**3GPP TSG RAN WG1 Meeting #107-e R1-211xxxx**

e-Meeting, 11th – 19th November 2021 (Rev. R1-2110690)

**Agenda Item: 8.5**

**Source: Rapporteur (CATT)**

**Title: Summary of RAN1 agreements for Rel-17 NR Positioning Enhancements**

**Document for: Information**

1. Introduction

This contribution lists RAN1 agreements made so far for the Rel-17 WI on “NR Positioning Enhancements” [1]

2. Accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays

## RAN1#104e:

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| [**R1-2101764**](file:///Users/renda000/Downloads/Docs/R1-2101764.zip) **FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**[**R1-2101951**](file:///Users/renda000/Downloads/Docs/R1-2101951.zip) **FL Summary #2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**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 signalling, 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

[**R1-2102035**](file:///Users/renda000/Downloads/Docs/R1-2102035.zip) **FL Summary #3 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**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.

[**R1-2102122**](file:///Users/renda000/Downloads/Docs/R1-2102122.zip) **FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**Conclusion: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 signalling, 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.

Conclusion: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 signalling, 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.

Conclusion:Study the following options for mitigating UE Rx/Tx timing errors in DL+UL positioning: * Option 1:
	+ Support UE to provide the association information of UE Rx-Tx time difference measurements with UE Rx TEGs in the measurement report to LMF
* Option 2:
	+ Support UE to provide the association information of UE Rx-Tx time difference measurements with UE Tx TEGs in the measurement report to LMF
* Option 3:
	+ Combination of Option 1 and Option 2;
* Option 4:
	+ Support UE to provide the association information of UE Rx-Tx time difference measurements with UE RxTx TEGs in a measurement report to LMF for multi-RTT positioning
		- FFS: the definition of UE RxTxTEG. It includes both UE Rx timing and Tx timing errors.
* Option 5:
	+ Support UE to provide the association information of DL-RSTD measurements with UE RxTx TEGs in a measurement report to LMF for simultaneous DL-TDOA and UL-TDOA configuration for positioning
* Option 6:
	+ Support UE to provide the timing errors per Rx/Tx TEG, or the timing error differences between the Tx/Rx TEGs to LMF
* Option 7:
	+ Support UE to provide the timing errors per RxTx TEG, or the Tx timing error differences between the RxTx TEGs to LMF
* FFS: the details of signaling, 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.

Conclusion:Study the following options for mitigating gNB Rx/Tx timing errors in DL+UL positioning: * Option 1:
	+ Support TRP to provide the association information of gNB Rx-Tx time difference measurements with TRP Rx TEGs in the measurement report to LMF
* Option 2:
	+ Support TRP to provide the association information of gNB Rx-Tx time difference measurements with TRP Tx TEGs in the measurement report to LMF
* Option 3:
	+ Combination of Option 1 and Option 2;
* Option 4:
	+ Support TRP to provide the association information of gNB Rx-Tx time difference measurements with TRP RxTx TEGs in a measurement report to LMF for multi-RTT positioning
* Option 5:
	+ Support TRP to provide the timing errors per Rx/Tx TEG, or the timing error differences between the Tx/Rx TEGs to LMF
* Option 6:
	+ Support TRP to provide the timing errors per RxTx TEG, or the Tx timing error differences between the RxTx TEGs to LMF
* FFS: the details of signalling and procedures
* 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.

**Decision:** As per email posted on Feb 5th,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 signalling, 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.

Final summary in [R1-2102204](file:///Users/renda000/Downloads/Docs/R1-2102204.zip). |

## RAN1#104bis-e:

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| **R1-2103781 FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**[104b-e-NR-ePos-01] – Ren Da (CATT)Email discussion/approval on accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays with checkpoints for agreements on Apr-15, Apr-20**R1-2103875 FL Summary #2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)****R1-2103992 FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**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

**R1-2104053 [DRAFT] LS on UE/TRP Tx/Rx Timing Errors CATT****Decision:** As per email decision posted on April 20th, the draft LS is endorsed. Final version is approved in R1-2104111. |

## RAN1#105e:

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| **[R1-2105967](../Docs/R1-2105967.zip) FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**[105-e-NR-ePos-01] – Ren Da (CATT)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**[R1-2106091](../Docs/R1-2106091.zip) FL Summary#2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**[**R1-2106156**](../Docs/R1-2106156.zip) **FL Summary#3 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**[**R1-2106259**](../Docs/R1-2106259.zip) **FL Summary#4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**From GTW sessions: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

Agreement:Send an LS to RAN2/RAN3 (cc SA2), including the following content:* RAN1 has evaluated the use of positioning reference units (PRUs) with known locations for positioning and observes improvements in using PRUs for enhancing the positioning performance. But, RAN1 has not identified specification enhancements needed in RAN1 specifications. RAN1 kindly requests RAN2/RAN3 (cc SA2) to determine if and what specification enhancements are adopted for PRUs for positioning.
* Notes:
	+ The term “positioning reference unit (PRU)” is only used as a terminology in this discussion. PRU does not necessarily mean an introduction of a new network node.
	+ PRU may support, at least, some of the Rel-16 positioning functionalities of UE, if agreed, which is up to RAN2. The positioning functionalities may include, but not limited to, the following:
		- Provide the positioning measurements (e.g., RSTD, RSRP, Rx-Tx time differences)
		- Transmit the UL SRS signals for positioning
	+ PRU may be requested by the LMF to provide its own known location coordinate information to the LMF. If the antenna orientation information of the PRU is known, the information may also be requested by the LMF.

[**R1-2106265**](../Docs/R1-2106265.zip) **[Draft] LS on positioning reference unit (PRU) for enhancing the positioning performance CATT****Decision:** As per decision posted on May 27th, the draft LS is endorsed. Final version is approved in [R1-2106326](../Docs/R1-2106326.zip).Agreement:For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE may support, up to UE capability, one or both of the following options:* Option 1: Reporting of UE RxTx TEG ID is supported by the UE
	+ FFS: Further details on how the RxTx TEG IDs are related/associated to Tx TEG IDs and/or Rx TEG IDs and to the Rx-Tx measurements.
* Option 2: Reporting of UE RxTx TEG ID is not supported by the UE; reporting of Rx TEG ID and Tx TEG ID is supported.
* In either option, a Tx TEG ID is associated with (downselection needed)
	+ Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the Rx-Tx measurement
	+ Alt. 2: the Tx timing of the Rx-Tx measurement
	+ Alt. 3: one or more UL SRS resources for positioning
* Note: An Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement
* FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).
* FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements

Final summary in:[**R1-2106339**](../Docs/R1-2106339.zip) **FL Summary#5 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)** |

## RAN1#106e:

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| [**R1-2108241**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108241.zip) **FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)****Decision:** From GTW session on Aug 16th,Agreement:* Subject to UE capability, support a UE to include one UE Rx TEG ID for the RSTD reference time and one UE Rx TEG ID for each DL RSTD measurement (including each additional DL RSTD measurement), in a DL TDOA measurement report. These UE Rx TEG IDs can be the same or different.
* Note: RSTD reference time is related to the DL\_PRS\_Reference\_Info IE

[**R1-2108242**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108242.zip) **FL Summary #2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)****Decision:** From GTW session on Aug 18th,Agreement:Make the following modification of the previous agreement:For mitigating UE Tx/Rx timing errors for DL+UL positioning, a UE ~~may~~ should support, up to UE capability, either one or both of the following options:* Option 1: Reporting of UE RxTx TEG ID ~~is supported by the UE~~
	+ FFS: Further details on how the UE RxTx TEG IDs are related/associated to UE Tx TEG IDs and/or UE Rx TEG IDs and to the UE Rx-Tx measurements.
* Option 2: Reporting of ~~UE RxTx TEG ID is not supported by the UE; reporting of~~ UE Rx TEG ID and UE Tx TEG ID ~~is supported~~.
* In either option, a UE Tx TEG ID is associated with (downselection needed)
	+ Alt. 1: an UL SRS resource for positioning corresponding to the Tx timing of the UE Rx-Tx measurement
	+ Alt. 2: the Tx timing of the UE Rx-Tx measurement
	+ Alt. 3: one or more UL SRS resources for positioning
* Note: An UE Rx TEG ID is associated with one DL PRS resource (or more DL PRS resources) corresponding to the Rx time of the measurement
* FFS: How to resolve potential mismatch between UE and gNB Rx-Tx time difference measurements (e.g. UE provides the UE Rx-Tx measurements associated with a Tx TEG with SRS1, while gNB provides the gNB Rx-Tx measurements with a Rx TEG associated with SRS2).
* FFS: The potential impact and modification on the definition of Rx-Tx time difference measurements

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

[**R1-2108243**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108243.zip) **FL Summary #3 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**From GTW session:Agreement:* Consider supporting one of the following alternatives related to the UE Rx-Tx time difference (decision to be made in RAN1#106b):
	+ Option 1:
		- Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.
		- Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):
			* If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it shall compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS.
	+ Option 2:
		- Subject to a UE capability, a UE may optionally report Timing Adjustment (TA) change information
			* Option 3A: The TA change information is included in the UE Tx TEG report
			* Option 3B: The TA change information is included in the Rx-Tx measurement report
			* Note: TA change information corresponds to: Tx Timing change with a timestamp that this change occurred.
	+ Option 3:
		- Subject to UE capability, the UE may report an additional UL Timestamp associated to a UE Rx-Tx measurement, corresponding to the timing of the uplink subframe of a positioning SRS.
		- Add the following to the UE Rx-Tx time difference definition (similar to the definition for HD-FDD UE in TS 36.214):
			* If the UE does not transmit SRS in subframe #j, and if the UE reports an additional timestamp for the positioning SRS associated to the measurement, it is up to UE to compensate for the difference in the transmit timing of uplink subframe #j and the transmission timing of the subframe containing positioning SRS, or include the difference (Timing Adjustment change) without compensation within the report
	+ Other options are not precluded.

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

[**R1-2108244**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108244.zip) **FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**From GTW session:Agreement:* If a Tx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE should also report the association of the Tx TEG ID to the UL SRS resource(s)
	+ FFS: how the the association of the Tx TEG ID to the UL SRS resource(s) is determined by UE.
	+ FFS: details of the signalling

Agreement:If a RxTx TEG ID is reported with a UE Rx-Tx time difference measurement, the UE may optionally also report a Tx TEG ID. Final summary in [R1-2108245](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108245.zip). |

## RAN1#106bis-e:

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| **R1-2110391** FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing Delays Moderator (CATT)**R1-2110392** FL Summary #2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**R1-2110393** FL Summary #3 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**R1-2110579** FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)Working assumption:* + - For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
			* The serving gNB should forward the association information provided by the UE to the LMF.
				+ FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs
			* UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
		- For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs *directly* to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
			* FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs
			* UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT *directly* to the LMF.
		- FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.

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

Agreement:* For mitigating TRP Tx/Rx timing errors for DL+UL positioning, when a gNB reports a gNB Rx-Tx time difference measurement, the gNB can support either or both of the following options:
* Option 1: Reporting of a TRP RxTx TEG ID, and optionally a TRP Tx TEG ID
* Option 2: Reporting of a TRP Rx TEG ID and a TRP Tx TEG ID
* Note: The TRP Rx TEG ID is associated with one UL positioning SRS resource (or more UL positioning SRS resources) corresponding to the Rx time of the gNB Rx-Tx time difference measurement.
* If a TRP Tx TEG ID is reported with a gNB Rx-Tx time difference measurement, the gNB also reports the association of the TRP Tx TEG ID to the DL PRS resource(s) to the LMF under the condition that the TRP has more than one DL PRS resource.
* FFS: how the association of the Tx TEG ID to the DL PRS resource(s) is determined by the TRP and how the association is reported to the LMF.
* FFS: details of the signalling

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

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| **Parameter Description** | **Values in specifications (e.g., TS 37.355, TS 38.455)** | **Values that can be signaled as part of UE Capability** | **Comments** |
| The maximum number of UE RxTEGs [for UE-assisted DL TDOA and/or Multi-RTT] | [32]  | [1, 2,4,6,8,12,16,24,32]FFS: per UE/band /FL/FR | The parameter is used for supporting DL-TDOA and/or Multi-RTT |
| The maximum number of UE TxTEGs [for UL-TDOA and/or Multi-RTT] | [8] | [1, 2,4,6,8]FFS: per UE/band /FL/FR | The parameter is used for supporting UL-TDOA and/or Multi-RTT |
| The maximum number of UE-RxTx TEGs | [256]  | [1, 2,4,6,8,12,16,24,32,64, 128, 256]FFS: per UE/band /FL/FR  | The parameter is used for supporting Multi-RTT |

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

## RAN1#107-e:

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| **R1-2112510** FL Summary for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**Agreement**Confirm and modify the working assumption with the following modifications:* For mitigating UE Tx timing errors for UL TDOA, subject to UE’s capability, support the serving gNB to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs to the serving gNB if the UE supports multiple UE Tx TEGs for UL TDOA.
	+ The serving gNB should forward the association information provided by the UE to the LMF.
		- ~~FFS: whether to support the serving gNB to forward the association information to the neighboring gNBs~~
	+ UE should report its capability of supporting multiple UE Tx TEGs for UL TDOA to serving gNB.
* For mitigating UE Tx timing errors for Multi-RTT, subject to UE’s capability, support the LMF to request a UE to provide the association information of UL SRS resources for positioning with Tx TEGs directly to the LMF if the UE supports multiple Tx TEGs for Multi-RTT.
	+ ~~FFS: whether to support the LMF to forward the association information to the serving and neighboring gNBs~~
	+ UE should report its capability of supporting multiple UE Tx TEGs for Multi-RTT directly to the LMF.
* Note: For mitigating UE Tx timing errors when both UL-TDOA and Multi-RTT, or UL-TDOA and DL-TDOA are used, the UE should provide the association information of UL SRS resources for positioning with Tx TEGs, subject to UE capability (in the bullets above):
	+ to the serving gNB if a request to provide the association information is received from the gNB
	+ to the LMF if a request to provide the association information is received from the LMF.
* ~~FFS: Mitigation of UE Tx timing errors when Multi-RTT, UL-TDOA and/or DL-TDOA are used.~~

**R1-2112511** FL Summary #2 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**Agreement**Make the following modification on the previous agreement made in RAN#106bis-e:* Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple RSTD measurements.
	+ - N=[2, 3, 4, 6, 8] ~~(FFS: other values),~~ where the maximum value of N depends on UE capability, and applies to all DL PRS positioning frequency layers
		- Note: If N is not explicitly included in the request, it is up to UE to determine the number of different UE Rx TEGs to measure the same DL PRS resource within its capability
	+ The TRP can be either a “RSTD” reference TRP or a neighbour TRP
	+ FFS: details of the signalling, procedures, and UE capability
	+ The timestamps of the multiple RSTD measurements in the same measurement report can be the same or different.
	+ Note: All RSTD measurements are relative to a single reference timing
* Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP Rx TEGs and report the corresponding multiple RTOA measurements.
	+ M = [2, 3, 4, 6, 8] ~~(FFS: other values)~~  applies to all configured SRS resources ~~for positioning~~
	+ Note: If M is not explicitly included in the request, it is up to TRP to determine the number of different TRP Rx TEGs to measure the same SRS resources for positioning
	+ FFS: details of the signalling, procedures
	+ The timestamps of the multiple RTOA measurements in the same measurement report can be the same or different.

**Agreement**Each measurement instance in a TRP measurement report can be configured by LMF with either N=1 or 4 SRS measurement time occasions.**Agreement*** Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE Rx TEGs and report the corresponding multiple UE Rx-Tx time difference measurements.
	+ - N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability, and applies to all DL PRS positioning frequency layers
		- Note: If N is not explicitly included in the request, it is up to UE to determine the number of different UE Rx TEGs to measure the same DL PRS resource within its capability
	+ FFS: details of the signalling, procedures, and UE capability
	+ The timestamps of the multiple UE Rx-Tx time difference measurements in the same measurement report can be the same or different.
* Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP Rx TEGs and report the corresponding multiple gNB Rx-Tx time difference measurements.
	+ M = [2, 3, 4, 6, 8] applies to all configured SRS resources.
	+ Note: If M is not explicitly included in the request, it is up to TRP to determine the number of different TRP Rx TEGs to measure the same SRS resources
	+ FFS: details of the signalling, procedures
	+ The timestamps of the multiple gNB Rx-Tx time difference measurements in the same measurement report can be the same or different.

**R1-2112512** FL Summary #3 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**R1-2112513** FL Summary #4 for accuracy improvements by mitigating UE Rx/Tx and/or gNB Rx/Tx timing delays Moderator (CATT)**Agreement*** For UL-TDOA, supporting the following for the serving gNB to request a UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning, subject to UE capability of supporting UE Tx TEG:
	+ Based on a configured periodicity, a UE may report the UE Tx TEG association for the SRS resources for positioning that have already been transmitted during the configured period
		- It is up to RAN2 to decide how to indicate the change of the Tx TEG association during the configured period (e.g., using the timestamps)
		- It is up to RAN4 to decide when the Tx TEG association is changed
	+ The values of the configurable periodicities are up to RAN2
	+ Note: Tx TEG association information reporting by single request/response mode is assumed already supported with the previous agreement.
* Send an LS to RAN2/RAN4 (cc: RAN3)
	+ to RAN2, including the following RAN1’s agreement related to the reporting of the UE Tx TEG, for RAN2 to work on the signaling
	+ to RAN4 for checking the agreement and work on how to decide when the Tx TEG association is changed

R1-211xxxx [DRAFT] LS on the reporting of the Tx TEG association information Moderator (CATT)(To be reviewed and endorsed on Nov 29~30)**Agreement*** Subject to UE capability, support the LMF to request a UE to optionally measure the same DL PRS resource of a TRP with N different UE RxTx TEGs with the same UE Tx TEG, and report the corresponding multiple UE Rx-Tx time difference measurements.
	+ - N=[2, 3, 4, 6, 8], where the maximum value of N depends on UE capability, and applies to all DL PRS positioning frequency layers
		- Note: If N is not explicitly included in the request, it is up to UE to determine the number of different UE RxTx TEGs to measure the same DL PRS resource within its capability
	+ FFS: details of the signalling, procedures, and UE capability
	+ The timestamps of the multiple UE Rx-Tx time difference measurements in the same measurement report can be the same or different.
* Support the LMF to request a TRP to optionally measure the same SRS resource of a UE with M different TRP RxTx TEGs with the same TRP Tx TEG and report the corresponding multiple gNB Rx-Tx time difference measurements.
	+ M = [2, 3, 4, 6, 8] applies to all configured SRS resources.
	+ Note: If M is not explicitly included in the request, it is up to TRP to determine the number of different TRP RxTx TEGs to measure the same SRS resources
	+ FFS: details of the signalling, procedures
	+ The timestamps of the multiple gNB Rx-Tx time difference measurements in the same measurement report can be the same or different.

 **Agreement*** The maximum number of reported RSTD measurements obtained from different DL PRS resources per UE Rx TEG per target TRP is 4.
	+ The target TRP can be the same as the RSTD reference TRP or a neighbor TRP
	+ Note: The number of DL PRS resources per target TRP in a measurement report is still limited to 4 as in Rel-16.
* The maximum number of reported RTOA measurements obtained from different UL SRS resources for positioning per TRP Rx TEG for a UE is 4.
* The maximum number of reported UE Rx-Tx time difference measurements obtained from different DL PRS resources per UE Rx TEG for a TRP is 4.
* The maximum number of reported gNB Rx-Tx time difference measurements obtained from different UL SRS resources per TRP Rx TEG for a UE is 4.
* The maximum number of reported UE Rx-Tx time difference measurements obtained from different DL PRS resources per UE RxTx TEG for a TRP is 4.
* The maximum number of reported gNB Rx-Tx time difference measurements obtained from different UL SRS resources per TRP RxTx TEG for a UE is 4.
* Signaling details are left to RAN2 and RAN3
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3. Accuracy improvements for UL-AoA positioning solutions

## RAN1#104e:

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| [R1-2101859](file:///Users/renda000/Downloads/Docs/R1-2101859.zip) Feature Lead Summary #1 for NR Positioning UL-AoA Enhancements Moderator (Intel Corporation)[**R1-2101860**](file:///Users/renda000/Downloads/Docs/R1-2101860.zip) **Feature Lead Summary #2 for NR Positioning UL-AoA Enhancements Moderator (Intel Corporation)**[**R1-2102036**](file:///Users/renda000/Downloads/Docs/R1-2102036.zip) **Feature Lead Summary #3 for NR Positioning UL-AoA Enhancements Moderator (Intel Corporation)**Agreement:NR supports at least the following additional assistance signaling from LMF to gNB/TRP to facilitate UL measurements of UL-AOA* Indication of expected AoA/ZoA value and uncertainty (of the expected AoA/ZoA value) range(s)
* FFS: Details of procedure for providing the assistance
* FFS: Reference angle of expected AoA/ZoA

Agreement:* Further study which option is used to potentially enhance signaling of UL-AOA measurement report in case of a linear array antenna
* Option 1: gNB reports UL-AOA measurement which is a function of the actual azimuth and zenith angles of arrival in a given coordinate system
* Option 2: The z-axis of LCS is defined along the linear array axis. gNB reports only the ZoA relative to z-axis in the LCS, and the LCS-to-GCS translation function is used to set up the specific z-axis direction
* Other options are not precluded from the study

[**R1-2102046**](file:///Users/renda000/Downloads/Docs/R1-2102046.zip) **Feature Lead Summary #4 for NR Positioning UL-AoA Enhancements Moderator (Intel Corporation)**Agreement:* NR supports reporting of M > 1 UL-AOA (AoA/ZoA) measurement values by gNB to the LMF at least for the first arrival path
	+ FFS: Supporting of UL-AOA measurements for additional paths
	+ FFS: Supporting of N >= 1 UL-AOA values per path for additional paths
	+ FFS: Whether the multiple values can correspond to the same time stamp.
* FFS: Further details of measurement and reporting
* Note: The reporting by gNB to the LMF is optional
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## RAN1#104bis-e:

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| **R1-2103794 Feature Lead Summary #0 for Enhancements of UL-AOA Positioning Moderator (Intel)**R1-2103862 Feature Lead Summary #1 for Enhancements of UL-AOA Positioning Moderator (Intel)**R1-2103863 Feature Lead Summary #2 for Enhancements of UL-AOA Positioning Moderator (Intel)**Agreement:* The following option is supported to enhance signaling of UL-AOA measurement report in case of a linear array
	+ Option 2: The z-axis of LCS is defined along the linear array axis. gNB reports only the ZoA relative to z-axis in the LCS, and the LCS-to-GCS translation function is used to set up the specific z-axis direction
* UL-AOA signalling details for support of Option 2 are left up to RAN WG3

Agreement:* Uncertainty range for expected UL AoA/ZoA is defined as follows
	+ Expected azimuth angle of arrival as (φAOA - ΔφAOA/2, φAOA + ΔφAOA/2)
		- φAOA - expected azimuth angle of arrival, ΔφAOA – uncertainty range for expected azimuth angle of arrival
	+ Expected zenith angle of arrival as (θAOA - ΔθAOA/2, θAOA + ΔθAOA/2)
		- θAOA - expected zenith angle of arrival, ΔθAOA – uncertainty range for expected zenith angle of arrival
* Select one of the following coordinate system alternatives for signaling UL AoA/ZoA assistance information
	+ Alt.1: Only GCS is supported for AoA/ZoA assistance information indication
	+ Alt.2: Both GCS and LCS are supported for AoA/ZoA assistance information indication
* FFS: Additional signaling for AoA/ZoA assistance information (expected value and uncertainty range)

Agreement:Reporting to LMF of M > 1 UL-AOA (AoA/ZoA) measurement values associated with the first arrival path and corresponding to the same timestamp is supported. |

## RAN1#105e:

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| [**R1-2106021**](../Docs/R1-2106021.zip) **Feature lead summary#0 for e-mail discussion [105-e-NR-ePos-02] Moderator (Intel Corporation)**[**R1-2106022**](../Docs/R1-2106022.zip) **Feature lead summary#1 for e-mail discussion [105-e-NR-ePos-02] Moderator (Intel Corporation)**[**R1-2106023**](../Docs/R1-2106023.zip) **Feature lead summary#2 for e-mail discussion [105-e-NR-ePos-02] Moderator (Intel Corporation)**From GTW sessions:Agreement:* Both GCS and LCS are supported for UL AoA/ZoA assistance information indication.
* Note: Existing signalling can be used for obtaining LCS to GCS translation information

Agreement:* Granularity of 0.1 degrees is applied for the expected AoA (φAOA), expected ZoA (θZOA ) and the corresponding uncertainty values

Agreement:LMF to gNB signalling of UL AoA/ZoA assistance information (expected value and uncertainty range) is supported for UL-TDOA and Multi-RTT positioning methodsAgreement:Send an LS to RAN3 (potentially also to RAN2 at least as cc) capturing RAN1 agreements on UL AOA/ZOA assistance information (expected value and uncertainty range) and request them to define signalling[**R1-2106201**](../Docs/R1-2106201.zip) **Draft LS on support of UL-AOA/ZOA assistance information signalling for NR positioning Intel Corporation****Decision:** As per decision posted on May 27th, the draft LS is endorsed. Final version is approved in [R1-2106202](../Docs/R1-2106202.zip).MCC to correct the sourcing information to RAN1 only.Agreement:NR supports gNB reporting of the first arrival path UL-AOA/ZOA measurement per SRS for positioning resource and SRS for MIMO resource* Note: The use of SRS for MIMO resource is transparent to the UE

Final summary in:[**R1-2106334**](../Docs/R1-2106334.zip) **Feature lead summary#3 for e-mail discussion [105-e-NR-ePos-02] Moderator (Intel Corporation)** |

## RAN1#106e:

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| [**R1-2108289**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108289.zip) **Feature Lead Summary#1 for E-mail Discussion [106-e-NR-ePos-02] Moderator (Intel)****Decision:** From GTW session on Aug 18th,Agreement:The maximum number of UL-AOAs values (pair of AOA & ZOA values) to be reported per SRS resource for the first arrival path corresponding to the same timestamp is 8.Conclusion:It is up to RAN3 to decide how to support indication of UL AoA/ZoA assistance information in LCS for LCS to GCS translation.**Decision:** As per email decision posted on Aug 19th,Agreement:Further study and conclude whether association of UL-AOA, UL-TDOA, Multi-RTT measurements with ARP (Antenna Reference Point) information is supported at RAN1#106bis-e.[**R1-2108290**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108290.zip) **Feature Lead Summary#2 for E-mail Discussion [106-e-NR-ePos-02] Moderator (Intel Corporation)****Decision:** From GTW session on Aug 20th,Agreement:Reporting of one UL-RTOA and multiple UL-AOAs measurements for the first arrival path per SRS resource for positioning and per SRS resource for MIMO in a single gNB report to LMF is supported* The above measurements are associated with SRS resource ID which is also reported to LMF
* FFS: Reporting of RSRP for the first arrival path
* Note: The use of SRS for MIMO resource is transparent to the UE
* FFS: Reporting of gNB Rx-Tx

**Decision:** As per email decision posted on Aug 25th,Agreement:Reporting of one gNB Rx-Tx time difference and multiple UL-AOAs measurements for the first arrival path per SRS resource for positioning in a single gNB report to LMF is supported * The above measurements are associated with SRS resource ID which is also reported to LMF
* FFS: Reporting of RSRP for the first arrival path

Final summary in [R1-2108291](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108291.zip). |

## RAN1#106bis-e:

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| **R1-2110453** Feature Lead Summary#1 for E-mail Discussion [106bis-e-NR-ePos-02] Moderator (Intel Corporation)**R1-2110454** Feature Lead Summary#2 for E-mail Discussion [106bis-e-NR-ePos-02] Moderator (Intel Corporation)**R1-2110455** Feature Lead Summary#3 for E-mail Discussion [106bis-e-NR-ePos-02] Moderator (Intel Corporation)Agreement:Association of UL-AOA positioning measurements with gNB ARP is supported in Rel.17.Agreement:* For the first arrival path measurements on SRS for positioning resource,
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one-gNB Rx-Tx time difference}
	+ FFS additional option: gNB can report to LMF the following set of measurements {multiple SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA, one-gNB Rx-Tx time difference}
	+ All gNB measurements above are associated with SRS resource ID and timestamp, which are also reported to LMF
* For the first arrival path measurements on SRS for MIMO resource,
	+ gNB can report to LMF the following set of measurements {one SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ FFS: gNB can report to LMF the following set of measurements {multiple SRS-RSRP, multiple UL-AOAs (AoA/ZoA pairs), one UL-RTOA}
	+ All gNB measurements above are associated with SRS resource ID and timestamp, which are also reported to LMF
	+ Note: The operation of SRS for MIMO is transparent to the UE
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## RAN1#107-e:

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|  **R1-2112566** Feature Lead Summary#1 for E-mail Discussion [107-e-NR-ePos-02] Moderator (Intel Corporation)**Agreement*** ARP location is associated with UL measurements for NR Positioning (UL AOA, UL-RTOA, UL SRS-RSRP, UL SRS-RSRPP and gNB Rx-Tx time difference measurements)
* Use of ARP ID for potential overhead reduction in NRPPa signaling is up to RAN3
* Send LS to RAN3 to enable relevant signaling in RAN3 specification

R1-2112739 [DRAFT] LS on ARP location association with UL measurements for NR positioning Moderator (Intel)Final LS endorsed in R1-2112740.**Agreement**Definition for UL SRS-RSRPP:**Definition*** UL SRS reference signal received path power (UL SRS-RSRPP) is defined as the power of the received UL SRS signal configured for the measurement at the i-th path delay of the channel response, where UL SRS-RSRPP for 1st path delay is the power corresponding to the first detected path.
	+ - Working assumption: For frequency range 1, the reference point for the UL SRS-RSRPP shall be the antenna connector of the gNB. For frequency range 2, UL SRS-RSRPP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch.
		- FFS: For frequency range 1 and 2, if receiver diversity is in use by the gNB, the reported UL SRS-RSRPP value shall not be lower than the corresponding UL SRS-RSRPP of any of the individual receiver branches
		- FFS: Note: First and additional paths RSRP, when provided in the same report, use the same RX branch(es) selected for the first arrival path and for the UL SRS-RSRP if the UL SRS-RSRP is reported
	+ FFS: whether/how to capture the note in the specifications

Send LS to RAN4R1-2112743 [DRAFT] LS on UL SRS-RSRPP definition Moderator (Intel)Final LS endorsed in R1-2112744.**R1-2112567** Feature Lead Summary#2 for E-mail Discussion [107-e-NR-ePos-02] Moderator (Intel Corporation)R1-2112568 Feature Lead Summary#3 for E-mail Discussion [107-e-NR-ePos-02] Moderator (Intel Corporation)**Agreement**Apply the following changes to the definition for UL SRS-RSRPP in the previous agreement:**Definition** UL SRS reference signal received path power (UL SRS-RSRPP) is defined as the power of the received UL SRS signal configured for the measurement at the i-th path delay of the channel response, where UL SRS-RSRPP for 1st path delay is the power corresponding to the first detected path. * Working assumption: For frequency range 1, the reference point for the UL SRS-RSRPP shall be the antenna connector of the gNB. For frequency range 2, UL SRS-RSRPP shall be measured based on the combined signal from antenna elements corresponding to a given receiver branch.
* ~~FFS: For frequency range 1 and 2, if receiver diversity is in use by the gNB, the reported UL SRS-RSRPP value shall not be lower than the corresponding UL SRS-RSRPP of any of the individual receiver branches~~
* ~~FFS: Note: First and additional paths RSRP, when provided in the same report, use the same RX branch(es) selected for the first arrival path and for the UL SRS-RSRP if the UL SRS-RSRP is reported~~
	+ ~~FFS: whether/how to capture the note in the specifications~~

Note: The following two options are supported by gNB to LMF:* Option 1 (RX diversity for the first path UL SRS-RSRPP)
	+ The same RX branch(es) as applied for the first path UL SRS-RSRPP measurements are used for the additional paths UL SRS-RSRPP measurements if those are provided together
	+ For frequency range 1 and 2, if receiver diversity is in use by the gNB for UL SRS-RSRPP measurements, then reported UL SRS-RSRPP value for the first path shall not be lower than the corresponding UL SRS-RSRPP for the first pathof any of the individual receiver branches
* Option 2 (RX diversity for UL SRS-RSRP)
	+ The same RX branch(es) as applied for UL SRS-RSRP measurements are used for UL SRS-RSRPP measurements (i.e., the first and additional paths UL SRS-RSRPP if those are provided)
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4. Accuracy improvements for DL-AoD positioning solutions

## RAN1#104e:

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| [**R1-2101920**](../Docs/R1-2101920.zip) **FL summary for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**[**R1-2102093**](../Docs/R1-2102093.zip) **FL summary #3 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement:For UE-assisted DL AOD, select one of the following options for reporting of RSRP measurements per TRP* Option 1: Up to 8 measurements in a measurement report (as in release 16)
* Option 2: Up to 8 measurements in a measurement report, for the same Rx beam index
* Option 3: Up to N>=8 measurements
	+ Note: Multiple measurements corresponding to different Rx Beam index may be reported for a given PRS resource.
	+ FFS: value for N.

Agreement:* For both UE-based and UE-assisted DL-AOD study the following enhancements that enable the UE to measure and report (for UE-assisted) information related to the first arriving path
	+ Option 1: Information corresponds to PRS-RSRP of the first arriving path
	+ Option 2: Information corresponds to the angle of departure of the first arriving path
	+ Option 3: Information corresponds to the arrival time of the first path
	+ Option 4: Information corresponds to phase of the CIR corresponding to the first arriving path
	+ Option 5: Information corresponds to received signal value (amplitude and phase of the channel estimated from the first path which can be achieved as a combination of option 1 and option 4) of the first arriving path
* FFS: Reporting of additional path to the first arriving path.
* FFS: Measurement definition details
* FFS: additional assistance data to support these enhancements
* FFS: how the “first path” is selected among PRS resources in a PRS resource set
* Note 1: Supporting multiple options as well as none of the options above is not precluded.

Agreement:For UE-assisted DL-AOD positioning method, study the following options to enable the UE to measure/report a PRS resource with an additional, adjacent PRS resources measurement/report:* Option 1: UE can be requested to measure and report on specific PRS resources
* Option 2: Enhancing the assistance data to identify adjacent beams
* Option 3: Enhancing the reporting to include the measurements of adjacent beams
* FFS: Detailed signaling and procedure
* FFS: How to define adjacent beams
* Note: Depending on the discussion results, none/one/multiple of above options may be adopted in Rel-17

Final summary in [R1-2102239](../Docs/R1-2102239.zip). |

## RAN1#104bis-e:

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| **R1-2103865 FL summary #1 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)****R1-2103951 FL summary #2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)****R1-2104047 FL summary #2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement:Regarding support of angle calculation enhancement for DL-AoD:* Support gNB providing the beam/antenna information to the LMF.
	+ The gNB beam/antenna information can be provided to the UE for UE-based DL-AoD
	+ FFS: the details of contents of the beam/antenna information
	+ FFS: the details of how to provide the beam/antenna information.
	+ Note: The antenna information is related to reducing the overhead of beam information
* Send an LS to RAN2/RAN3 regarding the option of angle report from gNB to LMF for UE-A DL-AoD requesting them to consider this option in Rel-17.

Agreement:Support the following enhancements under UE capability for both UE-B and UE-A DL-AOD positioning method * Enhancing the signaling to UE for the purpose of PRS resource(s) measurement and (for UE-A) report
	+ FFS: The detailed signaling (e.g, the boresight direction for UE-A DL-AoD, further spatial information of PRS resources, processing prioritization of PRS resources)
* FFS: The following options
	+ Option 1: Enhancing the reporting to include the measurements of adjacent beams PRS resources that related with each other indicated by the assistance data.
	+ Option 2: UE can be requested to measure and report on specific PRS resources

Agreement:* For the purpose of both UE-B and UE-A DL-AoD, and with regards to the support of AOD measurements with an expected uncertainty window, study further whether to support at most one of the following options:
	+ Option 1: Indication of expected DL-AoD/ZoD value and uncertainty (of the expected DL-AoD/ZoD value) range(s) is signaled by the LMF to the UE
		- Single Expected DL-AoD/ZoD and uncertainty (of the expected DL-AoD/ZoD value) range(s) can be provided to the UE for each [TRP]
	+ Option 2: Indication of expected DL-AoA/ZoA value and uncertainty (of the expected DL-AoA/ZoA value) range(s) is signaled by the LMF to the UE
		- Single Expected DL-AoA/ZoA and uncertainty (of the expected DL-AoA/ZoA value) range(s) can be provided to the UE for each [TRP]
	+ Option 3: Indication of expected AoD/ZoD or AoA/ZoA value and uncertainty is not introduced.
	+ FFS: details of signaling
* FFS: Applicability of this agreement to other Positioning methods

**R1-2104088 [DRAFT] LS on DL-AoD angle calculation enhancement Ericsson****Decision:** As per email decision posted on April 20th, the draft LS is endorsed. Final version is approved in R1-2104089. |

## RAN1#105e:

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| [**R1-2106079**](../Docs/R1-2106079.zip) **FL summary #1 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**[**R1-2106144**](../Docs/R1-2106144.zip) **FL summary#2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**[**R1-2106255**](../Docs/R1-2106255.zip) **FL summary#3 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**From GTW sessions:Agreement:For both UE-based and UE-assisted DL-AOD, the UE can be requested subject to UE capability to measure and report (for UE-assisted) the PRS RSRP of the first path* FFS: Details of measurement and reporting of PRS RSRP of the first path

Agreement:For UE-assisted DL-AOD positioning method, select one or more of the following to enhance the signalling to the UE for the purpose of PRS resource(s) measurement and reporting:* Option 1: the LMF explicitly identify adjacent beams in the assistance data (AD)
* Option 2: the LMF send the beam information in the AD with an order of priority of PRS resources.
* Option 3: the LMF includes boresight direction information for each PRS resource in the assistance data.
* Option 4: the LMF send the beam information in the AD with indicated subset of PRS resources.
* FFS: Detailed signalling and procedure
* FFS: How to define adjacent beams

Agreement:For the beam/antenna information to be optionally provided to the LMF by the gnodeB, select one or more of the following:* Option 1: the gNB reports the antenna configuration including at least the following parameter:
	+ the number of antenna elements (vertical and horizontal)
	+ antenna spacing dh and dv
	+ FFS: For DFT-based beams, precoder information for each PRS resource
		- Check whether the already reported boresight directions are sufficient, or whether more information is needed
	+ FFS: Antenna Element pattern Information
		- FFS: Details
	+ FFS: If additional information about panel/orientation is needed
* Option 2: the gNB reports a mapping of angle and beam gains for each of the PRS resources.
	+ FFS: representation of the mapping (e.g. parametric function approximating the beam response, or gain/angle table, beamwidth, intersection point of multiple beams (angle, RSRP)intersection point)
* Other options are not precluded
* In either option, the gNB beam/antenna information can optionally be provided to the UE by the LMF for UE-based DL-AoD

Agreement:* For both UE-based and UE-assisted DL methods, at least for two-stage PRS beam sweeping, study further at least the following:
	+ Enhancements in the association between resources belonging to two DL PRS resource sets of the same TRP
* Companies are encouraged to evaluate whether other potential enhancements in this subagenda or other subagendas (e.g. additional beam information, on-demand PRS framework) could be used to enable this feature (potentially by implementation).
* Note: Two-stage PRS beam sweeping corresponds to different DL PRS resource sets
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## RAN1#106e:

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| [**R1-2108311**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108311.zip) **FL summary #1 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**[**R1-2108507**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108507.zip) **FL summary #2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**From GTW session on Aug 24th,Agreement:For the beam/antenna information to be optionally provided to the LMF by the gnodeB, decide to support one of the following options:* Option 2.1: The gNB reports quantized version of the relative Power/Angle response per PRS resource per TRP
	+ The relative power is defined with respect to the peak power of that resource
	+ FFS: How many relative power levels can be included (e.g., single -3 dB power-levels, multiple power-levels, etc).
* Option 2.2: The gNB reports quantized version of the relative Power between PRS resources per angle per TRP.
	+ The relative power is defined with respect to the peak power in each angle
	+ For each angle, at least two PRS resources are reported.
* FFS: support of multiple levels of quantization
* FFS: how the report is constructed
* FFS: overhead reduction mechanisms, including reusing of associated-dl-PRS-ID as a way of signaling that 2 TRPs have the same beam information
* The gNB beam/antenna information can optionally be provided to the UE by the LMF
* Note: Up to RAN2 & RAN3 the signaling/procedures on how the LMF receives this information from the gNBs
* Send an LS to RAN2 & RAN3 with this agreement

[**R1-2108577**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108577.zip) **FL summary #3 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement:For definition of the path PRS RSRP, consider the following options until RAN1#106b-e:* Option 1: the measured path PRS RSRP correspond to the power of the channel impulse response, at a certain path delay, over which the DL PRS is received.
* Option 2: the path PRS RSRP correspond to the accumulated power of the channel impulse response over which the DL PRS is received, over a time duration corresponding to the given path delay
	+ FFS: whether/how is the window conveyed to the UE (i.e., fixed in specification or configured in measurement request or determined by the UE)
* FFS on relationship with the UE DL PRS measurement bandwidth.
* FFS: normalization of the path RSRP measurement with DL PRS RSRP (i.e. RSRP for all path as defined in Rel-16) could be included in the measurement definition.
* FFS: Further details of the definition, e.g. definition of the certain path delay
* Up to RAN4 to define any test/requirement for the measurement.

[**R1-2108623**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108623.zip) **FL summary #4 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement:* For UE-A DL-AOD, support reporting more than 8 DL PRS RSRP measurements per TRP.
	+ Note: Multiple RSRPs corresponding to same or different Rx Beam index should be able to be reported for a given PRS resource for different timestamps.
* FFS: Limit the maximum number of DL PRS RSRP associated with the same Rx beam index

[**R1-2108645**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108645.zip) **[DRAFT] LS on beam/antenna information for DL AOD in NR positioning Moderator (Ericsson)****Decision:** As per email decision posted on Aug 27th, the draft LS is endorsed. Final LS is approved in [R1-2108646](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108646.zip). |

## RAN1#106bis-e:

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| **R1-2110460** FL summary #1 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**R1-2110500** FL summary #2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**R1-2110578** FL summary #3 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**R1-2110625** FL summary #4 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)Agreement:The measured path DL PRS RSRP for ith path delay is defined as the power of the received DL PRS signal configured for the measurement at the ith path delay of the channel response, and* path DL PRS RSRP for 1st path delay is the power corresponding to the first detected path
* FFS: Whether the path RSRP measurement is normalized with PRS RSRP.
* FFS: Whether the definition of the ith path delay (other than i=1) is required.
* Note: UE may choose to use a time window to compute path DL PRS RSRP by UE implementation (there is no impact to specifications managed by RAN1 for this)
* Note: This does not imply that the path delay has to be reported in DL-AoD positioning
* Send LS to RAN4 to check the details of the definition and feedback if they identify any update is necessary

Agreement:The agreement from RAN1#106e on the number of DL PRS RSRP measurements per TRP is extended as follows:* For UE-A DL-AOD, support reporting ~~more than 8~~ up to ~~16~~ N DL PRS RSRP measurements per TRP, where N is UE capability and candidate values include {16,24}.
* For UE-A DL-AOD, support reporting ~~more than 8~~ up to ~~16~~ M first path PRS RSRP measurements per TRP, where M is a UE capability
	+ FFS: Values of M. Candidate values include {2,4,8,16,24}.
	+ FFS: Whether M is always equal to N
* Note: Multiple RSRPs corresponding to same or different Rx Beam index should be able to be reported for a given PRS resource for same or different timestamps.
* Note: the maximum number of DL PRS RSRP associated with the same Rx beam index is up to the UE implementation

R1-2110626 [DRAFT] LS on definition of DL PRS path RSRP Moderator (Ericsson)Final LS agreed in R1-2110627 with “Dates of next TSG RAN1 meeting” modified to “Dates of next TSG RAN WG1 meeting”.R1-2110627 LS on definition of DL PRS path RSRP RAN1, Ericsson |

## RAN1#107-e:

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| **Conclusion**The current definition of measured path DL PRS RSRP for ith path delay is sufficient and will not be discussed further in AI 8.5.3 * Note: discussion in other agenda items, if necessary, is not precluded.

R1-2112641 FL summary #1 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)R1-2112643 FL summary #3 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement**From the RAN1 perspective, for the TRP beam/antenna information to be optionally provided by the LMF to the UE for UE-based DL-AoD:* The LMF provides the quantized version of the relative Power between PRS resources per angle per TRP.
	+ The relative power is defined with respect to the peak power in each angle
	+ For each angle, at least two PRS resources are reported.
	+ Note: the peak power per angle is not provided
* Note: up to RAN3 to decide how the TRP beam information is provided to the LMF for both UE-assisted and UE-based
* Send an LS to RAN2/RAN3 to decide on the signaling details

R1-2112843 [DRAFT] LS on TRP beam/antenna information Moderator (Ericsson)Final LS endorsed in R1-2112844.**Agreement**For reporting of DL PRS RSRPP and PRS RSRP in UE-A DL-AOD* The maximum number of DL PRS RSRPP M is a UE capability and its candidate values include {2,4,8,16,24}.
* The capabilities for DL PRS RSRPP (M value) and DL PRS RSRP (N values) are such that M is less than or equal to N

**R1-2112642** FL summary #2 for AI 8.5.3 Accuracy improvements for DL-AoD positioning solutions Moderator (Ericsson)**Agreement** For the purpose of both UE-B and UE-A DL-AoD, and with regards to the support of AOD measurements with an expected uncertainty window, the following is supported * Indication of expected angle value and uncertainty (of the expected azimuth and zenith angle value) range(s) is signaled by the LMF to the UE
* The type of expected angle and uncertainty can be requested by the UE, between the following options
	+ - Option 1: Indication of expected DL-AoD/ZoD value and uncertainty (of the expected DL-AoD/ZoD value) range(s) is signaled by the LMF to the UE
		- Option 2: Indication of expected DL-AoA/ZoA value and uncertainty (of the expected DL-AoA/ZoA value) range(s) is signaled by the LMF to the UE

**Agreement** For UE-assisted DL-AOD positioning method, to enhance the signaling to the UE for the purpose of PRS resource(s) reporting, the LMF may indicate in the assistance data (AD), one or both the following: * option 1: subject to UE capability, for each PRS resource, a subset of PRS resources for the purpose of prioritization of DL-AOD reporting:
	+ a UE may include the requested PRS measurement for the subset of the PRS in the DL-AoD additional measurements if the requested PRS measurement of the associated PRS is reported
		- The requested PRS measurement can be DL PRS RSRP and/or path PRS RSRP.
	+ UE may report PRS measurements only for the subset of PRS resources.
	+ Note: The subset associated with a PRS resource can be in a same or different PRS resource set than the PRS resource
* option 2: subject to UE capability, for each PRS resource, the boresight direction information.
* Note: Either case does not imply any restriction on UE measurement
* FFS: prioritization of the PRS resources and resource subsets to be measured
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5. Latency improvements for both DL and DL+UL positioning methods

## RAN1#105e:

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| [**R1-2105989**](../Docs/R1-2105989.zip) **FL summary #1 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**[**R1-2105990**](../Docs/R1-2105990.zip) **FL summary #2 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**[**R1-2105991**](../Docs/R1-2105991.zip) **FL summary #3 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**[**R1-2106183**](../Docs/R1-2106183.zip) **FL summary #4 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**From GTW sessions:Agreement:M-sample (1<=M<4) PRS processing corresponding to measurements performed within M instances of the DL PRS resource set on a PRS resource, subject to UE capability, is beneficial from a RAN1 perspective for latency reduction.* One sample corresponds to one instance
* Send an LS to RAN4 informing that
	+ M-sample (1<=M<4) measurements corresponding to measurements performed within M (1<=M<4) instances of the DL PRS resource set on a PRS resource are beneficial for reduction of measurement latency from RAN1 point of view.
	+ RAN4 is requested to check the feasibility of measurements performed within M (1<=M<4) instances of the DL PRS resource set and identify the impact on requirements/side condition.
* RAN1 to further study at least the following aspects for allowing M-sample (1<=M<4) PRS processing
	+ Details of UE capability
	+ Signaling details, e.g., to indicate whether measurement is based on one or more samples
	+ Whether the PRS sample processing time is defined and the relation with (N, T).
		- Note: This may have RAN4 dependency

**[R1-2106184](../Docs/R1-2106184.zip) [DRAFT] LS on PRS processing samples Moderator (Huawei)****Decision:** As per decision posted on May 28th, the draft LS is endorsed. Final version is approved in [R1-2106185](../Docs/R1-2106185.zip).Agreement:RAN1 to further study at least the following aspects for MG enhancement with regards to MG requesting and configuration/activation/triggering for the purpose of latency reduction for positioning:* Preconfiguration of multiple MGs
* Triggering/activation of MG(s) with lower layer signalling (DCI or DL MAC CE)
* Request of MG(s) with lower layer signalling by the UE to the gNB
* Request/determination of MG(s) by LMF indication to the gNB/UE
* Note: The combination of the above items is possible.

Agreement:* Further study the following options (with the same numerology) to support PRS measurement without MGs for latency reduction in Rel-17
	+ Option 1: The PRS is from the serving cell and UE measurement is inside the active DL BWP
	+ Option 2: The PRS can be from the serving cell and non-serving cell, and UE measurement is inside the active DL BWP
	+ Option 3: The PRS (from the serving cell or non-serving cell) used for UE measurement may extend outside or be completely outside the active DL BWP (including with potentially a different numerology)
	+ Note: RAN1 strives not to increase the PRS measurement time compared with Rel-16 MG-based measurement
* The following aspects are FFS
	+ PRS processing prioritization window
	+ Mechanism to trigger UE DL PRS measurements and report
	+ UE/gNB assumptions on processing of DL PRS and other DL physical channels / signals
	+ UE DL PRS processing capabilities
* Note: Companies are encouraged to compare the latency benefits of introducing MG-less PRS measurements over MG-based PRS measurements
* Note: Depending on the comparison of latency benefits (and other considerations such as complexity) between introducing MG-less PRS measurements and MG-based PRS measurements, none/one/multiple of the above options should be adopted in Rel-17.

Agreement:Send an LS to RAN2 informing that* From RAN1 perspective, it is beneficial to support a finer granularity for location response time in order to reduce latency.
* RAN2 is requested to check if it can be supported and design the signaling details if supported.

**[R1-2106315](../Docs/R1-2106315.zip) [DRAFT] LS on granularity of response time Huawei****Decision:** As per decision posted on May 28th, the draft LS is endorsed. Final version is approved in [R1-2106316](../Docs/R1-2106316.zip). |

## RAN1#106e:

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| [**R1-2108248**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108248.zip) **FL summary #1 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**From GTW session:Agreement:Subject to UE capability, support LMF to explicitly request UE to report the measurement with either M-sample or 4-sample, if RAN4 has supported M-sample measurement.* FFS signalling details.

Agreement:For the purpose of positioning latency reduction, with potential support of a new mechanism of MG request, consider the following options with a decision to be made in RAN1#106b.* Option. 1: by LMF (via a NRPPa message)
* Option. 2: by UE (via UCI or UL MAC CE)

Agreement:For the purpose of positioning latency reduction, with potential support a new MG activation and deactivation procedure, consider the following options with a decision to be made in RAN1#106b (and RAN4 to be informed about any decision made)* Option. 1: DCI
* Option. 2: DL MAC CE
* Option. 3: UE autonomously applies the MG

FFS whether deactivation can be implicit via configurable number of the MG occasions[**R1-2108249**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108249.zip) **FL summary #2 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**[**R1-2108250**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108250.zip) **FL summary #3 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**[**R1-2108583**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108583.zip) **FL summary #4 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**From GTW session:Working assumption:Subject to UE capability, support PRS measurement outside the MG, within a PRS processing window, and UE measurement inside the active DL BWP with PRS having the same numerology as the active DL BWP.* Inside the PRS processing window, subject to the UE determining that DL PRS to be higher priority, support the following UE capabilities:
	+ Capability 1: PRS prioritization over all other DL signals/channels in all symbols inside the window.
		- Cap. 1A: The DL signals/channels from all DL CCs (per UE) are affected.
		- Cap. 1B: Only the DL signals/channels from a certain band/CC are affected.
			* FFS: band or CC
	+ Capability 2: PRS prioritization over other DL signals/channels only in the PRS symbols inside the window
	+ A UE shall be able to declare a PRS processing capability outside MG.
		- FFS: Details of capability signalling (e.g., per UE or per band, etc.)
* For the purpose of this feature, PRS-related conditions are expected to be specified, with the following to be down-selected:
	+ Alt. 1: Applicable to serving cell PRS only
	+ Alt. 2: Applicable to all PRS under conditions to PRS of non-serving cell.
* Note: When the UE determines higher priority for other DL signals/channels over the PRS measurement/processing, the UE is not expected to measure/process DL PRS which is applicable to all of the above capability options.
* Further study
	+ Further details of which other DL signals/channels to be prioritized
	+ How the UE determines DL PRS’s priority based on one or more of the following:
		- Opt. 1: Based on indication/configuration from serving gNB
		- Opt. 2: Other options (e.g., implicit, signalling from LMF, etc)
	+ Whether UE can do the measurement for both inside MG (if MG is configured) and outside MG in a measurement period
	+ How to do the PRS measurement when the conditions cannot be satisfied, e.g. when BWP switching happens
	+ Prioritization conditions of processing PRS over other DL channels/signals or vice versa.
* Send an LS to RAN2, RAN3 and RAN4 informing them of this working assumption and requesting feedback in case they have concerns.

**R1-2108638 [DRAFT] LS on PRS measurement outside the measurement gap Moderator (Huawei)****Decision:** As per email decision posted on Aug 27th, the draft LS is endorsed. Final version is approved in R1-2108639. |

## RAN1#106bis-e:

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| **R1-2110445** FL summary #1 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**R1-2110446** FL summary #2 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)**R1-2110447** FL summary #3 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)R1-2110605FL summary #4 of 8.5.4 latency improvements for DL and DL+UL methods Moderator (Huawei)Agreement:Support the following options (in the agreement made in RAN1#106-e) for a new mechanism of MG activation request for the purpose of positioning.* Option 2: by UE (via UCI or UL MAC CE)
	+ Select only one of UCI and UL MAC CE in RAN1#106bis-e
* Option 1: by LMF (via an NRPPa message)
	+ Note: This is transparent to the UE

Conclusion:Potential enhancements to latency reduction with respect to MG sharing with other RRM procedures is up to RAN4 to decide.Agreement:For PRS measurement outside MG, support the following Alt. 2 in the working assumption made in RAN1#106-e with the following update of the PRS cell condition.* Alt. 2: Applicable to all PRS (serving and/or non-serving cell) under conditions to PRS of non-serving cell.
	+ The conditions at least include that the Rx timing difference between PRS from the non-serving cell and that from the serving cell is within a threshold
		- The UE is not expected to determine whether the above condition is satisfied by performing measurements and instead can be determined using assistance data
			* FFS: Rx timing difference between PRS from the non-serving cell and that from the serving cell is determined by the expected RSTD and expected RSTD uncertainty.
	+ Further discuss the necessity on the following additional conditions
		- When the PRS is higher priority than other channels/signals, for capability 1A and 1B, the PRS from the non-serving cell have to be inside the PRS prioritization window.
		- When the PRS is higher priority than other channels/signals, for capability 2, the PRS from the non-serving cell have to be in the same symbols as the PRS of the serving cell since the serving cell does not know the symbol position of neighbour cell PRS.

Agreement:* With regards to UE determining the PRS priority with other DL signal/channels within the PRS processing window for PRS measurement outside MG, support the priority indicated by gNB.
	+ FFS: What are the other DL signals/channels
* With regards to the PRS processing window for PRS measurement outside MG, at least support the window indicated by gNB.

Agreement:For the PRS processing sample number M, at least M = 1 is supported.Agreement:Introduce a new UE capability on lower Rx beam sweeping factor (<8) to reduce the PRS measurement latency for FR2 positioning frequency layers.* Send an LS to RAN4 to confirm.

Agreement:Support using UL MAC CE for MG activation request by UE (Option 2) for the purpose of positioning.Agreement:Support the following option (from the agreement made in RAN1#106-e) for a new MG activation procedure to be performed by the gNB for the purpose of positioning.* Option 2: DL MAC CE
* FFS: Deactivation process

Agreement:With regards to MG activation by DL MAC CE, further study* DL MAC CE payload
* The necessity of pre-configuration of MGs in higher layers.
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## RAN1#107-e:

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| **R1-2112457** Summary #1 of [107-e-NR-ePos-04] latency improvements Moderator (Huawei)**Agreement**Preconfiguration of MG(s) in RRC is supported from RAN1 perspective.* Each MG in the preconfiguration is associated with an ID
* The information in the UL MAC CE for MG activation request by the UE can be one ID associated with the preconfiguration of the MG
* Send an LS to RAN2 and RAN3

**Conclusion**Include in the LS the following content: * RAN1 understands it is up to RAN2 and/or RAN3 to decide how gNB determines the preconfiguration of MG(s).

**Conclusion**For the MG activation request to the gNB by the LMF, it is up to RAN3 to design the necessary information to be transferred in the NRPPa message.* Include it in the LS to RAN2 and RAN3.

R1-2112783 Draft LS on PRS measurement with preconfiguration of MG(s) Moderator (Huawei)Final LS endorsed in R1-2112784**Agreement**The DL MAC CE for MG activation indicates the ID associated with the preconfigured MG.[R1-2112411](file:///D%3A%5CE%5CDavid_E%5C3GPP%20upcoming%20meetings%5CRAN1_107%20Nov%202021%20e-meeting%5CLeadership%5CDocs%5CR1-2112411.zip) Draft LS on lower Rx beam sweeping factor for latency improvement Moderator (Huawei)Final LS endorsed in R1-2112767**R1-2112458** Summary #2 of [107-e-NR-ePos-04] latency improvements Moderator (Huawei)**Agreement**The following options are supported subject to UE capability for priority handling of PRS when PRS measurement is outside MG.* + Option 1: UE may indicates support of two priority states.
		- State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		- State 2: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	+ Option 2: UE may indicate support of three priority states
		- State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		- State 2: PRS is lower priority than PDCCH and URLLC PDSCH and higher priority than other PDSCH/CSI-RS
			* Note: The URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority.
		- State 3: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	+ Option 3: UE may indicate support of single priority state
		- State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS

Note: SSB is a separate issue.**Agreement**For the purpose of determining conditions for measuring the PRS outside of a MG, the expected Rx timing difference between the PRS from the non-serving cell and that from the serving cell is determined by expected RSTD and expected RSTD uncertainty in the assistance data.Send an LS to request RAN4 study and determine the threshold, which is used to be compared against with the Rx timing difference to determine whether the PRS from the non-serving cell satisfy the condition of PRS measurement outside MG.* + Examples for the threshold: CP length, 50% of the OFDM symbol, 1ms
	+ Other options can also be considered by RAN4
	+ Note: the requirement on whether UE needs to calculate the expected Rx time difference and/or compare against the threshold is also a part of the study request

**Agreement**At least the following parameters for PRS processing window from the gNB to the UE are supported.* + Starting slot
	+ Periodicity
	+ Duration/length
	+ Cell and SCS information associated with the above parameters

Discuss during the maintenance phase on the necessity of other parameters including but not limited to* + Processing type (associated with the corresponding UE capability 1A/1B/2)
	+ Band/CC-ID as needed depending on each scenario on which the PRS processing window is applied
	+ The above cell and SCS information to determine where/when the PRS processing window is applied

Note: Indication of processing type does not suggest UE indication of multiple capabilities among (1A/1B/2) is already supported, which is a separate discussion.Note: Some of the parameters above may not be mandatory for a PRS processing window**Agreement**The priority of PRS for UE supporting two priority states and three priority states can at least be indicated in RRC.**Agreement**For capability 1A as per working assumption made in RAN1#106-e, the DL signalings/channels in a per UE fashion (i.e. both across NR & LTE) inside the PRS processing window are dropped if the DL PRS is determined to be higher priority.For capability 1B as per working assumption made in RAN1#106-e, only the DL signalings/channels from a certain band inside the PRS processing window are dropped if the DL PRS is determined to be higher priority.

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| Working assumption:Subject to UE capability, support PRS measurement outside the MG, within a PRS processing window, and UE measurement inside the active DL BWP with PRS having the same numerology as the active DL BWP.* Inside the PRS processing window, subject to the UE determining that DL PRS to be higher priority, support the following UE capabilities:
	+ Capability 1: PRS prioritization over all other DL signals/channels in all symbols inside the window.
		- Cap. 1A: The DL signals/channels from all DL CCs (per UE) are affected.
		- Cap. 1B: Only the DL signals/channels from a certain band/CC are affected.
			* FFS: band or CC
	+ Capability 2: PRS prioritization over other DL signals/channels only in the PRS symbols inside the window
	+ A UE shall be able to declare a PRS processing capability outside MG.
		- FFS: Details of capability signalling (e.g., per UE or per band, etc.)
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**Agreement**PRS processing window request to the gNB by the LMF is supported from RAN1 perspective.* + It is up to RAN3 to design the necessary information to be transferred in the NRPPa message.
	+ Note: It is up to gNB to determine the usage of measurement gap or PRS processing window
	+ Include it in the LS to RAN2 and RAN3.

**Agreement**For PRS processing window configuration and indication, at least the following mechanism is supported* + RRC (pre-)configuration for PRS processing window configuration and DL MAC CE activation for PRS processing window, respectively.

Include it in the LS to RAN2 and request RAN2 to decide whether DL MAC CE is feasible for this indication. |

6. Potential enhancements of information reporting from UE and gNB for multipath/NLOS mitigation

## RAN1#105e:

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| [**R1-2106043**](../Docs/R1-2106043.zip) **Feature Lead Summary #1 for Potential multipath/NLOS mitigation Moderator (Nokia)**[**R1-2106087**](../Docs/R1-2106087.zip) **Feature Lead Summary #2 for Potential multipath/NLOS mitigation Moderator (Nokia)**[**R1-2106163**](../Docs/R1-2106163.zip) **Feature Lead Summary #3 for Potential multipath/NLOS mitigation Moderator (Nokia)**From GTW sessions:Agreement:* Study reporting of LoS/NLoS indicators for DL, UL, and DL+UL positioning measurements taken at both UE and TRP at least for UE assisted positioning.
* Study the following options (or combinations of the following options) for LoS/NLoS indicators
	+ Option 1: Binary (i.e., hard) value indicators
	+ Option 2: Soft value indicators (i.e., [0,1]).
		- FFS: Format and criteria for determination
	+ FFS: additional information or options
* FFS: LoS/NLoS indicators for UE-based positioning

Agreement:* Study multipath reporting enhancements for DL, UL, and DL+UL positioning to enable LoS/NLoS/multipath identification and mitigation at the LMF for UE-assisted positioning.
	+ FFS: Details of the enhancements.

Agreement:For multipath reporting enhancements, study reporting from TRP to LMF, angle, timing, phase (of additional paths) and power for the additional N paths (value of N is part of the study).* Note: Companies are not obligated to provide inputs for all parameters in their study

Agreement:For multipath reporting enhancements, study reporting from UE to LMF, relative timing of additional paths (additional to the first path) and the power (at least relative power) at least per DL PRS resource per additional path for at least DL-AoD reporting (the number of paths is part of the study).Agreement:* Study whether to support up to N>2 additional paths in the measurement reports from UE to LMF for at least DL-TDOA and multi-RTT,
	+ FFS: Exact value of N.
	+ FFS: reporting the power of the paths in addition to the timing.
	+ FFS: LMF requesting additional M non-distinct paths corresponding to the first path.
* Note 1: This agreement applies to N additional paths (i.e., not including the “first” path).
* Note 2: Rel-16 supports N=2 already.

Agreement:As part of studying LoS/NLoS information reporting, study at least the following options for information to enable/assist LoS/NLoS detection: * Option 1: Polarization information reporting from UE/gNB to LMF.
* Option 2: Coherence bandwidth information reporting from UE/gNB to LMF.
* Option 3: Propagation time difference information reporting from UE/gNB to LMF.
* Option 4: RSRP reporting from UE/gNB to LMF with finer granularity
* Option 5: Ricean factor and the variance of Channel Frequency Response (CFR) information reporting from UE/gNB to LMF
* Option 6: No specification impact outside of LoS/NLoS reporting

Note: Companies are encouraged to identify differences in information reporting and any performance gains compared with multipath information reporting |

## RAN1#106e:

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| [**R1-2108280**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108280.zip) **Feature Lead Summary #1 for Potential multipath/NLOS mitigation Moderator (Nokia)**From GTW session:Agreement:* For up to N>2 additional paths, support reporting relative timing (to the first detected path) in the measurement reports from UE to LMF for at least DL-TDOA and multi-RTT
	+ FFS: Definition of additional paths for N>2
	+ FFS: Whether power is additionally reported and if reported whether power is relative to first detected path or total power
* Support one of the following options for maximum value of N at RAN1#106-b (any further criteria for selection to be discussed during RAN1#106):
	+ Option 1: N = 4
	+ Option 2: N = 8
	+ Option 3: N = 16
	+ Option 4: N = 32

Agreement:* For multipath reporting enhancements, support reporting from TRP to LMF, angle, timing, for up to additional N>2 paths for at least UL-TDOA and multi-RTT.
	+ FFS: Definition of additional paths for N>2
	+ FFS: Whether power is additionally reported and if reported whether power is relative to first detected path or total power
* Down select between the following options for N at RAN1#106-b (any further criteria for selection to be discussed during RAN1#106):
	+ Option 1: N = 4
	+ Option 2: N = 8
	+ Option 3: N = 16
	+ Option 4: N = 32

[**R1-2108281**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108281.zip) **Feature Lead Summary #2 for Potential multipath/NLOS mitigation Moderator (Nokia)**From GTW session on Aug 24th,Agreement:* Support LoS/NLoS indicators which are reported to the LMF for DL and DL+UL positioning measurements taken at UE for UE-assisted positioning or UL and DL+UL measurements at the TRP for NG-RAN assisted positioning.
	+ Reporting from UE is subject to UE capability
* Positioning assistance data from LMF is enhanced for UE-based positioning by including LoS/NLoS indicators.
* FFS: Other kinds of positioning assistance data enhancements
* For LoS/NLoS detection method(s), there is no additional measurement IEs or assistance data outside of LoS/NloS indicator reporting (i.e., Option 6 from prior agreement).
* Note 1: No RAN4 requirements are expected for the LoS/NLoS indicators in RAN1’s understanding
* Note 2: LoS/NLoS indicators can be complementary to outlier rejection algorithms.

[**R1-2108282**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108282.zip) **Feature Lead Summary #3 for Potential multipath/NLOS mitigation Moderator (Nokia)**From GTW session:Agreement:Reporting multiple UL-AoA values per additional path is supported for at least UL TDOA and multi-RTT.* FFS: maximum number of UL-AoA values per additional path.

[**R1-2108629**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108629.zip) **Feature Lead Summary #4 for Potential multipath/NLOS mitigation Moderator (Nokia)**Agreement:**Decision:** As per email decision posted on Aug 28th, For LoS/NLoS indicators, a single-indicator can be reported and the supported values are a discrete set in the interval [0, 1]. * FFS: the number of discrete values to be supported
* Note: This does not preclude using binary values only which is up to UE/TRP implementation
* Note: Single-indicator means that one value in the interval [0, 1] is used for the LoS/NLoS indication
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## RAN1#106bis-e:

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| **R1-2110435** Feature Lead Summary #1 for Potential multipath/NLOS mitigation Moderator (Nokia)**R1-2110436** Feature Lead Summary #2 for Potential multipath/NLOS mitigation Moderator (Nokia)R1-2110437Feature Lead Summary #3 for Potential multipath/NLOS mitigation Moderator (Nokia)**R1-2110609** Feature Lead Summary #3 for Potential multipath/NLOS mitigation Moderator (Nokia)Agreement:For hybrid positioning methods where UL TDOA and multi-RTT are used in addition to UL AoA, support reporting of up to M=8 UL-AoA values per additional path Agreement:* For UE-based positioning, support the following options for LoS/NLoS indicators within positioning assistance data:
	+ Option 1 (Working assumption): LMF associates UE-based LoS/NloS indicators with each DL PRS resource for each TRP
	+ Option 2: LMF associates UE-based LoS/NloS indicators with each TRP
* Note: For option 1, one LoS/NloS indicator is associated with one DL-PRS resource

Agreement:* For UL-TDOA, UL-AoA and Multi-RTT one LoS/NLoS indicator can be associated with each UL RTOA, UL SRS RSRP, UL-AoA and/or gNB Rx-Tx time difference measurement, respectively, and reported by gNB for each TRP that performed measurements for a given UE
* For UL-TDOA, UL-AoA and Multi-RTT one LoS/NLoS indicator can be associated and reported by a TRP for a given UE
* For DL-AoD and Multi-RTT one LoS/NLoS indicator can be associated with each DL PRS RSRP and/or UE Rx-Tx time difference measurement, respectively, and reported by UE for each TRP
* For DL-AoD and Multi-RTT one LoS/NLoS indicator can be associated with each TRP in the measurement report from the UE
* For DL-TDOA one LoS/NLoS indicator can be associated with each RSTD measurement performed with a target TRP and one LoS/NLoS indicator is associated with the RSTD measurement performed with a reference TRP
* For DL-TDOA one LoS/NLoS indicator can be associated with each target TRP and one LoS/NLoS indicator can be associated with the reference TRP in the measurement report
* FFS: Dependence of indication of a LOS/Nlos indicator on the presence of Rx beam index for DL-AoD
* FFS: Whether the above bullets apply to additional path measurements.

Agreement:Support reporting the path RSRP for the first path and for additional paths as part of DL-TDOA, UL-TDOA, and multi-RTT reporting enhancements.* FFS: Support introducing a request from the LMF to the UE/TRP when the path-RSRP for additional paths is desired to be reported.
* FFS: Support of path RSRP for additional paths as part of DL-AoD.
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## RAN1#107-e:

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| **R1-2112492** Feature Lead Summary #1 for Potential multipath/NLOS mitigation Moderator (Nokia)**Agreement*** For enhanced multipath reporting support N=8 for the value of maximum number of additional paths.
	+ Define a UE capability for the UE to report its supported value of maximum number of additional paths (no larger than 8)

**Agreement*** Support the LMF to request DL PRS-RSRPP together with timing measurement as part of DL-TDOA and multi-RTT reporting enhancements
	+ Note: This applies to the first path and also to additional paths.
* Support the LMF to request UL SRS-RSRPP together with timing measurement as part of UL-TDOA and multi-RTT reporting enhancements
	+ Note: This applies to the first path and also to additional paths.

**Conclusion**Do not support LoS/NloS indicators for additional paths.**Agreement**Confirm the working assumption on UE-based LoS/NloS indicators option 1 with the following revision:* Option 1: LMF associates UE-based LoS/NloS indicators with each DL PRS resource for each TRP, provided the LMF can give different values for Los/NLos indicators of different DL PRS resource of one TRP.

**Conclusion**LoS/NloS indicator dependency on Rx beam index is not introduced.**R1-2112493** Feature Lead Summary #2 for Potential multipath/NLOS mitigation Moderator (Nokia)**Conclusion**The criteria for reporting additional path is left to UE/TRP implementation.**Agreement*** Support the following two options of values for LoS/NLoS indicator reporting from UE/TRP:
	+ Soft values: [0, 0.1, …, 0.9, 1] (in steps of 0.1)
	+ Hard values: [0, 1]
* The values correspond to the likelihood of LoS, with a value of 1 corresponding to LoS and a value of 0 corresponding to NLoS

R1-2112494 Feature Lead Summary #3 for Potential multipath/NLOS mitigation Moderator (Nokia)R1-2112495 Feature Lead Summary #4 for Potential multipath/NLOS mitigation Moderator (Nokia) |

7. Others

*Including aspects for RAN2-led on-demand transmission and reception of DL PRS for DL and DL+UL positioning for UE-based and UE-assisted positioning solutions, and RAN2-led methods/measurements/signalling and procedures to support positioning for UEs in RRC\_ INACTIVE state, for UE-based and UE-assisted positioning solutions.*

## RAN1#105e:

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| Agreement:* For potential signaling of one or more parameters (such signaling is not yet agreed) for both UE- and LMF- initiated on-demand DL PRS request, consider at least the following (all parameters will not necessarily be supported and all parameters may not be applicable to both UE-initiated and LMF-initiated on-demand DL PRS request)
	+ Start/end time of DL PRS transmission
	+ DL PRS resource bandwidth
	+ DL-PRS resource set IDs
	+ DL PRS resource IDs
	+ DL PRS transmission periodicity and offset
	+ DL PRS resource repetition factor
	+ Number of DL PRS symbols per DL PRS resource
	+ DL PRS muting patterns
	+ DL PRS QCL information
	+ Number of TRPs
	+ Number of PRS resources per PRS resource set
	+ Number frequency layers or frequency layer indicator
	+ Beam directions
	+ Combsize, start PRB, Point A of DL PRS
	+ ON/OFF indicator of the DL PRS
* FFS additional parameters indicated for UE and/or LMF initiated on-demand DL PRS request

Agreement:NR positioning supports DL PRS-RSRP (section 5.1.28 in the TS 38.215) and DL RSTD (section 5.1.29 in the TS 38.215) measurements by UEs in RRC\_INACTIVE state* FFS additional potential impact on RAN1
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## RAN1#106e:

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| [**R1-2108292**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108292.zip) **Feature Lead Summary#1 for E-mail Discussion [106-e-NR-ePos-06] Moderator (Intel Corporation)**From GTW session on Aug 18th:Agreement:* The following lists of on-demand DL-PRS parameters are discussed/prepared by RAN1 and provided as input to RAN2:
	+ List#1: List of parameters for UE-initiated on-demand DL PRS request
	+ List#2: List of parameters for LMF-initiated on-demand DL PRS request
* For the following lists of on-demand DL-PRS parameters, send an LS to RAN2 to check whether RAN2 would like RAN1 to send the list of parameters and request feedback as early as possible:
	+ List #3: List of parameters for UE-initiated on-demand DL PRS request associated with pre-configured set of on-demand DL PRS configurations
	+ List #4: List of parameters for LMF-initiated on-demand DL PRS request associated with pre-configured set of on-demand DL PRS configurations

[**R1-2108382**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108382.zip) **Draft LS to RAN2 with update on RAN1 discussion for on-demand DL PRS Moderator (Intel Corporation)****Decision:** As per email decision posted on Aug 19th, the draft LS is endorsed. Final LS is approved in [R1-2108383](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108383.zip).[**R1-2108293**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108293.zip) **Feature Lead Summary#2 for E-mail Discussion [106-e-NR-ePos-06] Moderator (Intel Corporation)**From GTW session on Aug 24th,Agreement:From RAN1 perspective, it is feasible to support transmission of SRS for positioning by UEs in RRC \_INACTIVE state for UL and DL+UL positioning under certain validation criteria* FFS: Type(s) of SRS for positioning (i.e., periodic, semi-persistent, aperiodic)
* FFS: Details of validation criteria which may also be discussed in RAN2
* Send LS to RAN2 informing them of this agreement

Agreement:Open loop power control defined in Rel.16 for transmission of SRS for positioning by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs.Agreement:Spatial relation defined in Rel.16 for transmission of SRS for positioning by RRC\_CONNECTED UEs is applicable for RRC\_INACTIVE UEs.Conclusion:It is up to RAN2 to define TA procedures for SRS for positioning transmission by RRC\_INACTIVE UEs.[**R1-2108563**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108563.zip) **Draft LS to RAN2 on SRS for Positioning Transmission by UEs in RRC\_INACTIVE State Moderator (Intel Corporation)****Decision:** As per email decision posted on Aug 26th, the draft LS is endorsed. Final LS is approved in [R1-2108564](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108564.zip).[**R1-2108294**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2108294.zip) **Feature Lead Summary#3 for E-mail Discussion [106-e-NR-ePos-06] Moderator (Intel Corporation)**From GTW session:Agreement:At least the following list of on-demand DL PRS parameters is supported for UE-initiated and LMF-initiated on-demand DL PRS requests1. DL PRS Periodicity2. DL PRS resource bandwidth3. DL PRS QCL informationConclude on remaining parameters at RAN1#106-bis-e//Handled under NWM – See ***RAN1-106-e-NWM-NR-ePos-07*** as the document name[106-e-NR-ePos-07] – Florent (Ericsson)Email discussion/approval on LS in [R1-2106435](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2106435.zip) from AI5 and any reply LS as necessary, with checkpoints for agreements until August 24th.[**R1-2106435**](file:///C%3A%5CMyMeetings%5CTSGR1_106-e%5CMinutes%5CDocs%5CR1-2106435.zip) **LS on determination of location estimates in local co-ordinates SA2, Ericsson****R1-2108508 Draft reply LS on determination of location estimates in local co-ordinates Moderator (Ericsson)****Decision:** As per email decision posted on Aug 28th, the draft LS is endorsed. Final LS is approved in R1-2108509. |

## RAN1#106bis-e:

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| R1-2110456 Feature Lead Summary#1 for E-mail Discussion [106bis-e-NR-ePos-06] Moderator (Intel Corporation)**R1-2110457** Feature Lead Summary#2 for E-mail Discussion [106bis-e-NR-ePos-06] Moderator (Intel Corporation)**R1-2110458** Feature Lead Summary#3 for E-mail Discussion [106bis-e-NR-ePos-06] Moderator (Intel Corporation)Agreement:* Send LS to RAN2 with the outcome of RAN1 discussion on types of SRS for positioning to be supported by UEs in RRC\_INACTIVE state
* From RAN1 perspective, support of semi-persistent SRS for positioning by RRC\_INACTIVE UEs is feasible
* It is up to RAN2 to confirm support of semi-persistent SRS for positioning by RRC\_INACTIVE UEs and determine necessary signalling details

Agreement:* For RRC\_INACTIVE UEs, SRS for positioning bandwidth, SCS and CP type are configured by RRC and can be different from that of initial UL BWP configured by the system information

Agreement:* For OLPC of SRS for positioning transmission by RRC\_INACTIVE UEs,
	+ Reuse validity criteria for pathloss measurement defined for RRC\_CONNECTED UEs in Rel.16
		- FFS: UE fallback behavior (i.e. whether to reuse fallback to pathloss measurement by RRC\_INACTIVE UE for the cell, from which the SS/PBCH is received to obtain MIB, is not accurate)
* For spatial relation of SRS for positioning transmission by RRC\_INACTIVE UEs,
	+ FFS: Whether to define validity criteria or reuse validity criteria for OLPC pathloss measurement to determine whether spatial relation with configured RS is valid

Agreement:* The following list of parameters is supported for UE-initiated and LMF initiated on-demand DL PRS request
	+ Start/end time of DL PRS transmission
	+ DL PRS resource repetition factor
	+ Number of DL PRS resource symbols per DL PRS resource
	+ DL-PRS CombSizeN
	+ Number of DL PRS frequency layers
	+ ON/OFF indicator (for LMF initiated request only)
* FFS values for requested on-demand DL PRS parameters and whether parameters are resource-specific, TRP-specific, or PFL-specific

Agreement:* From RAN1 perspective, in RRC\_INACTIVE state, reception of DL PRS has lower priority than other DL signals/channels (SSB, SIB1, CORESET0, MSG2/MSGB, paging, DL SDT)
	+ FFS how to determine conflicts in DL PRS and other DL signals/channels reception by UE
	+ FFS how to handle retuning time for the case when DL PRS and other DL signals/channels are allocated in different BW and/or have the same or different SCS as initial DL BWP
* Send LS to RAN4 (cc RAN2) and ask if there is any feedback

R1-2110643 Draft LS on DL PRS reception priority by RRC\_INACTIVE UEs Moderator (Intel)R1-2110644 LS on DL PRS reception priority by RRC\_INACTIVE UEs RAN1R1-2110597 Draft LS on support of SP-SRS for positioning by RRC\_INACTIVE UEsFinal LS agreed in R1-2110598 |

## RAN1#107-e:

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| **R1-2112569** Feature Lead Summary#1 for E-mail Discussion [107-e-NR-ePos-06] Moderator (Intel Corporation)**Agreement**For UE in RRC\_INACTIVE state can support DL PRS processing outside and inside of the initial DL BWP:* For DL PRS processing outside of the initial DL BWP, the SCS, CP type of DL PRS can be the same or different as for the initial DL BWP
* For DL PRS processing inside of the initial DL BWP, the SCS, CP type of DL PRS is the same as for the initial DL BWP.
* Potential impact of retuning time and expected RSTD assistance information on DL PRS reception performance is up to RAN4
* UE capability(ies) will be defined for DL PRS processing in RRC\_INACTIVE state
	+ details are FFS
* Send an LS to RAN4 on agreed by RAN1 UE behavior for reception of DL PRS in RRC INACTIVE state

R1-2112741 [DRAFT] LS on DL PRS processing by UEs in RRC\_INACTIVE state Moderator (Intel Corporation)Final LS endorsed in R1-2112742**R1-2112570** Feature Lead Summary#2 for E-mail Discussion [107-e-NR-ePos-06] Moderator (Intel Corporation)**Agreement**For spatial relation of SRS for positioning by RRC\_INACTIVE UEs,* Validity criteria for pathloss measurement (OLPC) is reused to determine validity of spatial relation for configured RS
* If the UE determines that the UE is not able to meet the above validity criteria for spatial relation then the UE stops transmission of SRS resource for positioning
* Note: the RS for spatial relation is a periodic or semi-persistent RS

**Agreement**For OLPC of SRS for positioning by RRC\_INACTIVE UEs, the following UE behaviour is used * If the UE determines that it is not able to accurately measure pathloss for pathloss reference RS, UE stops transmission on corresponding SRS resource set for positioning

**R1-2112571** Feature Lead Summary#3 for E-mail Discussion [107-e-NR-ePos-06] Moderator (Intel Corporation)**Agreement*** The following options are supported for SRS for positioning transmission by RRC\_INACTIVE UEs:
	+ Option 1:
		- Subject to UE capability (which is a prerequisite for option 2), a UE may be configured with an SRS for Positioning associated with the initial UL BWP and transmitted, during the RRC\_INACTIVE state, inside the initial UL BWP with the same CP and SCS as configured for initial UL BWP.
	+ Option 2:
		- Subject to UE capability, a UE may be configured with an SRS for Positioning where the following parameters are additionally configured for the transmission of the SRS for Positioning during the RRC\_INACTIVE state: frequency location and bandwidth, SCS, CP length.
			* The UE shall not transmit the SRS for Positioning when it is expected to perform UL transmissions in the initial UL BWP in RRC\_INACTIVE state.
* RAN1 assumes that
	+ SRS for positioning for UEs in RRC\_INACTIVE state is configured using the *SRS-PosResourceSet* IE
* Send LS to RAN2 to define signaling for SRS for positioning configuration for RRC\_INACTIVE UEs

R1-2112845 Draft LS on configuration and transmission of SRS for positioning in RRC\_INACTIVE state Moderator (Intel)Final LS endorsed in R1-2112846.**Agreement*** From RAN1 perspective, for LMF-initiated request of on-demand DL PRS, the following group of on-demand DL PRS parameters is defined and signaled
	+ per resource set per positioning frequency layer per FR
1. DL PRS Periodicity
2. DL PRS Resource Bandwidth
3. DL PRS Resource Repetition Factor
4. Number of DL PRS Resource Symbols per DL PRS Resource
5. DL-PRS CombSizeN

Two options for indication of DL PRS QCL-Info, either* + Option 1: per resource set per positioning frequency layer per FR
* LMF recommends a list of QCL sources
	+ Option 2: per resource set per positioning frequency layer per FR
		- LMF requests to provide the QCL information in the assistance data in NRPPa
	+ per FR
		- Number of DL PRS frequency layers
	+ either per resource set per positioning frequency layer or per UE
		- Start/end time of DL PRS transmission
	+ either per resource, or per resource set, or per UE
		- ON/OFF indicator (for LMF initiated request only)

**Agreement*** From RAN1 perspective, for UE-initiated request of on-demand DL PRS, the following group of on-demand DL PRS parameters is defined and signalled
	+ per positioning frequency layer per FR
1. DL PRS Periodicity
2. DL PRS Resource Bandwidth
3. DL PRS Resource Repetition Factor
4. Number of DL PRS Resource Symbols per DL PRS Resource
5. DL-PRS CombSizeN
	* per FR
6. Number of DL PRS frequency layers
	* per UE
7. Start/end time of DL PRS transmission

Two options for indication of DL PRS QCL-Info, either* + Option 1: per resource set per positioning frequency layer per FR
		- UE recommends a list of QCL sources
	+ Option 2: per resource set per positioning frequency layer per FR
		- UE requests to provide the QCL information in the assistance data
 |

9. 8. UE features for NR positioning enhancements

## RAN1#106bis-e:

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| R1-2109915 Summary of UE features for NR positioning enhancements Moderator (AT&T)AgreementThe agreements listed in Section 6 of R1-2109915 are endorsed.  |

## RAN1#107-e:

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| R1-2111810 Summary of UE features for NR positioning enhancements Moderator (AT&T)**Agreement**The agreements listed in Section 6 of R1-2111810 are endorsed. |

References

1. RP-210903, “Revised WID on NR Positioning Enhancements”, Intel Corporation, CATT
2. R1-2102281, Report of RAN1#104-e meeting, ETSI MCC
3. R1-2104151, Report of RAN1#104bis-e meeting, ETSI MCC
4. R1-2106402, Report of RAN1#105-e meeting, ETSI MCC
5. R1-2110434, Report of RAN1#106-e meeting, ETSI MCC
6. RAN1 Chair’s Notes, RAN1#106bis-e, v18