timing difference, we think RxTx TEG(s) is one Rx TEG combined with one or more assumed Tx TEG(s) which is also independent of the SRS. But if reporting UE RX-TX timing difference is *t*2+*e*2-(*t*1-*e*1*)*, we use one RxTx TEG error which is RX+TX group delay *e*2+*e*1 to calculate the UE RX-TX timing difference, then the UE RX-TX timing difference is dependent on the Tx chain, but also independent on SRS. We only need to transmit the Tx TEG with all the SRS, and LMF can match UE RX-TX timing difference and gNB RX-TX timing difference. |
| Huawei | To vivo:Just would like to confirm the understanding of the following issues before any detailed elaboration. First, usage of en: I am assuming based on the illustration, en is NOT TEG error, but rather the group delay estimate for compensation. One can argue that the UE may not do the calibration, but I do not think that it is case Ren mentioned in the example.Second, due to internal design, the same BB time and the same RF time may not be possible for two SRS transmitted in different Tx chains. So in the figure that you just drew, you may need to add another upright arrow and add a different horizontal blue line for the second Ant at the UE to match example Ren used earlier. Third, 215 defined UE Rx – Tx time difference with the reference point as the antenna connector at the UE. |
| vivo | To Huawei:Some replies as following, the previous figure may have some drawbacks but only used in the illustration. First, usage of en: I am assuming based on the illustration, en is NOT TEG error, but rather the group delay estimate for compensation. One can argue that the UE may not do the calibration, but I do not think that it is case Ren mentioned in the example.In our view, there is no difference for LMF using differential RTT regardless of the assumption of en is TEG error or the group delay estimate for compensation. Second, due to internal design, the same BB time and the same RF time may not be possible for two SRS transmitted in different Tx chains. So in the figure that you just drew, you may need to add another upright arrow and add a different horizontal blue line for the second Ant at the UE to match example Ren used earlier.I acknowledge the point that “the same BB time and the same RF time may not be possible for two SRS transmitted in different Tx chains”, so that it only means the UE RX-TX timing difference can only be combined with some gNB RX-TX timing difference(s) which correspond to the same Tx TEG to calculate RTT. Third, 215 defined UE Rx – Tx time difference with the reference point as the antenna connector at the UE.Yes, we respect the definition. But we believe the definition doesn’t consider this case since this definition wants to represent the Rx-Tx time difference under ideal conditions (antenna to antenna), but in practice, the Rx-Tx time difference is generally calculated from the baseband. |
| ZTE | Thanks for the nice discussions. Regarding FL's question below,* If two UE Rx – Tx time differences have the same TUE-RX, and two SRS resources of different Tx TEGs are transmitted in the same UL subframe, will UE provide two different UE Rx – Tx time difference measurements?

Our views are as follows:* If UE reports the Rx-Tx time difference measurement at BB side based on  two SRS resoueces associated with different Tx TEGs in the same UL subframe,  the two Rx-Tx time difference measurements are the same.
* If UE reports the Rx-Tx time difference measurement at RF side (which requires UE to have calibration capability, otherwise UE can only reports  the Rx-Tx time difference measurement at BB side), the two Rx-Tx time difference measurements are different since there could be some  different post-compensation Tx timing errors for  two SRS resources associated with different Tx TEGs in the same UL subframe
 |
| FL | Thanks for the good discussions. * From the discussion, it seems there are two opinions:
	+ A Rx-Tx time difference measurement is not independent of UE Tx TEG. In this case, there will be, at least, some clarifications on the definition of the UE Rx-Tx time difference measurements when TEG is introduced. We will also need to consider how to handling with the potential mismatch between UE and gNB Rx-Tx time difference measurements;
	+ A Rx-Tx time difference measurement can be independent of UE Tx TEG. In this case, we may keep the same definition of the UE Rx-Tx time difference measurements when TEG is introduced. It might be easier how to handling with the potential mismatch between UE and gNB Rx-Tx time difference measurements because of the decoupling of the Rx-Tx time difference measurement from UE Tx TEG.

Proposal 3.3-1 (Revision 2) (H)*For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE* ***may*** *support at least one of the following options:** *Option 1: Provide association of a UE Rx-Tx time difference measurement with one UE RxTx TEG ID to LMF.*
	+ *A UE may also provide association of the UE Rx-Tx time difference measurement to a {Rx TEG ID, Tx TEG ID} pair, or a Tx TEG ID.*
* *Option 2: Provide association of a UE Rx-Tx time difference measurement with a {Rx TEG ID, Tx TEG ID} pair to LMF.*
* *Option 3: Provide to LMF*
	+ *the association of a Rx TEG ID for each UE Rx-Tx time difference measurement*
	+ *the association information of Tx TEG with SRS resources in the measurement report*
	+ *the association information between RxTx TEG IDs with {Rx TEG ID, Tx TEG} pairs*
* *Whether UE supports Option 1 or Option 2 or Option 3 or combination of them is subject to UE capability*
* *Note 1: The Rx TEG ID is associated with the DL PRS corresponding to the Rx time of the measurement*
* *Note 2: The Tx TEG ID is associated with (downselection needed)*
	+ *Alt. 1: one or more UL SRS resources corresponding to the Tx timing of the measurement*
	+ *Alt. 2: the Tx timing of the measurement*
	+ *Alt. 3: one or more UL SRS resources*
* *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*
 |
|  |  |

### Proposal 3.3-1 (Revision 3) (H)

For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support at least one of the following options:

* Option 1: Provide association of a UE Rx-Tx time difference measurement with one UE RxTx TEG ID to LMF.
	+ A UE may also provide association of the UE Rx-Tx time difference measurement to a {Rx TEG ID, Tx TEG ID} pair, or a Tx TEG ID.
* Option 2: Provide association of a UE Rx-Tx time difference measurement with a {Rx TEG ID, Tx TEG ID} pair to LMF.
* Option 3: Provide association of a UE Rx-Tx time difference measurement with a Rx TEG ID to LMF. In addition, the UE provides:
	+ the association information of Tx TEG IDs with SRS resources, and
	+ the association information between RxTx TEG IDs with {Rx TEG ID, Tx TEG ID} pairs
* Whether UE supports Option 1 or Option 2 or Option 3 or combination of them is subject to UE capability
* Note 1: An Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement
* Note 2: A Tx TEG ID is associated with (downselection needed)
	+ Alt. 1: one UL SRS resource corresponding to the Tx timing of the measurement
	+ Alt. 2: the Tx timing of the measurement
	+ Alt. 3: one or more UL SRS resources
* FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).
* FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Quacomm | Unfortunately I think we are over-complicating the discussions. What is the fundamental difference in Option 1 and Option 3? In both cases all 3 TEGs can be reported, and the debate is: Whether Rx-Tx measurement is dependent Tx TEG or not. So, I think a good point to do one step further is to keep Option 1/3 still as a single option, where the common denominator is that it contains UE RxTx TEG ID reporting (one way or another), whereas in Option 2, there is no such capability from the UE. Another common denominator for all options is that we still haven’t converged on with what the Tx TEG is associated. I think the updated proposal below, would still go one step further, and expose the pain-points of our discussions.***For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, at least one 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.***
	+ ***FFS: Further details on how the Rx-Tx measurements are related to Tx TEG ID***
* ***In either option, a Tx TEG ID is associated with (downselection needed)***
	+ ***Alt. 1: an UL SRS resource 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*
* *Note: An Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement*
* *FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).*

*FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements* |
| ZTE | We’re generally fine with QC’s proposal. A bit update may be needed to distinguish with Alt.1 and Alt.3,* + *Alt. 3: ~~one or~~ more than one UL SRS resources*

From our side, we can support both options as a comprised solution, we would like to add another bullet,* *Whether UE supports Option 1 or Option 2 or both is subject to UE capability*
 |
| Apple | The intention is not clear to us. We had an agreement in 104be with pretty much the same Alts for a UE to provide the association information of a UE Rx-Tx time difference measurement with UE RxTx TEG. Now we have ID…What’s the delta between this proposal and prior agreement.  |
| FL | To QC: The proposal is fine to me. To ZTE: The main difference of Alt.3 and Alt.3 is that that for Alt. 3, the UL SRS resource(s) is not used to determine ***Tx timing of the Rx-Tx measurement.*** Not sure adding another bullet is needed, since the main bulet say “***a UE may support, up to UE capability, at least one of the following options”.*** If it is not clear enough, we may say “, since “***a UE may support, up to UE capability, ~~at least~~ one or both of the following options”*** To Apple:If we agree with QC’s proposal, I assume we have one step further in: a) we agree to support both options. In previous agreement, we only “support one of the following alternatives”; b) It lists more issues that need to be discussed in the next meeting. |

Proposal 3.3-2 (H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support one of the following options for the UE to provide the association information of UE Tx TEG with the UL Positioning SRS resources to LMF:
	+ Option 1: the association information is sent directly from UE to LMF
	+ Option 2: the association information is sent first to the serving gNB and then forwarded from serving gNB to LMF
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support option 1 for DL+UL positioning. |
| OPPO | A common solution for Proposal 3.2-1 and 3.3-2 should be ensured.  |
| CATT | Support Option 1. |
| vivo | Option1. Similar views as UL-TDOA. |
| Ericsson | The possibility to configure the UE to send UL SRS TX TEG association directly to the serving gNB should be supported primarily for UL TDOA purposes but could be used also for DL+UL positioning. For multi-RTT positioning the most efficient way to do this is, however, to signal the UL SRS TX TEG association together with the UE Rx-Tx time difference measurement in the multi RTT measurement report. We would be supportive of the following formulation:Option 1b: The UE TX TEG association information for the UL SRS used for TX timing in a UE Rx-Tx time difference measurement is included together with the UE Rx-Tx time difference measurement in the multi-RTT measurement report. |
| Qualcomm | Option 1. Single solution for both UTDOA and RTT is preferred.  |
| Apple | Support Option 1 |
| Nokia/NSB | Agree with Ericsson and support their option 1b in principle.  |
| SONY | Option 1 |
| Huawei, HiSilicon | We think that it is important to allow for the UE not supporting LPP protocol but can have positioning feature. |
| CMCC | We support Option 1. |
| Samsung  | Similar as above, option 1 is slightly preferred. |
| LG | Option 1. |
| InterDigital | Support Option 1 for the reason similar to Proposal 3.2-1. |
| FL | It seems the majorty companies are supportive to Option 1 (including some of the companies that is suppoted to Option 2 in Proposal 3.2-1. Maybe it is desirable for the UE Tx TEG to be sent to LMF through the same route.For HW’s comment, “it is important to allow for the UE not supporting LPP protocol but can have positioning feature”, I assume it is something that may be considered in the fugure release. Based on the comments and Ericsson’s suggestion, we could make it clear that to say: Proposal 3.3-2 (H)* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support the UE to provide the association information of UE Tx TEG with the UL Positioning SRS resources together with the report of UE Rx-Tx time difference measurements to LMF.
* FFS: the details of the signalling, procedures, and UE capability
 |
| Intel | Support option 1 |
| Ericsson | We are fine with the latest FL proposal. Added some small clarifications below with change marks:Proposal 3.3-2 (H)* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support the UE to provide the association information of UE Tx TEG of the UL Positioning SRS resource used for a UE Rx-Tx time difference measurement together with the report of UE Rx-Tx time difference measurement to LMF.
* FFS: the details of the signalling, procedures, and UE capability
 |

FL Comments

Proposal 3.3-2 is revised as follows based on the comments.

Proposal 3.3-2 (Revision 1)(H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support UE to provide the association information of UE Tx TEG of the UL Positioning SRS resource used for a UE Rx-Tx time difference measurement together with the report of UE Rx-Tx time difference measurement to LMF.
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Support. |
| vivo | Support |
| ZTE | We think this proposal is highly relative with proposal 3.3-1, no need to discuss it separately.  |
| LG | Support. |
| CATT | Support. |
| FL | To ZTE’s comment, Proposal 3.3-2 is about how the association information of UE Tx TEG is sent to LMF, by downselcting the to the two options in previous proposal.Although Proposal 3.3-2 is related to proposal 3.3-1, it applies to any of the options in proposal 3.3-1. Thus, we may made the decision separately. |
| Ericsson | Support |
| Qualcomm | We are supportive of the following revision; whether the association of UE Tx TEG to SRS is reported together with the measurement, or there can be a separate report, depends also on the outcome of the UTDOA dicsusison. Proposal 3.3-2 (Revision 1)(H)* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support UE to provide the association information of UE Tx TEG to UL Positioning SRS resource used for a UE Rx-Tx time difference measurement to LMF.
* FFS: Whether this report can be together with the UE Rx-Tx report.
* FFS: the details of the signalling, procedures, and UE capability
 |
| FL | It seems the proposal is supported by the majority. We may need a further discussion on adding the “FFS” for the reporting as suggested by QC is acceptable to all companies. |

Proposal 3.3-2 (Revision 2)(H)

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support UE to provide the association information of UE Tx TEG to UL Positioning SRS resource used for a UE Rx-Tx time difference measurement to LMF.
* FFS: Whether this report can be together with the UE Rx-Tx report.
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Support. |
| CMCC | OK |
| ZTE | Support. A wording modification:* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support UE to provide the association information of UE Tx TEG ~~to~~of UL Positioning SRS resource used for a UE Rx-Tx time difference measurement to LMF.
* FFS: Whether this report can be together with the UE Rx-Tx report.
* FFS: the details of the signalling, procedures, and UE capability
 |
| OPPO | Confused with the proposal.According to the current definition,

|  |
| --- |
| *TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i received from the TP.* |

the UE Rx-Tx time difference measurement is NOT measured on the actual SRS transmission. We have a related discussion in Proposal 2.1-1. However, no agreement is made so far.Thus, What does “UL Positioning SRS resource used for a UE Rx-Tx time difference measurement” refer to in this proposal? |
| InterDigital | Support |
| vivo | SupportTo OPPO, in our view, LMF needs to match the Rx-Tx timing difference of UE and gNB side. Given the definition of Rx-Tx timing difference is decoupled with transmitting signal, we need additional signaling to decide whether gNB Rx-Tx timing difference matches the UE side measurement (that is, the measured Tx TEG of SRS resource in the gNB side is the same with Tx TEG of UE side in UE Rx-Tx time difference measurement reporting) |
| Nokia/NSB | We understand the intention but perhaps using the wording of SRS resources used to determine the Tx time for the UE Rx-Tx measurement would be better?  |
| Intel | Support |
| FL | To ZTE:* The proposed modification seems reasonable.

To OPPO:* Similar view as vivo. There is a need for matching UE/gNB Rx-Tx timing difference measurements. The impact of the definition can be discussed separately.

To Nokia:* The proposed modification seems reasonable
 |

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

* For mitigating UE Tx/Rx timing errors for DL+UL positioning, support UE to provide the association information of UE Tx TEG of UL Positioning SRS resource used to determine UE Rx-Tx time difference measurement to LMF.
* FFS: Whether this report can be together with the UE Rx-Tx report.
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CATT | Support.  |
| Nokia/NSB | Ok.  |
| Intel | Support |

### Proposal 3.3-3 (H)

* For mitigating gNB Tx/Rx timing errors for DL+UL positioning, adopt one of the following options:
	+ Option 1:
		- Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a pair of TRP {Rx TEG, Tx TEG} to LMF, where the Rx TEG is used to receive the UL positioning SRS and the Tx TEG is used to transmit the DL PRS;
	+ Option 2:
		- Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a TRP RxTx TEG to LMF. The TRP RxTx TEG is associated with one or more {UL Positioning SRS resource, DL PRS resource} pairs
			* FFS: whether the gNB provides the association information of UL Positioning SRS resources to TRP Rx TEG to LMF for gNB RxTx measurements specifically
	+ Option 3:
		- Support a gNB to provide the association information of a gNB Rx-Tx time difference measurement with a TRP RxTx TEG to LMF. The TRP RxTx TEG is associated with one or more TRP {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.
* FFS: the details of the signalling, procedures, and UE capability

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support option 1 for consistency. |
| OPPO | Ok to further discuss it. Option 1 is preferred. |
| CATT | Support option1. In our point of view, it will make the signalling for mitigating UE Rx/Tx timing errors more complicated and increase the overhead, if RxTx TEGs are introduced for DL+UL positioning methods. |
| Ericsson | We don’t see the need for a gNB TEG (see discussion in our RAN4 contribution). Among the options above, we prefer option 1.  |
| Qualcomm | As discussed in Proposal 3.3-1, same argument and figure. We consider RxTx TEGs really essential to be reported.  |
| Apple | Option 2 is preferred |
| Nokia/NSB | Support Option 2.  |
| SONY | Prefer option 1 |
| CMCC | We support Option 3. |
| Samsung  | Similar as above UE one, we support option 2. |
| LG | We slightly support option 1. |
| InterDigital | Support Option 3 for the reason similar to Proposal 3.3-1 |
| Intel | Option 1 |
| FL | After we conclude the discussion of Proposal 2.3-1, we may take the similar approach for this proposal. |

### Proposal 3.3-4

* + Support the use of the SRS resource(s) in the most recent SRS instance in advance of the Rx-Tx time difference measurement to derive RxTx TEG or Tx TEG in { Rx TEG, Tx TEG } pairs for Rx-Tx time difference measurements.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | For UE side: Postpone it until we have any conclusion for Proposal 2.2-1 since they are coupled with each other.For gNB side: the SRS used for the measurement should be used to derive the TEGs. |
| vivo | Support, only if actual SRS transmission is used to derive RxTx TEG or Tx TEG in {Rx TEG, Tx TEG} pairs.If actual SRS transmission is used to derive RxTx TEG or Tx TEG in {Rx TEG, Tx TEG} pairs, we should clarify how the SRS resource for deriving RxTx TEG or Tx TEG in { Rx TEG, Tx TEG } pairs is obtained e.g. which SRS occasion to associate with the SRS resource; since from the definition of Rx-Tx time difference, the ‘Tx time’ in ‘Rx-Tx time difference’ is determined by the time of the UL subframe that is closest in time to the receiving time of PRS resource which is not associated with actual SRS transmission. |
| ZTE | Suggest to discuss this proposal together with proposal 2.2-1, both of them may possibly change the definition of UE Rx-Tx time difference measurement in 38.215. |
|  |  |

### Proposal 3.3-5

* + Support TRPs to report RX+TX group delay measurement to solve the inter-TRP transmission and receiving timing difference mathematically at the location server
	+ Support UE to report RX+TX group delay measurement for each pair of {RX TEG, TX TEG} to solve transmission timing difference between TX TEGs and receiving timing difference between RX TEGs mathematically at the location server.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | How does UE know the group delay? If it know the group delay, UE can do calibration. |
| MTK | 1, to OPPO, UE can perform self calibration to learn RX+TX group delay, but UE can’t perform self calibration to learn RX or TX group delay. So when UE knows RX+TX group delay through self calibration, UE still doesn't know RX group delay is, and TX group delay is.2, UE cares about RX group delay difference between two RX TEGs, and TX group delay difference between two TX TEGs.3, In proposal 3.1-3, UE measures same TRP signal simultaneously by 2 RX TEGs. What we worry is, it doesn't guarantee the 2 RX TEGs could have good RSRP level, because the receiving beam direction of the 2 RX TEGs could be quite opposite. We are thinking another solution to calculate RX group delay difference between 2 RX TEGs and TX group delay difference between 2 TX TEGs, when RX+TX group delays are measured for each {RX TEG, TX TEG} pair. The concept is like, we learn 10, but we don't know it is 6 (RX1) +4 (TX1), and we also learn 7, but we don't know it is 4(RX2) + 3(TX2). We can further derive RX1-RX2 = 2, and TX1-TX2 = 1, through the value of 10 and 7, and by DL-TDOA and UL-TDOA measurementFor TDOA technique, at UE side, we care about RX1 - RX2, and TX1 - TX2Our proposal is not for DL+UL positioning, instead, it is to assst UE to improve DL-TDOA, and UL-TDOA.To FL, we don't think it is proper to put the proposal in 3.3. Is it okay to move our proposal to 3.1 and 3.2?  |
| SONY | Support. Not all UE can do calibration. If the UE has performed calibration then the LMF needs to be informed. |
| CATT | Support. |
| Huawei, HiSilicon | Just would like clarify the understanding from our side based on the proposal:TRP1 will report its round trip time delay T1+R1, and TRP 2 will report its own T2+R2.From UE side, UE has 2Tx and 2Rx, but here the proposal is to address the case that partial RTT measurement is conducted, e.g. UE knows t1+r1, and t2+r2, but UE does not know those cross-terms, e.g. t1+r2, t2+r1, right? Otherwise UE will be able to compenstate its Tx timing error and Rx timing error.Given the condition, using DL-TDOA + UL-TDOA, associated with the information from TRPs (T1+R1, T2+R2), or from the UE (t1+r1, t2+r2), and the related RSTD and UL-RTOA measurements associated with the correct RxTEG and TxTEG, LMF will be able to mitigate the inter-gNB group delay error without deploying the reference device? |
| MTK2 | Respond to Huawei:1, Yes, UE can only learn t1+r1 and t2+r2 through self calibration, and UE can not know t1+r2, t2+r12, Yes, DL-TDOA+UL-TDOA doesn't need to rely on reference device. Or the inter-gnb group delay error can be learned through reference device, and then this information can assist LMF to figure out UE side RX group delay difference (r1- r2) , and TX group delay difference (t1- t2), if UE can measure t1+r1, and t2+r2In our view, to learn r1-r2 through measuring same TRP signal may not always be successful. This is because each panel’s beam direction would be quite opposite, and therefore, the beam of 2 panels may not always have the chance to aim at same TRP. It depends on probability.Also, if UE and gNB also support RTT technique, the ability of RX+TX group delay measurement is needed. Otherwise, we don't need to talk about Rel-17. Rel-16 UE is enoughWe just think that, if UE can measure RX+TX group delay, it can further help to learn r1- r2, and t1 –t2. We understand that UE may require some additional circuit. But for IIOT device, it could be feasible since the IIOT device doesn't require complicated band combination.  |
| OPPO | Reponse to MTK:The measurement of group delay measurement should be involved with RAN4 for the feasibility and accuracy of the measurement. Thus, we cannot make any progress without RAN4 input. |
| MTK3 | To OPPO:This depends on UE capability. We are also okay to send LS for RAN4 for checking the feasibility.Note that, right now, we may only have a solution on the table to measure RX group delay difference, which is to receive same signal by two RX TEGs. We already express our concern that it may depend on probability to accomplish the measurement because the beam direction of each RX TEG is quite different.For our proposal, each RX TEG could choose the signal with good RSRP. The effort is to the capability of RX+TX group delay measurement, and we also believe that a UE which can support M-RTT of Rel-17 should be able to do that |
|  |  |

### Proposal 3.3-6 (suggested to be closed)

* + Support 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.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Low priority |
| FL | Only one company provides the feedback. Suggest closing the discussion if most of the companies are not interested in the proposal. |
|  |  |

FL Comments

Due to the lack of support, suggest closing the discussion with “*Consensus cannot be reached for the proposed enhancement*”.

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |

## Variations of Rx/Tx timing errors and error statistics of TEGs

Submitted Proposals

* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 7: The UE should provide the information of the UE Tx TEG(s) change associated with SRS resource(s) to the LMF, when the UE Tx TEG associated with SRS resource(s) changes, e.g. due to switching of UE antenna panel to avoid blockage.
	+ The UE can provide this information based on event-triggerred reporting
* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 8: The information of the UE Tx TEG and Tx TEG change information associated with SRS resource(s) should also be provided to the gNBs performing RTOA measurement, to prevent the gNBs joint processing on different SRS measurement time occasions associated with different UE Tx TEGs for the same SRS resource(s).
	+ After the LMF obtains the information of UE Tx TEG(s) change, it can further transmit this information to the gNB performing RTOA measurement
* (CMCC, [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc)[5]) Proposal 2: Support UE to report the statistics (variance) of differences of the RX TEGs to LMF for mitigating TRP Tx timing errors and/or UE Rx timing errors for DL TDOA
* (CMCC, [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc)[5]) Proposal 3: Support a UE to provide the statistics (variance, bound, etc.) of the Tx timing error differences between Tx TEGs to LMF
* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 2: With regards to TEG Information reporting, a device (UE or gNB) should be able to provide TEG-ID consistency information (e.g., a flag when TEG IDs are being reset). This applies to both Tx TEG, Rx TEG for both UEs and gNBs.
* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 7: For mitigating timing errors in DL-TDOA, UL-TDOA or DL+UL Positioning:
	+ Support providing at least a timing Error uncertainty/margin associated with a TEG ID
	+ Consider supporting in addition an average timing error associated with a TEG ID.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 5: Support the LMF to configure a maximum difference between any two timing errors within a TEG.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 10: For UE-B positioning methods, support the UE to request the information of gNB TEG.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 11: Support a UE to indicate TEG in the measurement reporting when TEG information is changed compared to the previous reporting.
* (Apple, [R1-2105105](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105105.doc)[10]) Proposal 2: At least for UE-based method, LMF will provide the effective error to UE, e.g., through the LPP message Provide Assistance Data, or it may ask gNB to broadcast the effective error within posSIB
	+ Each effective error value may be associated with a set of TRP IDs of candidate NR TRPs for measurement
* (Apple, [R1-2105105](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105105.doc)[10]) Proposal 3: UE will indicate, e.g., through LPP message Provide Location Information, to the LMF whether or not the effective error is compensated/applied to the positioning measurements and/or location calculation
* (Sony, [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc)[11]) Proposal 3: Support the time-varying property of TEG. The association information can be used to identify the TEGs at different time.
* (Samsung, [R1-2105310](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105310.doc))[12]) Proposal 3: For indication of TEG in UL-TDOA, a time domain resource (e.g. a slot) containing the TEG (associated with the corresponding SRS-pos is supported.
* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-5: For DL-RSTD measurement, the statistics (variance) of RX group delay difference at UE which are related to different frequency layers for receiving, or different RX TEGs for receiving may report to the location server
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 4: Support a TRP to provide the statistics (variance, bound, etc.) of the Tx timing error and Rx timing errors within one TEG to LMF.
* (Fraunhofer, [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) [17]) Proposal 6: Support a UE to provide the statistics (variance, bound, etc.) of the Tx timing error and Rx timing errors within one TEG to LMF.
* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 7 TX TEG association reports should have a configurable periodicity and the reports should include the UE TX TEG association of each transmission occasion of each SRS resource during the reporting period.
* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 14 In NR Rel-17, support the UE to associate both a spatial and a temporal UE RX TEG index to each TOA measurement and to indicate both these indices in RSTD and UE RX-TX time difference measurements.
* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 15 In NR Rel-17, support the UE to associate both a spatial and a temporal UE TX TEG index to each UL SRS transmission and to signal the associated indices in a message to the LMF.
* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 16 Study how to handle frequency-dependent timing errors in NR Rel-17.

FL Comments

If a UE or a TRP has the statistical information related to Tx/Rx timing errors associated with the Rx/Tx TEGs, the information may be useful for the LMF/UE for the estimation of the UE position as proposed by multiple companies ([5][6][8][10][11][16][17][19]). Here, it is suggested to consider separately providing the error margins of Rx/Tx/RxTx TEGs and providing the difference of error margins between Rx/Tx/RxTx TEGs.

In addition, the timing errors of UE Rx/Tx TEGs may changes with time for various reasons as discussed by multiple companies (e.g., [2][6][8][11][19]). Thus, there is a need to consider how to handle the time-varying property of TEGs for information consistency.

### Proposal 3.4-1 (H)

* Subject to UE’s capability, support UE to provide the margin of the Rx timing errors of a UE Rx TEG to LMF for DL-TDOA
* Subject to UE’s capability, support UE to provide the margin of the Tx timing errors of a UE Tx TEG to LMF for UL- TDOA
* Subject to UE’s capability, support UE to provide the margin of the RxTx timing errors of a UE RxTx TEG to LMF for Multi-RTT if UE RxTx TEG is supported
* FFS: how the error margin is defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not supportWe don’t have any knowledge about the margin, e.g.., whether is a value for all UE or different UE can have different values. It is RAN4 issue. RAN1 can do nothting without any input from RAN4 |
| CATT | We only support the first and the second bullets, since we think whether introduce RxTx TEG needs further discussion. |
| vivo | We are not sure the margin can be determined in RAN1. |
| Ericsson | We do not support the above formulations. It’s the maximum timing error ***difference*** between different measurements/transmissions associated with the same TEG that is of interest, not the timing errors themselves. The margin (i.e. the maximum timing error *difference* between different measurements/transmissions associated with the same TEG) could be specified by RAN4. Possibly it could be different depending on UE capabilities or signaled as a UE capability. |
| Huawei, HiSilicon | We understand we defined “margin” in the TEG definition. However, how this margin is associated with the TEG error (difference) is not clear. For example, one can model the TEG error (difference) as Gaussian distribution, what would be the “margin” then? Should it be the sigma or 3 sigma of the Gaussian distribution? One also also model the TEG error as uniform distribution, in which case the margin could be the upper bound? |
| Qualcomm | Yes it is the maximum error difference between the measurements associated with the same TEG. I guess some reformulation is needed. Either way, having multiple options as UE capability and the flexibility to provide different margin will be forward compatible and more general, so we are generally supportive. To HW: We don’t see the need really to go to such details in RAN1, especially at this stage.Maybe RAN4 could look into it. From RAN1 perspective, do we see the need to have a UE that says: “I support the feature assuiming a margin of X nsec” and another UE that says “Y nsec”?  |
| Apple | Do not support (similar view as OPPO) |
| Nokia/NSB | We are in principle supportive. We think the UE can report the maximum assumed margin within some confidence margin (the confidence margin could be hard coded while the maximum timing margin is signaled, e.g., in capability signaling) |
| SONY | We have similar view as Ericsson. |
| ZTE | Do not support(similar view as OPPO) |
| Samsung | Not support. It depends on more discussion of TEG, e.g., RAN4 input.Due to similar reasons, we are not yet really to support following proposal 2~5 as well. |
| LG | Do not support(similar view as OPPO) |
| InterDigital | We support the proposal. We already agreed that TEG is defined as the transmission/reception, which has the timing error within a certain **margin**. If we just have one timing error per TEG, we do not need to define TEG. Having said that, if the UE is aware of the margn of the timing error, (Tx, Rx, or RxTx), it should provide to the network. |
| Intel | In our understanding the discussion should be left up to RAN4 |
|  |  |

### Proposal 3.4-2 (H)

* Support gNB to provide the margin of the Rx timing errors of a TRP Rx TEG to LMF for UL-TDOA
* Support gNB to provide the margin of the Tx timing errors of a TRP Tx TEG to LMF for DL- TDOA
* Support gNB to provide the margin of the RxTx timing errors of a TRP RxTx TEG to LMF for Multi-RTT if TRP RxTx TEG is supported
* FFS: how the error margin is defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support. Same comment as Proposal 3.4-1 |
| CATT | We only support the first and the second bullets, since we think whether introduce RxTx TEG needs further discussion. |
| vivo | We are not sure the margin can be determined in RAN1. |
| Ericsson | We don’t support the above formulations. It’s the maximum timing error ***difference*** between different measurements/transmissions associated with the same TEG that is of interest, not the timing errors themselves. |
| Huawei, HiSilicon | We understand we defined “margin” in the TEG definition. However, how this margin is associated with the TEG error (difference) is not clear. For example, one can model the TEG error (difference) as Gaussian distribution, what would be the “margin” then? Should it be the sigma or 3 sigma of the Gaussian distribution? One also also model the TEG error as uniform distribution, in which case the margin could be the upper bound? |
| Qualcomm | Similar comments above. There should not be an attempt to define numbers nor distrivutions. Do we agree with the principle that different UEs/gNBs may have different margins? Or will the feature be a black/white scenario? Either the /gNBs meets a margin or no? We prefer to have some flexibility and different level of margins for forward compatibility.  |
| Apple | Same comment as Proposal 3.4-1 |
| Nokia/NSB | Same comments as on Proposal 3.4.-1 |
| SONY | Same comments as on Proposal 3.4.-1 |
| ZTE | Same comments as on Proposal 3.4.-1 |
| LG | Same comments as on Proposal 3.4.-1 |
| InterDigital | Support |
| Intel | Same view as Proposal 3.4-1 |

### Proposal 3.4-3 (H)

* Support UE to provide the margin of the Rx timing error differences between UE Rx TEGs to LMF for DL-TDOA
* Support UE to provide the margin of the Tx timing error differences between UE Tx TEG to LMF for UL- TDOA
* Support UE to provide the margin of the RxTx timing error differences between UE RxTx TEG to LMF for Multi-RTT if UE RxTx TEG is supported
* FFS: how the margin of the error difference is defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not support. Same comment as Proposal 3.4-1 |
| CATT | We only support the first and the second bullets, since we think whether introduce RxTx TEG needs further discussion. |
| Vivo | We are not sure the margin can be determined in RAN1. |
| Ericsson | We don’t support the above formulations. It’s the maximum timing error difference between different measurements/transmissions associated with the ***same*** TEG that is of interest. The margin (i.e. the maximum timing error difference between different measurements/transmissions associated with the ***same*** TEG) could be specified by RAN4. Possibly it could be different depending on UE capabilities or signaled as a UE capability. |
| Huawei, HiSilicon | We understand we defined “margin” in the TEG definition. However, how this margin is associated with the TEG error (difference) is not clear. For example, one can model the TEG error (difference) as Gaussian distribution, what would be the “margin” then? Should it be the sigma or 3 sigma of the Gaussian distribution? One also also model the TEG error as uniform distribution, in which case the margin could be the upper bound? |
| Qualcomm | Similar comments above. There should not be an attempt to define numbers nor distrivutions. Do we agree with the principle that different UEs/gNBs may have different margins? Or will the feature be a black/white scenario? Either the /gNBs meets a margin or no? We prefer to have some flexibility and different level of margins for forward compatibility.  |
| Apple | Same comment as Proposal 3.4-1 |
| Nokia/NSB  | Don’t support.  |
| SONY | Do not support |
| ZTE | Same comments as on Proposal 3.4.-1 |
| LG | Same comments as on Proposal 3.4.-1 |
| InterDigital | Support |
| Intel | Same view as Proposal 3.4-1 |

### Proposal 3.4-4 (H)

* Support gNB to provide the margin of the Rx timing error differences between TRP Rx TEGs to LMF for UL-TDOA
* Support gNB to provide the margin of the Tx timing error differences between TRP Tx TEG to LMF for DL- TDOA
* Support gNB to provide the margin of the RxTx timing error differences between TRP RxTx TEG to LMF for Multi-RTT if TRP RxTx TEG is supported
* FFS: how the margin of the error difference is defined (e.g., The statistics of variance, the error bound (maximum timing error), etc.)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CATT | We only support the first and the second bullets, since we think whether introduce RxTx TEG needs further discussion. |
| vivo | We are not sure the margin can be determined in RAN1. |
| Ericsson | We do not support the above formulations. It’s the maximum timing error difference between different measurements/transmissions associated with the ***same*** TEG that is of interest. |
| Huawei, HiSilicon | We understand we defined “margin” in the TEG definition. However, how this margin is associated with the TEG error (difference) is not clear. For example, one can model the TEG error (difference) as Gaussian distribution, what would be the “margin” then? Should it be the sigma or 3 sigma of the Gaussian distribution? One also also model the TEG error as uniform distribution, in which case the margin could be the upper bound? |
| Apple | Same comment as Proposal 3.4-1 |
| Nokia/NSB | Don’t support.  |
| ZTE | Same comments as on Proposal 3.4.-1 |
| LG | Same comments as on Proposal 3.4.-1 |
| InterDigital | Support |
| Intel | Same view as Proposal 3.4-1 |

### Proposal 3.4-5 (H)

* UE/gNB should provide the updates of the Rx/Tx/RxTx TEG information to LMF whenever the previously provided TEG information is no longer valid.
* Support one of the following options for the update of Rx/Tx/RxTx TEG information:
	+ Update or reset of Rx/Tx/RxTx TEG IDs;
	+ Including a timestamp (or temporal index) in Rx/Tx/RxTx TEG information and update the timestamp (or temporal index) when it is necessary.
* FFS: How UE/gNB determines the previous TEG information is invalid (e.g., up to UE/gNB implementation)

*Comments*

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Not supportWe don’t have any knowledge about TEG, e.g., validation of a TEG. It is RAN4 issue. RAN1 can do nothting without any input from RAN4 |
| CATT | Not sure the benefits of such scheme. We prefer to put this issue as low priority. |
| Ericsson | The solution need to be able to handle both discontinuous processes like timing adjustments and continuous processes like clock drifts. This could be achieved either bya) The combination of timestamps and TEG resets where the TEG reset is used only in case of discontinuous events like timing adjustmentsb) A UE counter which is increased like a clock to handle continuous processes and increased multiple steps in case of a discontinuous event like a timing adjustment. The counter value at the time of the measurement would be included in the measurement report. |
| Qualcomm | Generally supportive, the specific solutions that E// is showing can be discussed later on. ***Support UE/gNB to provide updates of the Rx/Tx/RxTx TEG information to LMF whenever the previously provided TEG information is no longer valid.**** ***FFS: Signaling details***

To CATT: The benefit is that we avoid confusion of how long are the “TEG Information” valid. If the UE reports a 1st measurement associated with TEG-1 and reports a 2nd measurement with TEG-1, if these 2 measurements are in different reports or even in the same report but different timestamp, does it mean that they really have timing errors that are similar? How does CATT plan to address this issue?  |
| Apple | Same comment as Proposal 3.4-1 |
| Nokia/NSB | Open to discuss this further but feel that we need to make progress on other topics above first before we can move to this level of discussion.  |
| SONY | Support. The LMF needs to be sure that the TEG information is still valid. Inaccurate/invalid TEG information degrades the positioning accuracy. |
| ZTE | Support Nokia’s view that we should discuss it later. |
| LG | We are open to discuss it as a low priority. |
| InterDigital | We support the proposal. In our view, the UE does need always provide the TEG information. Instead, the TEG information is necessary if the previously provided TEG is no longer valid. This topic is a general subject so it can be discussed along with other issues. |
| vivo | Support the first bullet. For the second bullet, we think it is detail solution and recommend FFS. At least on the UE side, during the time when the UE transmits the SRS resources, as the UE flips or is blocked, it is up to UE implementation to switch Tx panel for better uplink transmission. Thus, for the same SRS resources for positioning, the associated Tx panel and Tx TEG will also change accordingly. That is, the UE Tx TEG information of SRS resource(s) for different SRS instances may be not always fixed. From our point of view, the information of the UE Tx TEG(s) change should also be provided to the LMF.  |

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

Background

The following agreement was made in RAN1#104e related to the use of a reference device with a known location to support the mitigating UE/gNB Tx/Rx timing errors:

|  |
| --- |
| Agreement:* Study specification impact for enabling a reference device with known location to support the following functionalities:
	+ Measure DL PRS and report associated measurements (e.g., RSTD, Rx-Tx time difference, RSRP) to the LMF;
	+ Transmit SRS and enable TRPs to measure and report measurements (e.g., RTOA, Rx-Tx time difference, AOA) associated with the reference device to the LMF;
	+ FFS: The details of the behavior, the measurements, the parameters related to the Rx and Tx timing delays, AoD and AOA enhancements and measurement calibrations;
	+ FFS: The report of device location coordinate information to the LMF if the LMF does not have the information
	+ FFS: The device with the known location being a UE and/or a gNB
	+ FFS: Precision to which location of reference device is known
* Note: RAN1 assumes using these enhancements for the purpose of network synchronization is NOT within the scope of the WI
 |

The specification impact for enabling a reference device with a known location for the enhancements of the positioning performance was discussed internsively in RAN1#104bis-e without conclusion. The following is the latest version of the proposal for discussion in FL summary [21].

|  |
| --- |
| Proposal 4-1 (Revision 5) (H)* RAN1 has evaluated the use of reference devices, which can either be UE or TRP, for positioning and observes improvements in using reference devices for enhancing the positioning performance.
	+ Note 1: The position of the reference device is known;
	+ Note 2: If the device is a TRP, it needs at least to support some of the Rel-16 positioning functionalities, which will be defined by RAN2. For example, the device 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
	+ Note 3: If the device is a UE, it may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the device is known, the information may also be requested by the LMF;
	+ Note 4: The impact on the specification, the measurement reports, and the procedure for supporting a UE/TRP to be a reference device will be determined by RAN2/RAN3/SA2;
	+ Note 5: Up to RAN2/RAN3 discussions what type(s) of UE/TRP can be reference devices and any capabilities if/as needed
	+ Note 6: RAN1 has not identified specification enhancements needed in RAN1 specifications
* Send an LS to RAN2/RAN3/SA2 once RAN1 reaches the agreement for the above proposal and kindly asks RAN2 and RAN3 to determine if and what specification enhancements are needed in the relevant WGs to enable reference devices for positioning.
 |

Submitted Proposals

* (Huawei [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc)) Proposal 6: Support to reuse the LPP signaling to provide the location coordinate information of the reference UE and add a new location source to indicate where the information come from.
* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 16:
	+ Support to introduce new type of reference device, rather than normal UE or gNB/TRP, for Rx/Tx timing error mitigating.
		- it should have the ability to obtain and provide its own location with high accuracy and confidence
		- it may also be requested by the LMF to provide its own location information to the LMF
		- it should support basic positioning functionalities, such as providing the positioning measurements and transmitting the UL SRS for positioning.
	+ Note: it is up to RAN2/RAN3 to further define ‘the entity’, architecture and signalings for this new type of reference device.
* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 17: Support the ‘reference device’ being controlled by the LMF for better assisting network calibration, e.g., including
	+ support the LMF to indicate the use of Rx TEGs or Tx TEGs of the ‘reference device’
	+ support the LMF to indicate the mobility or the motion trajectory of the ‘reference device’
* (vivo, [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc)[2]) Proposal 18: The location information of ‘reference device’ can be provided to the gNB for angle error calibration by itself.
* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 16: NR Rel-17 should support reporting the location coordinate information of reference UE from UE to LMF for mitigating the Rx/Tx timing error of UE/TRPs, with the double differential positioning method.
* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 17: NR Rel-17 should support reference UE and target UE using the same way of signalling of DL/UL reference signal, and reporting the measurements for compensation the Rx/Tx timing error of target UE /TRPs, with Rel-16 DL/UL-TDOA / Multi-RTT positioning method.
* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 18: NR Rel-17 should support reference UE reporting the value of Rx/Tx timing error difference between different TRPs to LMF for UE-assisted positioning or to target UE via LMF for UE-based positioning.
* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 19: NR Rel-17 should support reporting the parameters related to gNB Rx/Tx timing error from gNB to LMF for UE-assisted positioning (or from gNB/LMF to UE for UE-based positioning).
* (CATT, [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc)[3]) Proposal 20: The following approaches can be supported to obtain the location coordinates of a reference device.
	+ The reference device is placed in a known position.
	+ The location of reference UE is calculated by RAT-independent positioning scheme (such as GPS etc.).
	+ The reference device is selected/placed at the location of a TRP with a known position.
* (CMCC, [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc)[5]) Proposal 1: From RAN1 perspective, support enabling a reference device with known location to mitigate and calibrate the timing/angle errors.
* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 8: Support a device to be used as a “Reference Location Device (RLD)”.
	+ Up to RAN2 to continue the specification work (and how/if to enable a UE/gNB to be a RLD).
* (OPPO, [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc)[7]) Proposal 12: Implementation based approach (Approach 2) is supported for the positioning based on reference device(s) with known location.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 1: Specification impact of reference devices includes at least assistance information which contains at least reference device ID, locations of reference devices.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 2: Study positioning procedures to support differential positioning techniques.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 3: A reference device is classified as a UE.
* (InterDigital, [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc)[8]) Proposal 4: Do not support features to allow enlistment of reference device(s) during the initial phase of reference-based positioning standardization study/work.
* (Intel, [R1-2104905](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104905.doc)[9]) Proposal 3: Support solution, where reference device is a UE, which may provide the following information based on the extended capabilities:
	+ It may be requested by LMF to provide its own known location coordinate information to LMF
	+ It may be requested by LMF to provide its antenna orientation information to LMF, if this information is available
* (Intel, [R1-2104905](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104905.doc)[9]) Proposal 4: Continue discussion on reporting format of the precisely known reference UE location coordinates from UE to LMF and whether additional indication/signaling is needed so that LMF can distinguish reference and basic UEs
	+ FFS: the details of the signaling, procedures
* (Intel, [R1-2104905](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104905.doc)[9]) Proposal 5: Specify reporting format of the reference UE antenna orientation in space from UE to LMF
	+ FFS: the details of the signaling, procedures
* (Apple, [R1-2105105](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105105.doc)[10]) Proposal 1: A reference device and any required specification is exclusively defined for a TRP, not a UE.
* (Sony, [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc)[11]) Proposal 4: Support to introduce reference device identification based on the device capability, which is to enable the LMF to select the capable devices (UE/gNB) to be reference device.
* (Sony, [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc)[11]) Proposal 5: Support to further study the signaling mechanism between reference device and LMF during the reference UE identification phase. Location uncertainty, location acquisition source and mobility of a candidate reference device can be considered as the factors of capability.
* (Nokia, R1-2105512[14]) Proposal 4: RAN1 to specific support for enabling a selected device with known location to support configuration by the network for at least some positioning calibration measurements.
* (MTK, [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc)[16]) Proposal 3-3: The inter-TRP transmission timing difference could be measured by the reference UE. Same measurement reporting as the normal UEs is expected. LMF may handle the extraction of the inter-TRP transmission timing difference from the measurement reports.
* (Lenovo, [R1-2105859](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105859.doc)[18]) Proposal 1: RAN1 to continue reference device discussions based on the FL’s latest version of the proposal (Revision 5) made during the RAN1#104-bis-e meeting.
* (Lenovo, [R1-2105859](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105859.doc)[18]) Proposal 2: Existing LPP procedures can be used to support reference devices. Other WGs such as RAN2/RAN3/SA2 can be consulted for feasibility and specification impacts.
* (Lenovo, [R1-2105859](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105859.doc)[18]) Proposal 3: Reference UE can report its location estimate information using existing LPP signalling methods or offline calibration methods.
* (Lenovo, [R1-2105859](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105859.doc)[18]) Proposal 4: Reference UE can include positioning QoS information as part of its location estimate report to determine the quality/uncertainty of the location estimate.
* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 21 No reference device should be specified in Rel. 17.

FL Comments

Based on the proposals submitted to this meeting, it seems to enable a reference device with a known location for the enhancements of the positioning performance is still supported by a majority of companies with the discussion of the benefits and potential impacts on the specification (e.g., [1][2][3][5][6][8][9][11][14][16][18]). However, there are still some different views. One of them is that the support of the feature has no specification impact [7][19], and another view is that UE’s location may not be known precisely.

Considering that the common view of the main specification impact is not in RAN1, but in other WGs, one possible way forward to conclude the discussion is to send an LS to RAN2/RAN3/SA2, informing them that RAN1 has discussed the issue, determined that there is no impact in RAN1 specification, and ask RAN2/RAN3/SA2 to take a look at the issue and determine whether there is any specification on their specifications. enhancements are needed to enable the reference UE/TRP for positioning. Proposal 4-1 is prepared in the following based on the consideration of the proposals submitted to this meeting and also the discussion in RAN1#104bs-e [21].

Proposal 4-1 (H)

* Send an LS to RAN2/RAN3/SA2, including the following content:
	+ RAN1 has evaluated the use of reference devices with known locations for positioning and observes improvements in using reference devices for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the reference UE/TRP for positioning.
	+ Notes:
		1. The reference device can either be a UE or a TRP. It is up to RAN2/RAN3 to decide what type(s) of UE/TRP can be reference devices;
		2. If the device is a TRP, it is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which will be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. If the device is a UE, it may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the device is known, the information may also be requested by the LMF. It is up to RAN2 to determine any UE capabilities if/as needed.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | Support FL’s proposal |
| OPPO | Some question for clarification:1. Is the refernce device is a stationary device or a mobile device?2. How does a refernce UE get the known location? If the refernce UE can get the known location via GNSS, why other UE cannot use GNSS to get it location? 3. How does UE know its antenna orientation information?4. Based on RAN1 evaluation, what’s the impact of the group timing delays of reference devices on the performance?  |
| CATT | Support FL’s proposal. We believe the reference devices are very important for the accuracy improvements of positioning. |
| vivo | To FL: as described in our contribution, new type of reference device rather than normal UE or gNB/TRP is discussed, we think it cannot be excluded by RAN1 and needs to be further determined by other groups. So, we suggest adding ‘new type of reference device rather than normal UE or gNB/TRP’ in Note 1.  |
| Ericsson | We do not support the proposal in the current form. To study a TRP with Rel-.16 UE positioning functionalities is far outside the scope of the work item and if the proponents want this to be studied they should bring a proposal to the RAN plenary. If the content of the LS is limited to the use of a UE as reference device it may be possible to agree on some formulation.We note that many companies seem to be interested in the use of UEs as reference device while only a few are interested in using a TRP. |
| Lenovo,Motorola Mobility | Support FL’s proposal. On the other hand, we can also live with Ericsson’s suggestion of focusing the proposal on UEs as reference device for the sake of progress. |
| QC | Support. |
| Nokia/NSB | Support. We are okay with UE only as a compromise as suggested by Ericsson.  |
| SONY | Support |
| CMCC | Support. |
| Samsung  | Fine. |
| LG | Support |
| InterDigital | Support FL’s proposal |
| OPPO | As we said, there are lots of issues for UE to server as an “reference”. In GNSS system, a reference basestation, rather than a reference satellite or a UE, is used. We can follow the similar approach for NR. Thus, we propose to change the proposal as below:* Send an LS to RAN2/RAN3/SA2, including the following content:
	+ RAN1 has evaluated the use of positioning reference unit ~~reference devices~~ with known locations for positioning and observes improvements in using positioning reference unit ~~reference devices~~ for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the positioning reference unit ~~reference UE/TRP~~ for positioning.
	+ Notes:
		1. ~~The reference device can either be a UE or a TRP. It is up to RAN2/RAN3 to decide what type(s) of UE/TRP can be reference devices;~~
		2. For the positioning reference unit ~~If the device is a TRP~~, it is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which will be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. For the positioning reference unit ~~If the device is a UE~~, it may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the positioning reference unit ~~the device~~ is known, the information may also be requested by the LMF. ~~It is up to RAN2 to determine any UE capabilities if/as needed.~~
 |
| FL | OPPO’s suggestion to use “positioning reference unit” may be a good way forward to resolve the issue. However, it is unclear to me why the first note is removed, since “positioning reference unit” is undefined in RAN1, and thus we will need RAN2 to work on it. If OPPO’s intention is to avoid mentioning UE explicitly, we may say “It is up to RAN2 to decide what types(s) of NR devices can be the “positioning reference unit”.* Send an LS to RAN2/RAN3/SA2, including the following content:
	+ RAN1 has evaluated the use of positioning reference units (PRUs) ~~reference devices~~ with known locations for positioning and observes improvements in using PRUs ~~reference devices~~ for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the ~~reference UE/TRP~~ PRUs for positioning.
	+ Notes:
		1. ~~The reference device can either be a UE or a TRP. It is up to RAN2/RAN3 to decide what type(s) of UE/TRP can be reference devices;~~ It is up to RAN2/RAN3 to decide what type of devices can be the PRUs;
		2. ~~If the device is a TRP~~ A PRU is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which will be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. A 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 ~~the device~~ is known, the information may also be requested by the LMF. ~~It is up to RAN2 to determine any UE capabilities if/as needed.~~
 |
| Nokia/NSB | We are okay in principle with the update from OPPO/FL but we feel that the main bullet should be updated to show that RAN1 has not agreed to identified specification enhancements not that we have not identified enhancements needed.  |
| Ericsson | We do not think we should introduce new terminologies/node like ‘positioning reference unit’ in RAN1. Introduction of new types of UEs or ‘positioning reference unit’ needs discussion in RAN3. Plus, we feel there is no need to capture the Notes in the LS. It is sufficient to say that whether enhancements are needed or not is up to other WGs. |
| FL | For Nokia’s comment, is the proposal to make the following changes:* RAN1 has evaluated the use of positioning reference units (PRUs) ~~reference devices~~ with known locations for positioning and observes improvements in using PRUs ~~reference devices~~ for enhancing the positioning performance. But, RAN1 has discussed, but cannot reach an agreement on the potential specification enhancements. RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the ~~reference UE/TRP~~ PRUs for positioning.

For Ericsson’s comments: 1. Is there a recommendation to replace “positioning reference units (PRUs)”?
2. The notes are for the clarification of the main bullet. They have been discussed in many rounds, after taking comments from many companies, including Ericsson’s comments. Thus, I would suggest keeping them. If there is special concern for a particular wording, then let us have a further discussion to address the concern.
 |

FL Comments

Proposal 4-1 is revised as follows based on the comments.

Proposal 4-1 (Revision 1) (H)

* Send an LS to RAN2/RAN3/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 reached the agreement on the identified specification enhancements. RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the PRUs for positioning.
	+ Notes:
		1. It is up to RAN2/RAN3 to decide what (new) type(s) of UE/TRP can be PRUs;
		2. If the PRUis a TRP, it is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which will be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. If the PRUis a UE, it 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.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Some comments:1. What does “RAN1 has not reached the agreement on the identified specification enhancements” refer to? If it refers to RAN1 spec, our group agree there are no RAN1 impact. If it refers to RAN2/RAN3/SA2 spec, how can RAN1 make any agreement for other working groups. Thus, we suggest to use the original wording.2. Based on the comment, Ericsson don’t want to support a TRP as a PRU. In our side, we don’t want to support a UE as a PRU. Vivo also support to consider other type of PRU rather than TRP/UE. That’s why I remove all the wording of TRP/UE in the proposal. RAN2/RAN3 can make their own decision. Thus, we propose to modify the proposal as below:* Send an LS to RAN2/RAN3/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 ~~reached the agreement on the~~ identified specification enhancements needed in RAN1 specifications . RAN1 kindly asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the PRUs for positioning.
	+ Notes:
		1. ~~It is up to RAN2/RAN3 to decide what (new) type(s) of UE/TRP can be~~ ~~PRUs~~;
		2. ~~If the~~ PRU~~is a TRP, it~~ is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which ~~will~~ can be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. ~~If the~~ PRU~~is a UE, it~~ 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.
 |
| CATT | Support FL’s proposal. We believe the reference devices are very important for the accuracy improvements of positioning. |
| Ericsson | Similar question as OPPO. The previous version said ‘There is no RAN1 specification impact’. The new version now says ‘RAN1 has not reached the agreement on the identified specification enhancements’. This essentially says RAN1 hasn’t done its homework. We don’t see the point of sending any LS if there is no RAN1 conclusion on specification impact related to RAN1 specs. As suggested by OPPO, we should go back to the previous version which says there is no RAN1 specification impact.Have concerns with Notes as they are specific enhancements not related to RAN1. These should be directly discussed/proposed in the other working groups. Given there is no RAN1 specification impact, RAN1 cannot suggest what enhancements the other working groups should consider.Important to clarify that “PRU” is only used as a terminology in this discussion. PRU does not mean an introduction of a new node which is none of RAN1’s business.Bottom line: For the sake of compromise and moving on with this issue, we are open to an LS that says it is upto other WGs to decide if any spec changes are needed. Suggest to remove notes, and leave discussions to other working groups. If this is not agreeable to companies, then we would have to revert to our original position which is not to agree anything. |
| SONY | Agree to send LS (latest by this RAN1#105e meeting). We also have a concern on this statement “But, RAN1 has not reached the agreement on the identified specification enhancements.”. We think RAN1 have studied and observed there are some benefits (in mitigating the timing errors). RAN1 can continues to investigate the spec impact in parallel or after getting the LS response. We suggest removing that sentence: e.g. ~~But, RAN1 has not reached the agreement on the identified specification enhancements.~~ |
| Intel | From RAN1 perspective we think that it is important to introduce a UE with known coordinate and antenna orientation in space. This will allow us to implement the calibration procedure based on Tx/Rx TEGs. The exact naming can be decided later if it is needed. |
| FL | Considering the issue related to the use of the reference device for positioning enhancements has been discussed intensively for a number of meetings, and the impact on the specification may not be in RAN1, it would be better for us to close the discussion in this meeting. OPPO’s suggestion seems to be a good compromise. Thus, I would suggest using the version suggested by OPPO, and add the Ericsson’s suggestion for the clarification of the term “positioning reference unit (PRU)” to see if we can close the discussion.  |

### Proposal 4-1 (Closed)

* Send an LS to RAN2/RAN3/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 asks RAN2/RAN3/SA2 to determine if and what specification enhancements are needed to enable the PRUs for positioning.
	+ Notes:
		1. 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.
		2. PRU is expected to support, at least, some of the Rel-16 positioning functionalities of UE, which can be defined by RAN2. The positioning functionalities may include, but not limited to, the following:
			- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
			- Transmit the UL SRS signals for positioning
		3. 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.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CATT | Support. |
| Nokia/NSB | Support. This seems like a good compromise to make progress on this issue.  |
| InterDigital | Support. |
| Ericsson | Not Support the current revision.Although some of our comments are addressed in the above version, not all concerns have been addressed. So, we cannot agree the current version. We are not ok with Notes 2 and 3. As mentioned in the main bullet, the other working groups (RAN2/RAN3/SA2) are asked to determine if there are spec enhancements needed. Hence, we don’t see the need to list specific enhancements (particularly those in notes 2 and 3) as part of the proposal. These can be directly discussed in the other working groups. So our proposal is to remove notes 2 and 3. |
| LG | We are fine with most of the proposal. However, for note 3, we prefer to add some concerns that we have. We think there might be some cases where the PRU is moved frequently or the known location of PRU from LMF is currently invalid. From this aspect, we think that it is necessary that some information such as pre-calculated/known location of PRU also needs to be provided from LMF to UE. We believe that the information is helpful for the PRU to recognize/decide whether it can be a reference or not by itself.So, we suggest to modify note 3 as below:3. PRU may be requested by the LMF to provide its own known location coordinate information to the LMF and the known(pre-calculated) location of PRU can be provided from LMF. If the antenna orientation information of the PRU is known, the information may also be requested by the LMF. |
| SONY | Support. It is already a good compromise. In our view, Note 2 and Note 3 are just guidance to other WGs to consider. |
| Nokia/NSB\_2 | To Ericsson, in note 2 and 3 are there technical concerns? It already says that the functionalities are up to RAN2 and these are not really “enhancements” if the PRU is a UE. It just says the PRU may be able to make positioning measurements, transmit SRS for positioning, and report location/orientation information. That seems fairly basic to this concept which Ericsson has said can be done by implementation.  |
| FL | It looks there is no further comment to the main bullet and the 1st note. To LG: I would suggest letting RAN2 to work on the details, including the information/messages between LMF and PRU. To the discussion between Ericsson and Nokia:Let us have further discussion online to see if we can reach a compromise. |

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

Background

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

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

FL Comments

In RAN1#104e, it was agreed that a UE/TRP will support reporting one or more measurement instances in a single measurement report, and each measurement instance is reported with its own timestamp. In RAN1#104bis-e, there was only very limited discussion on this topic due to the TU limitation.

In this meeting, many companies have presented their views on the report of one or more measurement instances in a single measurement report, especially on the FFSs in the above agreement, which are summarised as follows:

* About the measurement time window for the measurement instances:
	+ In [3], CATT proposes:
		- The measurement time windows should be configurable.
		- UE measurement time windows and TRP measurement time windows can be configured independently. They can be configured to be the same or different
		- UE (or TRP) is not expected to measure DL-PRS (or SRS-Pos) outside of the measurement time window.
	+ In [3] CATT proposes two methods for the configuration of the measurement time window (MTW) for UE/TRP with the definitions of the length of UE/TRP MTWs of these methods:
		- For Method 1, MTW is configured with the periodicity, the start time, and end time of UE/TRP (for periodic MTW).
		- For Method 2, MTW is configured with is the periodicity, the start time, and duration
	+ In [6], Qualcomm proposes support LMF sending a “Time-domain Window” configuration(s) to both UE and gNBs: Each window is defined with a start/End configuration. The device (UE/gNB) is expected to perform measurements and reporting that start no earlier than the startTime, and perform measurements no later than the EndTime.
	+ In [6], Qualcomm proposes to study further the UE behavior when a limited number (or none) of PRS instances appears within a configured time-domain window.
	+ In [13], LG proposed to introduce measurement acquisition rules on
		- UE Rx-Tx time difference measurement and gNB Rx-Tx time difference measurement
		- RSTD measurement and UE/gNB Rx-Tx time difference
	+ In [14], Nokia proposes UE to provide gNB its measurement time window for UE Rx-Tx time difference measurement.
	+ In [18], Lenovo proposes
		- The time group selection or measurement window can be associated with an ID, identifying all associated timestamps for all measurement instances within the time group selection/ measurement window for easier processing and management at the LMF.
		- Length of the DL-PRS time group selection/measurement time window should be based on a number of occasions and (N,T) DL-PRS processing UE capability.
	+ In [19], Ericsson proposed it shall be possible to configure the measurement window for a measurement instance to be so short that there is no risk for the TEG associations to change during the measurement window.

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

* About the timestamp for a measurement instance:
	+ In [1], Huawei proposes support for a single report containing multiple measurement instances, and specifying the time stamp selection for each measurement instance and scattering the measurement instances throughout the measurement time;
	+ In [2], vivo proposes the UE or the TRP can be configured to report one or more measurement instances in a single measurement report to the LMF,
	+ In [2], vivo proposes 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.
	+ In [3], CATT proposes
		- The timestamp of the UE measurement instance corresponds to any of the time instances between the first and the last DL-PRS resource set contained by the measurement instance;
		- The timestamp of the TRP measurement instance corresponds to a time instance between the first and the last SRS-Pos resource set contained by the instance.
	+ In [4], ZTE proposes the time stamp is a time window indicated by,
		- A starting timestamp that corresponds to a reception time of the first reference signal for determining a measurement instance, and
		- An ending timestamp that corresponds to a reception time of the last reference signal for determining the measurement instance.
	+ In [18], Lenovo proposes:
		- the timestamp should correspond to the reception time of the last received PRS in a set of one or more measurement instances within a time group selection or measurement window.
		- The time group selection or measurement window can be associated with an ID, identifying all associated timestamps for all measurement instances within the time group selection/ measurement window for easier processing and management at the LMF.

**FL:** Further discussion in Proposal 5-2.

* About the UE measurement instances and the number of instances of the DL-PRS Resource Set,
	+ In [4], ZTE proposes to consider a number of alternatives to configure the number of instances of DL PRS resource set in a UE measurement instance (i.e. the value N)
		- Alt 1: configured by LMF per DL PRS resource set.
		- Alt 2: configured by LMF per TRP.
		- Alt 3: configured by LMF per positioning frequency layer.
		- Alt 4: configured by LMF per measurement report.
	+ In [6], Qualcomm proposes the support of LMF requesting the UE or gNB to perform measurements on specific PRS/SRS resources across multiple time-domain instances.

**FL:** The value “N” is one of the remaining issues in the previous agreement. Further discussion in Proposal 5-3.

* About the association between measurement instances and UE measurement report
	+ In [4], ZTE proposes the following options
		- Option 1: multiple measurement instances are associated with the indicated DL PRS resource.
		- Option 2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.
		- Option 3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.
		- Option 4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.
		- Option 5: Multiple measurement instances are directly associated with a measurement report.

**FL:** Further discussion in Proposal 5-4.

* About details of procedures, and UE capability
	+ In [2], vivo proposes the relationship between ‘the number of DL-PRS Resources Set instances related to each UE measurement instance’ and ‘the number of PRS samples for RSTD/Rx-Tx time difference/PRS-RSRP measurements’ defined by RAN4’ should be clarified, and send an LS to RAN4 for consistent understanding.

**FL:** Not sure if we need to have the LS to RAN4 for this issue now. Further discussion in Proposal 5-5.

* + In [18], Lenovo proposes the existing UE timing quality indication can be extended to indicate the quality of timing-based measurement instances such as RSTD and UE Rx-Tx time difference measurements. FFS if the indication is applicable to one or more measurement instances.

**FL:** Further discussion in Proposal 5-6.

* About LPP/NRPPa signalling
	+ In [7], OPPO, proposes:
		- The current LPP signaling can support the feature that UE reports one or more measurement instances in a single measurement report to LMF, with potential extension to support a larger number than 4.
		- No enhancement is needed for the current NRPPa signaling to support the feature that TRP reports one or more measurement instances with the same quantity in a single measurement report to LMF.
		- Enhancement on the association of measurement instances should be introduced to support the feature that TRP reports one or more measurement instances with different quantities in a single measurement report to LMF.

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

* About dditional enhancement related to measurement reporting of multi-paths and quality metric
	+ (Intel, R1-2104871[9]) Proposal 6:
		- Support introduction of the LOS/NLOS indicator associated with the UE DL RSTD and UE Rx-Tx time difference measurements
		- Support introduction of the LOS/NLOS indicator associated with the gNB UL RTOA and gNB Rx-Tx time difference measurements

**FL:** Suggest the LOS/NLOS indicator to be discussed in AI 8.5.5.

### Proposal 5-1 (H)

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

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | We think there is no need to define measurement time window. The time duration between two measurement report can be seen as a measurement time window. |
| OPPO | Measurement time window is not needed. Each measurement instance is reported with its own timestamp and LMF can know whether these measure instance is close enough or not. |
| CATT | Support FL’s proposal. The The measurement time window can help LMF to eliminate the influence of timing errors of TRPs and UE. The purposes for introducing measurement time window are as follows:* Limit the measurement behaviour of UE or TRP, and only DL-PRS/ SRS-Pos resources within the measurement time window will be measured.
* Limit the measurement time of each measurement instance, and support the measurement instance which only corresponds to one DL-PRS/SRS-Pos occasion for one-shot measurement.
* Facilitate the timestamps matching among various measurement instances, e.g., among UE Rx-Tx time difference measurement instances and gNB Rx-Tx time difference measurement instances for multi-RTT positioning method.
* Indicate whether the measurement instances are measured within the same measurement time window.
* Help LMF to track and mitigate the timing error drift over time.
 |
| vivo | We wonder whether MTW is related to ‘schedule location time’ stated in the LS S2-2102048 from SA2. If it is, regarding ‘schedule location time’, companies have different understandings. And in the last meeting, RAN2 has identified many questions that need to be clarified by SA2. Therefore, the impact of schedule location time on the RAN side is still unclear. It is more appropriate to deal with this issue after RAN2 reaching a conclusion. |
| Ericsson | Not supportive of the proposal. We prefer the solution in Proposal 5-3. |
| Huawei, HiSilicon | Support in principle |
| Lenovo,Motorola Mobility | Support intention of the proposal but we view this in terms of the different sets of timestamps to be reported for easier management at the LMF. The LMF should be able to distinguish one set of timestamps of one or multiple measurement instances with another set of timestamps associated with multiple measurement instances. These sets may not be overlapping and therefore can be reported to the LMF as different sets/groups (each set comprising of timestamps of one or more measurement instances).  |
| Qualcomm | A lot of similarity between 5-1 and 5-3. Lets first agree that there will be a configured measurement window and then we can decide the details. Both 5-1 and 5-3 talk about a specific time-domain measurement window/instance to be used, just there is a different formulation in both. Suggest to merge them. |
| Apple | Support the intention |
| Nokia/NSB | Can a proponent explain how this solves the Tx/Rx timing error problem?  |
| SONY | We think MTW is not needed. |
| CMCC | We share similar view as other companies that it seems no need to define and configure the measurement time window. |
| Samsung  | No need the MTW for now. |
| LG | We are supportive. Without measurement time window, UE can report the UE Rx-Tx time difference measurement based on the most recent measurement samples, but the gNB can assume the UE which is semi-static, and then it may calculate the average value of the gNB Rx-Tx time difference measurement acquired over a relatively long time duration for the improved measurement accuracy. It leads to an inaccurate RTT measurement at the LMF. Thus, both of the UE and the gNB should follow an aligned rule (within measurement time window) to determine a measurement for reporting of the Rx-Tx time difference and RSTD. |

Proposal 5-2 (H)

* The timestamps for the measurement instances in a measurement report are defined by one of the following options:
	+ Option 1:
		- The timestamp of a UE (or TRP) measurement instance can be any time instance between the reception time of the first and the last DL-PRS resource set(s) (or SRS-Pos resource set(s)) that are used to determining the measurement instance.
	+ Option 2:
		- The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource set (or the last SRS-Pos resource set) that are used to determining the measurement instance.
	+ Option 3:
		- Not specify the timestamps for the measurement instances (i.e., up to UE/TRP implementation)

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE  | We suggest to add a new option:* + Option 4:
		- The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the ~~last~~ first DL-PRS resource set (or the ~~last~~ first SRS-Pos resource set) that are used to determining the measurement instance.
 |
| OPPO | Reuse the same meaning of timestamps in TS 37.355, i.e., timestamp specifies the time instance at which the measurement instance is performed |
| CATT | We support Option1. |
| vivo | Option2 is preferred. |
| Ericsson | We support option 2. Good with a well defined UE/TRP behaviour. The reception time of the last DL-PRS resource set is a bit unclear (e.g. which PRS resource in the set is used for the time stamp?) |
| Huawei, HiSilicon | Support Option 2. |
| Lenovo,Motorola Mobility | Support Option 2, the timestamp should be associated with the last measured DL-PRS resource (to avoid ambiguity mentioned by Ericsson).  |
| Nokia/NSB | We are okay with Option 2. Good to have common understanding between LMF and UE/TRP on the timestamp meaning.  |
| SONY | Same view as OPPO |
| CMCC | We are OK with Option 2. |
| Samsung  | Option 2. |
| FL | Based on the comments, most companies are fine with Option 2, and no company support Option 3.For OPPO and SONY’s comment, the problem with the current definition in TS 37.355, i.e., timestamp specifies the time instance at which the measurement instance is performed” is that the measurement may be obtained by multiple measurement instances. The question is which one should be used. There is a need for the clarification. f anyone can be used, then it is Option 1. Since most companies are fine with Option 2. Suggest take Option 2, since it seems  |

FL Comments

### Proposal 5-2 (Revision 1)(H)

* The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the last DL-PRS resource set (or the last SRS-Pos resource set) that are used to determining the measurement instance.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| vivo | OK |
| ZTE | We are not sure the value N(instances of PRS in a measurement instance) is configured per resource set, or per TRP, or per frequency layer, etc. For example, if N is configured per TRP, different PRS resource sets in this TRP may have different periodicities, whether N is the instance of the larger period PRS resource set or the smaller period of PRS resource set? So the question is,**If timestamp is only about a first or last reception time, and N can not be guaranteed, the length of each measurement instance can not be settled.**So we suggest to add another option to clarify that the length of measurement instance can be acquired through the timestamp in option 2:The timestamps for the measurement instances in a measurement report are 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 set/PRS resource (or the last SRS-Pos resource set/SRS-Pos resource) that are used to determining the measurement instance.
* Option 2: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the first and last DL-PRS resource set/PRS resource (or the first and last SRS-Pos resource set/SRS-Pos resource) that are used to determining the measurement instance.
* Note: other options are not precluded.
 |
| LG | We slightly support ZTE’s proposal.  |
| Ericsson | Support FL’s proposal. |
| Apple | Questions for clarification, does the proposal address the case we have multiple measurement instances per each measurement report? If so, what is Rel-16 behavior (in our understanding, timestamp is associated with the instance that UE really performs measurement). Why can’t we go with the same specification? What’s the enhancements? |
| Nokia/NSB | We are okay to go with resource instead of resource set. |
| FL | To Apple:The problem with the current definition in TS 37.355, i.e., “timestamp specifies *the time instance* at which the measurement instance is performed” is that UE may obtains the measurement at multiple *time instances* (e.g., from multiple DL-PRS resource sets that are transmitted in different *time* *instances in multiple DL PRS periods*. It is unclear based on the currenty definition on which one of the different *time* *instances* should be used as the timestamp for the measurement instance. To ZTE:Okay. Let us further discuss the options and make the decision in the next meeting. |

### Proposal 5-2 (Revision 2)(H)

The timestamps for the measurement instances in a measurement report are 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 set/PRS resource (or the last SRS resource set/SRS resource for the positioning purpose) that are used to determining the measurement instance.
* Option 2: The timestamp of the UE (or TRP) measurement instance corresponds to the reception time of the first and last DL-PRS resource set/PRS resource (or the first and last SRS resource set/SRS resource for the positioning purpose) that are used to determining the measurement instance.
* Note: other options are not precluded.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| Huawei, HiSilicon | Just to clarify our understanding here that the timestamp is the timestamp in the measurement report? In addition, we think that the SRS-Pos resource and SRS-Pos resource set, since we are discussing the TRP measurement as well, we do not want to exclude MIMO-SRS here. It should be SRS resource set/SRS resource for the positioning purpose. |
| ZTE | Support FL’s proposal |
| OPPO | Some questions for clarification1. Reagarding “the reception time of the last DL-PRS resource set/PRS resource”, does it refer to the reception of the first symobol or the last symbol for the PRS? We should make it clear for this proposal2. Regarding Option 2, the timestamp corresponding to the reception time of the first and the last PRS. Which is the correct understanding? (Assume t1 is the reception time of the first PRS and t2 is the reception time of the last PRS) \*Alt.1: the timestamp is a function of (t1, t2), whether this function will be discussed later \*Alt.2. UE can freely to choose the timestamp within the range [t1, t2] \*Alt.3: It is up to UE to choose the timestamp as t1 or t2 \* … |
| FL | To Huawei:We have the agreement that there is timestamp from each measurement instance in the measurement report.I assume it is reasonable to change the “SRS-Pos resource/ SRS-Pos resource” to ” SRS resource set/SRS resource for the positioning purpose”To OPPO and ZTE:I assume the intention of the Option 2 (proposed by ZTE) is to include both of the first and last times. Maybe ZTE can clarify the Option 2 a little further. |

### Proposal 5-3 (H)

* Each UE measurement instance can be configured by LMF with *N* instances of the DL-PRS Resource Set, where
	+ Option 1: N=[1,2, 4, 8,…,256]
		- FFS: the configuration is per measurement report, or per TRP, or per positioning frequency layer
	+ Option 2: *N* is decided by RAN4
* Each TRP measurement instance can be configured by LMF with *M* instances of the UL-SRS Resource Set, where
	+ Option 1: M=[1,2, 4, 8,…,256]
		- FFS: the configuration is per measurement report, or per TRP, or per positioning frequency layer
	+ Option 2: the configuration is decided by RAN4

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | The FFS should include that N is configured per DL-PRS resource set, because even for a same TRP, different measurement instances may have different instances of its corresponding PRS resource set. Like the figure used in our tdoc(with a little modification), measurement instance 1 contains 3 times of PRS resource set 1, measurement instance 2 contains 2 times of PRS resource set 2.measurement instance-1 |
| OPPO | It up to RAN4 (i.e., RAN4) as the number is related to the positioning requirement |
| CATT | Support FL proposal. |
| vivo | Support option2.The relationship between ‘the number of DL-PRS Resources Set instances related to each UE measurement instance’ and ‘the number of PRS samples for RSTD/Rx-Tx time difference/PRS-RSRP measurements’ defined by RAN4’ should be clarified. In TS38.133, in RSTD measurement requirement, ‘$N\_{sample}$’ is defined as the number of PRS RSTD samples (or instances of DL-PRS Resource Set here) and ‘$N\_{sample}$’= 4. The motivation behind allowing more than one PRS sample in defining the measurement period is to ensure that with channel variations or deep fading, there is at least one PRS sample that satisfies the side conditions. That is, the UE needs to measure 4 PRS samples to get a measurement result. Compared with the requirement of RAN4, RAN1 seems to be more inclined to configure the number of DL-PRS Resource Set instances in a measurement instance flexibly. Therefore, we suggest to ask RAN4 to reach a consensus, and then we can determine the value of N and whether N can be configured by the network. |
| Ericsson | We support Option 1. We understand this as that each measurement instance utilize max N occasions of a DL PRS resource set. Important to be able to configure UE to use only one DL PRS occasion (i.e. not to filter/average) so that timing errors don’t drift during the measurement instance. |
| Huawei, HiSilicon | Support. |
| Lenovo,Motorola Mobility | Support FL’s proposed options for both UE and TRP measurement instances. Options can be further downselected at a later stage. |
| Qualcomm | A lot of similarity between 5-1 and 5-3. Lets first agree that there will be a configured measurement window and then we can decide the details. Both 5-1 and 5-3 talk about a specific time-domain measurement window/instance to be used, just there is a different formulation in both. Suggest to merge them.For example, if the measurement window is small enough, then there will “N=1” instances inside. Whether we count the window in “instances” or in “start/end” is a detail.  |
| Nokia/NSB | Can a proponent explain how this mitigates Rx/Tx timing errors?  |
| CMCC | It can be up to RAN4 |
| Samsung  | Either option2 or we can discuss further. |
| LG | It is up to RAN4. However, since some companies consider N=1 instance for latency reduction, we are open to inform RAN4 with related information. |
| ZTE2 | The FFS in the second bullet, positioning frequency layer should be replaced by carrier since SRS does not have frequency layer.  |
|  |  |

### Proposal 5-4

* Consider the following options for the measurement enhancements:
	+ Option 1: multiple measurement instances are associated with the indicated DL PRS resource.
	+ Option 2: For each indicated DL PRS resource set in a measurement report, multiple measurement instances are associated with the indicated DL PRS resource set.
	+ Option 3: For each indicated measurement element (i.e. TRP) in a measurement report, multiple measurement instances are associated with the indicated measurement element.
	+ Option 4: For each indicated positioning method in a measurement report, multiple measurement instances are associated with the indicated positioning method.
	+ Option 5: Multiple measurement instances are directly associated with a measurement report.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| ZTE | We prefer option 3. |
| OPPO | More discussion is needed. There are some overlapping between different options. Option 3 is our first preference. |
| CATT | We prefer Option 2. Each UE measurement instance can be configured with N instances of the DL-PRS Resource Set. |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

### Proposal 5-6

* Discuss whether to send an LS to RAN4 for the clarification of the relationship between ‘the number of DL-PRS Resources Set instances related to each UE measurement instance’ and ‘the number of PRS samples for RSTD/Rx-Tx time difference/PRS-RSRP measurements’.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| CATT | Support. According to TS38.133, the UE needs to measure 4 DL-PRS samples to get a RSTD/Rx-Tx time difference/PRS-RSRP measurements. Therefore, we prefer to send an LS to RAN4 for the clarification of the N (instances of the DL-PRS Resource Set). |
| ZTE | This is discussed in agenda 8.5.4, no need to repeat it in 8.5.1 |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

### Proposal 5-5

* Support extending the existing UE timing quality indication to indicate the quality of timing-based measurement instances such as RSTD and UE Rx-Tx time difference measurements.
* FFS if the indication is applicable to one or more measurement instances.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Additional proposals

## Configure an SRS with a spatial relation towards a DL PRS or SSB

Submitted Proposals

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 8 It shall be possible to configure an SRS with a spatial relation towards a DL PRS or SSB together with a configuration to utilize a certain UE TX TEG.

FL comments

For the estimation UE TX timing error difference, it was proposed in [19] to configure an SRS with a spatial relation towards a DL PRS or SSB together with a certain delay group, in order to support the UE to transmit each SRS towards TRPs with each delay group (i.e., antenna panel). A similar proposal was discussed in RAN#104e without a conclusion. Suggest further discuss the proposed enhancement, including the potential benefits and implementation issues.

### Proposal 6.1-1

* Support to configure an SRS with a spatial relation towards a DL PRS or SSB together with a configuration to utilize a certain UE TX TEG

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |
|  |  |
|  |  |

## Beam and delay group sweeping

Submitted Proposals

* (Ericsson, [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc)[19]) Proposal 9 Support SRS with beam and UE TX TEG sweeping.

FL Comments

In [19], beam and UE TX TEG sweeping is supported for the SRS to reduce positioning overhead for multi antenna panel SRS transmission scheme.

### Proposal 6.2-1

* Study whether and how to support beam and UE TX TEG sweeping for the transmission of the UL Positionig SRS.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# LS To/From other WGs

## Reply LS SA2 (R1-2102306)

Background

In the LS from SA2 (R1-2102306), SA2 asks RAN1 and RAN2 whether support can be provided for a scheduled location time as part of Rel-17 and as defined in the attached CR to TS 23.273.

Submitted Proposals

* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 9: Send a draft Reply LS:
	+ RAN1 thanks SA2 for their LS on Scheduling Location in Advance to reduce Latency.
	+ RAN1 discussed the subject matter and agrees that scheduling location in advance is within the positioning enhancement work item objective, and RAN1 will target supporting this feature in Rel-17 positioning enhancement time frame in alignment with the CR received from SA2.
* (Qualcomm, [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc)[6]) Proposal 10: Send a draft Reply LS:
	+ For UE-based positioning, a UE is expected to report a location estimate which is valid for the requested “Location Time”.

FL comments

The proposals can be discussed in the email thread for the reply LS to SA2.

Comments

|  |  |
| --- | --- |
| **Company** | **Comments**  |
| OPPO | Where is the attached CR? I don’t find the attached CR in the LS |
| Nokia/NSB | Agree with FL comments.  |
|  |  |
|  |  |
|  |  |

# References

1. [R1-2104277](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104277.doc) Enhancement to mitigate gNB and UE Rx/Tx timing error Huawei, HiSilicon
2. [R1-2104359](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104359.doc) Discussion on potential enhancements for RX/TX timing delay mitigating vivo
3. [R1-2104520](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104520.doc) Discussion on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays CATT
4. [R1-2104590](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104590.doc) Positioning accuracy improvement by mitigating timing delay ZTE
5. [R1-2104611](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104611.doc) Discussion on mitigation of gNB/UE Rx/Tx timing errors CMCC
6. [R1-2104671](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104671.doc) Enhancements on Timing Error Mitigations for improved Accuracy Qualcomm Incorporated
7. [R1-2104739](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104739.doc) Enhancement of timing-based positioning by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays OPPO
8. [R1-2104871](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104871.doc) Discussion on accuracy improvements by mitigating timing delays InterDigital, Inc.
9. [R1-2104905](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2104905.doc) Mitigation of UE/gNB TX/RX Timing Errors Intel Corporation

1. R1-2105105 Positioning accuracy enhancements under timing errors Apple
2. [R1-2105168](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105168.doc) Discussion on mitigating UE Rx/Tx and gNB Rx/Tx timing delays Sony

1. R1-2105310 Discussion on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Samsung
2. [R1-2105482](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105482.doc) Discussion on accuracy improvement by mitigating UE Rx/Tx and gNB Rx/Tx timing delays LG Electronics
3. [R1-2105512](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105512.doc) Views on mitigating UE and gNB Rx/Tx timing errors Nokia, Nokia Shanghai Bell
4. [R1-2105699](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105699.doc) Discussion on mitigating UE and gNB Rx/Tx timing delays NTT DOCOMO, INC.
5. [R1-2105759](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105759.doc) Mitigation of RX/TX timing delays for higher accuracy MediaTek Inc.
6. [R1-2105856](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105856.doc) On methods for Rx/Tx timing delays mitigation Fraunhofer IIS, Fraunhofer HHI
7. [R1-2105859](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105859.doc) Enhancements for mitigation of Tx/Rx Delays Lenovo, Motorola Mobility
8. [R1-2105908](file:///E%3A%5C1%20Meetings%5CRAN1%5CDocs%5CR1-2105908.doc) Techniques mitigating Rx/Tx timing delays Ericsson
9. RP-202900, “New WID on NR Positioning Enhancements”, CATT, Intel Corporation, Ericsson, December 7th – 11th, 2020.
10. R1- 2103992, FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays, Moderator (CATT)
11. R1-2105937 Discussion on scheduling location in advance to reduce latency Huawei, HiSilicon
12. R1-2104167 Response LS on Scheduling Location in Advance to reduce Latency RAN2, Qualcomm