**3GPP TSG RAN WG1 Meeting #104bis-e R1-2104053**

**e-meeting, April 12th– 20th, 2021**

**Title: [DRAFT] LS on UE/TRP Tx/Rx Timing Errors**

**Release:** Rel-17

**Work Item:** NR\_pos\_enh

**Source:** CATT [RAN1]

**To:** RAN4

**Cc:**

**Contact Person:**

#### Name: Ren Da

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**Attachments:** None

**1. Overall Description:**

RAN1 has started working on Rel-17 WI on NR Positioning Enhancements [1]. One of the WI objectives is as follows:

* *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*
	+ *DL, UL and DL+UL positioning methods*
	+ *UE-based and UE-assisted positioning solutions*

When working on the above objective, RAN1 has made the following agreement in RAN1#104bis-e:

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| 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
	+ 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 signalling, procedures, and UE capability
* Send an LS to RAN4 to check if there is any issue to support the above enhancements

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

Agreement: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:* 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
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The definitions of UE/TRP Tx/Rx timing errors and UE/TRP Tx/Rx/RxTx timing error groups were agreed in RAN1#104e as follows:

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| 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.
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**2. Actions:**

**To RAN4:** RAN1 kindly requests RAN4 to review the above RAN1 agreements and provides feedback in case RAN4 has any suggestions and/or comments, especially the feasibility for a UE to determine its UE Tx TEG, UE Rx TEG, UE RxTx TEG, the feasibility for a gNB to determine its TRP Tx TEG, TRP Rx TEG, TRP RxTx TEG.

**3. Date of Next TSG-RAN WG1 Meetings:**

TSG-RAN WG1 Meeting #105-e May 19 – 27, 2021

TSG-RAN WG1 Meeting #106-e Aug 16 – 27, 2021

**4. References:**

1. RP-210903, Revised WID on NR Positioning Enhancements, Intel Corporation, CATT