**3GPP TSG-RAN WG2 Meeting #116bis R2-21xxxxx**

**Online, 17 – 26 January 2022**

**Agenda item:** 8.11.17

**Source:** Apple (moderator)

**Title:** Summary of [AT116bis-e][612][POS] Positioning accuracy enhancements (Apple)

**Document for:**  Discussion

# 1. Introduction

This document summarizes the following email discussion:

 **[AT116bis-e][612][POS] Positioning accuracy enhancements (Apple)**

      Scope: Discuss the contributions in AI 8.11.7 on accuracy enhancements (excluding PRU topics).  Determine agreeable RAN2 spec impact from RAN1 conclusions and identify any issues requiring further RAN2 discussion.

      Intended outcome: Report to Monday CB session

      Deadline:  Friday 2022-01-21 1600 UTC

## 1.1 References

1. R2-2200297 Discussion on additional TRP beam/antenna information CATT discussion Rel-17 NR\_pos\_enh-Core
2. R2-2200299 Discussion on stage-2 impact of mitigating UE and TRP RxTx timing delays CATT discussion Rel-17 NR\_pos\_enh-Core
3. R2-2200300 Discussion on LPP and RRC signaling impact of mitigating UE and TRP RxTx timing delays CATT discussion Rel-17 NR\_pos\_enh-Core
4. R2-2200301 [Draft]Reply LS on the reporting of the Tx TEG association information CATT LS out Rel-17 NR\_pos\_enh-Core To:RAN1, RAN3 Cc:RAN4
5. R2-2200330 Discussion on accuracy enhancements vivo discussion Rel-17 NR\_pos\_enh-Core
6. R2-2200429 Discussion on accuracy enhancement Huawei, HiSilicon discussion Rel-17 NR\_pos\_enh-Core
7. R2-2200916 Considerations on Timing Error aspects Sony discussion Rel-17 NR\_pos\_enh-Core
8. R2-2201062 LPP Positioning enhancements on timing errors , DL-AoD and LoS/NLoS/multipath Ericsson discussion Rel-17
9. R2-2201104 Signalling impacts of RAN1 agreements on accuracy enhancements Apple discussion NR\_pos\_enh-Core
10. R2-2201189 Discussion on Accuracy Enhancements InterDigital, Inc. discussion Rel-17 NR\_pos\_enh-Core
11. R2-2201360 Discussion on accuracy improvement for UE-assisted DL-AOD positioning vivo discussion Rel-17 NR\_pos\_enh-Core
12. R2-2200527 Discussion on signalling support of RAN1 agreements ZTE discussion
13. R2-2201066 Beam/antenna information for DL AOD in NR positioning Ericsson discussion Rel-17
14. R2-2201069, “ Discussion on RRC and MAC Impacts, TP on RRC Impacts”, Ericsson discussion Rel-17

## 1.2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

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| --- | --- | --- |
| Company | Name | Email Address |
| Apple | Sasha Sirotkin | ssirotkin@apple.com |
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| Huawei, HiSilicon | YinghaoGuo | yinghaoguo@huawei.com |
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# 2. Discussion

A note from the moderator:

The contributions submitted have varying levels of detail, ranging from high level proposals to detailed stage-3 TPs.

As the intention is to have at some agreeable TPs by the end of this meeting, the moderator proposes to conduct this email discussion in two phases:

1. collect comments on questions asked below (Deadline Wednesday 2022-01-19 1600 UTC)
2. discuss the TPs (Deadline Friday 2022-01-21 1600 UTC)

After the first deadline (Wednesday 2022-01-19 1600 UTC), based on the answers to the questions, the moderator will select TPs which will need to be revised in accordance with the consensus or the majority view. The TPs will then be discussed till the final deadline (Friday 2022-01-21 1600 UTC).

## 2.1 Assistance Data

In this section the moderator asks for feedback on all the proposals related to assistance data (for all the positioning methods).

### 2.1.1 Background

#### 2.1.1.1 TRP beam/antenna information

CATT in R2-2200297 [1] propose to enable the LMF to provide TRP beam/antenna information as assistance information by enhancing the IE NR-DL-AoD-RequestAssistanceData and NR-DL-AoD-ProvideAssistanceData LPP IEs.

Huawei in R2-2200429 [6] have a similar proposal, specifically for that information to include:

* A list of angles (AoD/AoA or ZoD/ZoA or a combination of AoD/AoA and ZoD/ZoA)
* Under each angle
	+ A primary PRS resource ID that radiates the maximum power at the angle
	+ A list of radiation power differences and PRS resource IDs at the angle indicating the power differences for the target PRS resources with respect to the primary PRS resource

Apple in R2-2201104 [9] propose to enhance LPP ProvideAssistanceData to convey TRP beam/antenna information.

Furthermore, ZTE in R2-2200527 [12] also have similar proposals, specifically:

* The signaling structure is for a specific TRP can be a two-dimensional chart, where each DL PRS and each angle is associated with a power value that is calculated relatively to a PRS resource with the highest power in the angle.
* The relative power can be provided per frequency layer per TRP per angle per PRS resource set

On a related note, Ericsson in R2-2201066 [13] propose to liaise RAN1 with questions about resolution of the angular grid. The moderator proposes to discuss the LS separately (see clause 2.5 below).

#### 2.1.1.2 TRP Tx TEG ID association with DL PRS resources

Huawei in R2-2200429 [6] propose to add a new field prs-TxTEG-ID-Info for the IE ReferenceTRP-RTD-Info and RTD-InfoElement to represent the association between PRS and Tx TEG.

Apple in R2-2201104 [9] also propose to enhance LPP ProvideAssistanceData and posSIB to convey the association information of DL PRS resources with TRP Tx TEG ID.

#### 2.1.1.3 PRS subset

Huawei in R2-2200429 [6] propose to add a field assocSubsetInfo for the IE NR-DL-PRS-Resource that includes a list of PRS resource IDs and optionally a DL PRS resource set ID.

Alternatively, Apple in R2-2201104 [9] point out that RAN1 haven’t made the selection between a subset of PRS resources for the purpose of prioritization of DL-AOD reporting, and boresight direction information and therefore they propose to discuss which option (a subset of PRS resources for the purpose of prioritization of DL-AOD reporting, and boresight direction information) of PRS resource reporting to support.

Furthermore, vivo in R2-2201360 [5] also propose to introduce a PRS resource subset list in NR-DL-PRS-Info and each PRS resource subset is identified by a resource subset ID.

#### 2.1.1.4 DL-AOD expected angle

Huawei in R2-2200429 [6] propose to enhance the assistance request/reponse messages to support DL angle search window as follows:

* NR-DL-AoD-RequestAssistanceData
	+ Add a new field expectedAngleSearchWindowType to indicate whether expected DL-AoD/uncertainty or expected DL-AoA/uncertainty is desired.
* NR-DL-AoD-ProvideAssistanceData
	+ Add a pair of new fields nr-DL-PRS-ExpectedAngle and nr-DL-PRS-ExpectedAngleUncertainty for the IE NR-DL-PRS-AssistanceDataPerTRP

There is also a similar proposal made by Apple in R2-2201104 [9], specifically to enhance LPP RequestAssistanceData to allow UE to request the expected angle value and uncertainty.

### 2.1.2 Discussion

**Question 2.1-1: Do you agree to enhance LPP assistance data signalling to allow UE to request and LMF to provide TRP beam/antenna information?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. But theRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | On the signaling details of the assistance data, our preference is as what is proposed in R2-2200429.In principle, it could be implemented by extending the IE *NR-DL-PRS-BeamInfoPerTRP*.Note this is attempting to align with the following RAN1 agreement in the LS R2-2200082**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
 |
| CATT | Yes  | Agree to enhance LPP assistance data signaling to allow UE to request and LMF to provide TRP beam/antenna information for UE-based. |
| Ericsson | Yes |  |
| InterDigital | Yes | Following the RAN1 agreement from RAN1#107e, at least the information indicated in the agreement referred to by HW should be included in LPP assistance data |
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**Question 2.1-2: Do you agree to enhance LPP assistance data signalling to allow LMF to provide the association information of DL PRS resources with TRP Tx TEG ID?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. But theRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | On the signaling details of the assistance data, our preference is as what is proposed in R2-2200429.In principle, the information can be included under the IE *NR-RTD-Info* |
| CATT | Yes | Agree to allow LMF to provide the TRP info for position calculation in UE, i.e. UE-Based. The signalling of TRP TxTEG info for DL-TDOA UE-Based method in TS 37.355 is shown as below:*– NR-PositionCalculationAssistance*The IE *NR-PositionCalculationAssistance* is used by the location server to provide assistance data to enable UE‑based downlink positioning.-- ASN1STARTNR-PositionCalculationAssistance-r16 ::= SEQUENCE { nr-TRP-LocationInfo-r16 NR-TRP-LocationInfo-r16 OPTIONAL, -- Need ON nr-DL-PRS-BeamInfo-r16 NR-DL-PRS-BeamInfo-r16 OPTIONAL, -- Need ON nr-RTD-Info-r16 NR-RTD-Info-r16 OPTIONAL, -- Need ON ..., [[ nr-TRP-TxTEG-Set-r17 NR-TRP-TxTEG-SET-r17 OPTIONAL -- Need ON ]]}-- ASN1STOP– *NR-TRP-TxTEG-Set*The IE *NR-TRP-TxTEG* is used by the location server to provide a list of TRP Tx TEG associated with the transmissions of one or more DL PRS resources.-- ASN1STARTNR-TRP-TxTEG-SET-r17 ::= SEQUENCE { trp-TxTEG-InfoList-r17 TRP-TxTEG-InfoList-r17, ...}TRP-TxTEG-InfoList-r17 ::= SEQUENCE (SIZE (1..nrMaxFreqLayers-r16)) OF  TRP-TxTEG-InfoListPerFreqLayer-r17TRP-TxTEG-InfoListPerFreqLayer-r17 ::= SEQUENCE (SIZE(1..nrMaxTRPsPerFreq-r16)) OF TRP-TxTEG-InfoElement-r17TRP-TxTEG-InfoElement-r17 ::= SEQUENCE { dl-PRS-ID-r17 INTEGER (0..255), nr-PhysCellID-r17 NR-PhysCellID-r16 OPTIONAL, -- Need ON nr-CellGlobalID-r17 NCGI-r15 OPTIONAL, -- Need ON nr-ARFCN-r17 ARFCN-ValueNR-r15 OPTIONAL, -- Need ON nr-TRP-TxTEG-r17 NR-TRP-TxTEG-r17 OPTIONAL, -- Need ON ...}-------editor’s notes: the NR-TRP-TxTEG-r17 should be algined with the report from gNB to LMFNR-TRP-TxTEG-r17 := SEQUENCE { nr-TimeStamp-r17 NR-TimeStamp-r16, nr-trp-TxTEG-ID-r17 INTEGER (0.. maxNumOfTRP-TxTEG-1-r17), nr-trp-DL-PRS-ResourceSetsAssociation-r17 SEQUENCE (SIZE(1..nrMaxSetsPerTrpPerFreqLayer-r16)) OF NR-DL-PRS-ResourceSets-Element-r17 OPTIONAL, ...}NR-DL-PRS-ResourceSets-Element-r17 ::= SEQUENCE { nr-dl-PRS-ResourceSetID-r17 NR-DL-PRS-ResourceSetID-r16 OPTIONAL, nr-dl-PRS-ResourceAssociationBitmap-r17 BIT STRING (SIZE (64)) OPTIONAL, ...}-- ASN1STOP |
| Ericsson | Yes |  |
| InterDigital | Yes |  |
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**Question 2.1-3: Do you agree to also include the association information of DL PRS resources with TRP Tx TEG ID in posSIB?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. But theRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | Agree and we need to be careful with the backward compatibility issues |
| CATT | Yes | TRP TxTEG ID and association is used in position calculation when UE-Based. It should be included in posSIB. |
| Ericsson | No | We do not think RAN1 has an agreement with regards to this. Further, SI scheduling is currently an issue. We can wait to add for UE-Based later. |
| InterDigital | Yes |  |
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**Question 2.1-4: Do you include the information about subset of PRS resources for the purpose of prioritization of DL-AOD reporting?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel |  | Would be good to wait for RAN1 inputs. TheRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | On the signaling details of the assistance data, our preference is as what is proposed in R2-2200429.In principle, it could be implemented under the current IE *NR-DL-PRS-Resource*. |
| Ericsson |  | Agree with Intel |
| InterDigital | Yes | According to the RAN1 agreement from RAN1#107, it was agreed that the LMF sends association information to the UE that includes both a subset of PRS resources, the PRS resource information (i.e., PRS resource ID and PRS resource set ID) the subset is associated with. The UE should report measurements for the subset of PRS resourcesAs reference, the RAN1 agreement is shown below.**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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**Question 2.1-5: Do you include the boresight direction information?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| Company | Yes/No | Comments |
| Intel |  | Would be good to wait for RAN1 inputs. TheRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | A straightforward way is to add *NR-DL-PRS-BeamInfo* to the IE *NR-DL-PRS-AssistanceData*. |
| Ericsson |  | Agree with Intel |
| InterDigital | Yes | Boresight information should be included per PRS resource. |
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**Question 2.1-6: Do you agree to enhance LPP assistance data signalling to allow UE to request and LMF to provide the expected angle value and uncertainty?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agreed in RAN1. But theRAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes | On the signaling details of the assistance data, our preference is as what is proposed in R2-2200429. |
| InterDigital | Yes | According to the RAN1 agreement made in RAN1#107e, one of the following options is requested by the UE. Thus, the LMF should send the UE requested information in LPP assistance data.* + 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
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### 2.1.3 Conclusions

## 2.2 Measurements

In this section the moderator asks for feedback on all the proposals related to measurements, including LPP and RRC, (for all the positioning methods).

### 2.2.1 Background

#### 2.2.1.1 UE Rx/Tx timing delays

CATT and Ericsson in the TP for R2-2200300 [3], R2-2201069 [14] respectively suggest that the association information of UL SRS resources for positioning with Tx TEGs is sent by a UE in UEAssistanceInformation. Furthermore, they propose:

* UE report of multi-RSTD per RxTEG in DL-TDOA in NR-DL-TDOA-MeasElement
* UE report of UE Rx TEG and UE RxTx TEG in Provide Location Information
* UE report multiple UE Rx-Tx time difference measurements per UE Rx TEG or per UE RxTx TEG to LMF

Furthermore, they propose to discuss the configurable periodicities and the maximum number of the change of TxTEG.

vivo in R2-2200330 [5] propose that:

* The gNB can request the UE to provide the association information of UL SRS resources for positioning with Tx TEGs by RRC message RRCReconfiguration.
* The UE can provide the association information of UL SRS resources for positioning with Tx TEGs to gNB by RRC message UEAssistanceInformation or a new RRC message.
* The LMF can request the UE to provide the association information of UL SRS resources for positioning with Tx TEGs by LPP message *RequestLocationInformation*.
* The UE can provide the association information of UL SRS resources for positioning with Tx TEGs to LMF by LPP message *ProvideLocationInformation*.
* the gNB can request the UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources periodically.

Huawei in R2-2200429 [6] propose to add:

* In IE NR-DL-TDOA-RequestLocationInformation
	+ Request of Rx TEG ID for the report
	+ The maximum number of Rx TEGs for the same PRS resource.
* In IE NR-DL-TDOA-MeasElement
	+ Add a new field nr-DL-TDOA-AdditionalMeasurements to incorporate additional 28 measurements per TRP.
	+ Add a new field rxTEG-ID for the IE NR-DL-TDOA-MeasElement and NR-DL-TDOA-AdditionalMeasurementElement to represent the Rx TEG ID associated with the RSTD measurement.
* In IE *NR-Multi-RTT-RequestLocationInformation*
	+ Request of Rx TEG ID or RxTx TEG ID for the report.
	+ Request of Tx TEG ID for the report.
	+ The maximum number of Rx TEGs or RxTx TEG ID for the same PRS resource.
* In IE *NR-Multi-RTT-MeasElement*
	+ Add a new field *nr-Multi-RTT-AdditionalMeasurements* for the IE to incorporate additional 28 measurements per TRP.
	+ Add a new field *teg-ID-Info* for the IE *NR-Multi-RTT-MeasElement* and *NR-Multi-RTT-AdditionalMeasurementElement* forthe Rx TEG ID, RxTx TEG ID and Tx TEG ID associated with the UE Rx – Tx time difference measurement.
* In IE *NR-Multi-RTT-ProvideLocationInformation*
	+ Add a new field *srs-TxTEG-ID-Info* for the association between SRS and Tx TEG.

Sony in R2-2200916 [7] argue that UE has the capability to report changes of TEG association in a timely manner.

Ericsson in R2-2201062 [8] propose:

* Rx TEG IDs shall be introduced for RSTD reference time and for each DL RSTD measurement in the UE DL-TDOA measurement report
* Introduce support for an LMF request and UE attributes to enable Rx TEG sweeping (measurement of DL timing over different UE Rx TEG IDs for the same DL-PRS)
* Rx TEG IDs shall be introduced for each DL measurement and Tx TEG IDs shall be introduced for UL-SRSs (two possible signalling options, UE->gNB->LMF or UE->LMF), and UE RxTx TEG IDs shall be introduced for the combined UL+DL TEGs

Apple in R2-2201104 [9] propose to enhance LPP ProvideLocationInformation to convey the following information: association of UL SRS for positioning resources with UE Tx TEGs ID, multiple RSTD measurements (for N different UE Rx TEGs), multiple UE Rx-Tx time difference measurements (for N different UE Rx TEGs), and multiple UE Rx-Tx time difference measurements (for N different UE RxTx TEGs with the same UE Tx TEG).

Furthermore, Apple argue that two signalling options (LPP and RRC+NRPPa) to convey the association of UL SRS resources with UE Tx TEGs ID are not needed and only one (e.g. LPP) is sufficient.

InterDigital in R2-2201189 [10] propose:

* UE reports association between UE Tx TEG and SRSp resource at periodically configured reporting occasion if there are any changes to the association compared to the previous association.
* Granularity of periodicity of transmission of the association report should be the same as that of SRSp transmission periodicity
* For UL-TDOA,UE reports updated association information between UE Tx TEGs and UL SRS resources for positioning to the serving gNB via RRC
* For DL-TDOA, when requested by the LMF, UE includes UE RX TEG ID in LPP Provide Location Information

ZTE in R2-2200527 [12] propose:

* For multi-RTT, the reported Tx TEG and SRS association relationship is directly sent to LMF in ProvideLocationInformation.
* For UL-TDOA, the association relationship is sent to serving gNB via RRC signalling, it can be embedded in *MeasResults.*
* When reporting SRS and Tx TEG association relationship for UL/UL+DL positioning, to indicate the change of the Tx TEG association during the configured period, each SRS resource can be associated with a list of {Tx TEG ID, time stamp}.

#### 2.2.1.2 DL AoD, Multipath

Huawei in R2-2200429 [6] propose to support UE to feedback whether the PRS is measured in the angle search window.

Ericsson in R2-2201062 [8] propose:

* To introduce support for an LMF request and UE attributes to enable first path PRS RSRP reporting for DL-AoD.
* To introduce support for extended additional paths (more than 2)
* To introduce support for a LoS/NLoS indication per RSTD, RSRP and UE RxTx measurements

Apple in R2-2201104 [9] propose to enhance LPP ProvideLocationInformation to convey DL PRS RSRPP (reference signal received path power).

### 2.2.2 Discussion

**Question 2.2-1: Do you agree to introduce in LPP RequestLocationInformation:**

**request for UE Rx TEG ID,**

**maximum number of Rx TEGs for the same PRS resource,**

**request for UE Tx TEG ID,**

**maximum number of Tx TEGs for the same PRS resource,**

**request for UE RxTx TED ID,**

**maximum number of RxTx TEGs for the same PRS resource.**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Partly Yes | This answer should depend on positioning methods.For DL-TDOA, we expect the following signaling:request for UE Rx TEG ID for each RSTD measurement, maximum number of Rx TEGs for the same PRS resourceFor Multi-RTT, we expect the following signaling:request for UE Rx TEG ID for each UE Rx – Tx time difference measurement, maximum number of Rx TEGs for the same PRS resource,request for UE Tx TEG ID for each UE Rx – Tx time difference measurement, request for UE RxTx TED ID for each UE Rx – Tx time difference measurement, maximum number of RxTx TEGs for the same PRS resource.We do not understand why this is included.maximum number of Tx TEGs for the same PRS resource, |
| CATT |  | 1. Not only the request for RxTEG, but also for measurement with different RxTEG in DL-TDOA:
* *NR-DL-TDOA-RequestLocationInformation*

NR-DL-TDOA-RequestLocationInformation-r16 ::= SEQUENCE { nr-DL-PRS-RstdMeasurementInfoRequest-r16 ENUMERATED { true } OPTIONAL,-- Need ON nr-RequestedMeasurements-r16 BIT STRING { prsrsrpReq (0) } (SIZE(1..8)), nr-AssistanceAvailability-r16 BOOLEAN, nr-DL-TDOA-ReportConfig-r16 NR-DL-TDOA-ReportConfig-r16 OPTIONAL, -- Need ON additionalPaths-r16 ENUMERATED { requested } OPTIONAL, -- Need ON ..., [[ ueRxTEG-ID-Request-DL-TDOA-r17 ENUMERATED { true } OPTIONAL,-- Need ON measPRSwithDiffRxTEGsRequest-RSTD-r17 ENUMERATED {n2, n3, n4, n6, n8} OPTIONAL -- Need ON ]]}1. Not only the request for RxTxTEG group, but also for measurement with different RxTEG/RxTxTEG in Multi-RTT:
* *NR-Multi-RTT-RequestLocationInformation*

NR-Multi-RTT-RequestLocationInformation-r16 ::= SEQUENCE { nr-UE-RxTxTimeDiffMeasurementInfoRequest-r16 ENUMERATED { true } OPTIONAL, -- Need ON nr-RequestedMeasurements-r16 BIT STRING { prsrsrpReq(0)} (SIZE(1..8)), nr-AssistanceAvailability-r16 BOOLEAN, nr-Multi-RTT-ReportConfig-r16 NR-Multi-RTT-ReportConfig-r16, additionalPaths-r16 ENUMERATED { requested } OPTIONAL, -- Need ON ..., [[ ue-TxTEG-RequestMulti-RTT-r17 ENUMERATED { true } OPTIONAL, -- Need ON ue-RxTxTEG-ID-RequestMulti-RTT-r17 ENUMERATED { true } OPTIONAL, -- Need ON measPRSwithDiffRxTEGsRequestUERxTx-r17 ENUMERATED {n2, n3, n4, n6, n8, FFS n0} OPTIONAL, -- Need ON measPRSwithDiffRxTxTEGsRequestUERxTx-r17 ENUMERATED {n2, n3, n4, n6, n8, FFS n0} OPTIONAL -- Need ON ]]} |
| Ericsson |  | A TP is provided in R2-2201062 |
| InterDigital | Yes |  |
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**Question 2.2-2: Do you agree to introduce in LPP ProvideLocationInformation: UE Rx TEG IDs, UE Tx TEG IDs, and UE RxTx TEG IDs?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Partly Yes | This answer should depend on positioning methods.For DL-TDOA, we expect UE Rx TEG ID only for each TRP (target/reference TRP).For Multi-RTT, we expect all three IDs being included in the measurement report for each TRP. |
| CATT | Yes | Here is the summary of RAN1 LS on TEG parameters:

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| --- | --- | --- |
| **Positioning Methods** | **UE (Measurements) Report** | **Signalling between UE and NW(LMF/NG-RAN node)** |
| UL-TDOA | UE Tx TEG* ueTxTEG-ID
* [srs-PosResourceSetId]
* srs-PosResourceId
 | UE 🡪 serving gNB 🡪 LMF |
| Multi-RTT | ueRxTxTEG-ID-group with UE Rx-Tx time difference measurements* ueRxTxTEG-ID
* ueTxTEG-ID
* ueRxTEG-ID

Note: Multiple UE Rx-Tx time difference measurements can be obtained from:* different DL PRS resources with the same UE Rx/RxTx TEGs
* the same DL PRS resources with different UE Rx/RxTx TEGs
 | UE 🡪 LMF |
| UE Tx TEG* ueTxTEG-ID
* [srs-PosResourceSetId]
* srs-PosResourceId
 | UE 🡪 LMF |
| DL-TDOA | UE RxTEG-ID with RSTD measurementsNote: Multiple RSTD measurements can be obtained from:* the same DL PRS resources with different UE Rx TEGs
* different DL PRS resources with the same UE Rx TEG
 | UE 🡪 LMF |

For more detail signaling design of LPP, please refer to R2-2200300, including – *NR-DL-TDOA-SignalMeasurementInformation*– *NR-Multi-RTT-SignalMeasurementInformation**– Multiplicity and type constraint definitions*BTW, For more detail signaling design of RRC to report TxTEG for UL-TDOA, please refer to R2-2200300, including – *UEAssistanceInformation*– *SRS-Config* |
| Ericsson |  | Agree with CATT. The RRC impacts are also captured in R2-2201069 [14] |
| InterDigital | Yes |  |
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**Question 2.2-3: Do you agree to introduce in LPP ProvideLocationInformation: multiple UE Rx-Tx time difference measurements (for N different UE Rx TEGs), and multiple UE Rx-Tx time difference measurements (for N different UE RxTx TEGs with the same UE Tx TEG)? What is your preference for N?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features. N should wait for RAN1 decision.  |
| Huawei, HiSilicon | Yes | We think that RAN1 already made the following agreement with respect to the number N.**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.

**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.
 |
| CATT | Yes but | According to the description in R1-2112976, the LMF request N to UE, i.e. 2,3,4,6,8 (shown in answer of Q2.2-1)

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| --- | --- | --- |
| MeasPRSwithDiffRxTEGs\_Request\_UXRxTx | The parameter is used by a LMF to request a UE to measure the same DL PRS with different UE Rx TEGs for UX Rx-Tx measurements | [2, 3, 4, 6, 8] |
| MeasPRSwithDiffRxTXTEGs\_Request\_UXRxTx | The parameter is used by a LMF to request a UE to measure the same DL PRS with different UE RxTX TEGs for UX Rx-Tx measurements | [2, 3, 4, 6, 8] |

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 capabilityAccording to the Note, it’s up to UE to determine the N not more than 8 which is the maximum of N. |
| Ericsson | Yes | Agree with Huawei and CATT |
| InterDigital | Yes |  |
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**Question 2.2-4: Which signaling option you prefer for association of UL SRS resources with UE Tx TEGs ID:**

**Option a) RRC UEAssistanceInformation**

**Option b) New RRC message**

**Option c) RRCReconfigurationComplete**

**Option d) LPP ProvideLocationInformation**

**Consider providing your preference for signalling details for your favourable option in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Option a or measurement report | RAN1 already agreed RRC approach as* *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:*

RRC UE assistanceInforamtion or measurement report can be reused.  |
| Huawei, HiSilicon | See comments | Option c) for UL-TDOA if the association is static during the LCS procedure.Option a) for UL-TDOA if the association may be change during the LCS procedure.Option b) for UL-TDOA for periodic reporting.Option d) for Multi-RTT. |
| CATT | Option a or d | Option a) for UL-TDOA for request/response including periodic report:UE TxTEG is required by LMF eventually. Even if it is recommended by RAN1 to report via RRC, the mechanism in RRC report still needs to follow the periodically report via LPP.i.e. the request to report UE TxTEG is explicitly required by network:UE-TxTEG-ReportConfig ::= SEQUENCE { reportAmount-r17 ENUMERATED {r1, r2, r4, r8, r16, r32, r64, infinity}, reportingInterval-r17 ENUMERATED {noPeriodicalReporting, ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, ms20480, NULL1, NULL2, NULL3, NULL4}, ...Below please find the LPP PeriodicalReportingCriteria for your reference.-- ASN1STARTCommonIEsRequestLocationInformation ::= SEQUENCE { locationInformationType LocationInformationType, triggeredReporting TriggeredReportingCriteria OPTIONAL, -- Cond ECID periodicalReporting PeriodicalReportingCriteria OPTIONAL, -- Need ON …PeriodicalReportingCriteria ::= SEQUENCE { reportingAmount ENUMERATED { ra1, ra2, ra4, ra8, ra16, ra32, ra64, ra-Infinity } DEFAULT ra-Infinity, reportingInterval ENUMERATED { noPeriodicalReporting, ri0-25, ri0-5, ri1, ri2, ri4, ri8, ri16, ri32, ri64 }}Option d) for Multi-RTT for request/response including periodic report. |
| Ericsson | Option a or measurement report for RRC (UTDOA) and d) LPP for Multi-RTT | RAN1 already agreed RRC approach as* *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:*

We can check if measurement report is ok instead of UEAssistanceInformation. |
| InterDigital | (a) | We think UEAssistanceInformation is adequate since gNB requests UE to report the Tx TEG association information between UE Tx TEG IDs and SRS resources for positioning. The association information can be sent periodically if there are any changes to the association of UL SRS resources with UE Tx TEGs ID |
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**Question 2.2-5: Do you agree to introduce support for an LMF to request and UE to report first path PRS RSRP for DL-AoD?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. RAN1 has agree it. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes |  |
| CATT | Yes |  |
| Ericsson | Yes |  |
| InterDigital | Yes |  |
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**Question 2.2-6: Do you agree to introduce support for extended additional paths beyond 2?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. RAN1 has agree it. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes |  |
| CATT | Yes |  |
| Ericsson | Yes | A TP is provided in R2-2201062 |
| InterDigital | Yes | According to the following RAN1 agreement, support to be introduced for additional paths beyond 2.**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)
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**Question 2.2-7: Do you agree to introduce support a LoS/NLoS indication per RSTD, RSRP and UE RxTx measurements?**

**If you answer yes and if you have a preference regarding signalling details, please provide those details in the comments column.**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes | Agree. RAN1 has agree it. The RAN1 parameter lists in R1-2112976 should be used as baseline for RAN2 discussion on each features.  |
| Huawei, HiSilicon | Yes, but | The per-TRP LoS/NLoS indicator should also be introduced. |
| CATT | Yes | A TP is provided in R2-2201062 |
| InterDigital | Yes | Following the RAN1 agreement, yes. In addition, a LOS/NLOS indicator is associated per TRP. |
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### 2.2.3 Conclusions

## 2.3 Capabilities

### 2.3.1 Background

vivo in R2-2200330 [5] propose that:

* The gNB can enquire UE’s capability of supporting multiple UE Tx TEGs for UL TDOA by RRC message UECapabilityEnquiry.
* The UE can report its capability of supporting multiple UE Tx TEGs for UL TDOA to the gNB by RRC message UECapabilityInformation.
* The LMF can enquire UE’s capability of supporting multiple UE Tx TEGs for Multi-RTT to the gNB by LPP message *RequestCapabilities*.
* The UE can report its capability of supporting multiple UE Tx TEGs for Multi-RTT to the LMF by RRC message *ProvideCapabilities*.

Ericsson in R2-2201062 [8] propose the following capability LPP signalling:

* UE capability indicating support for UE Rx TEG IDs for DL-TDOA
* UE capability indicating support for UE Tx TEG IDs for UL positioning
* UE capability indicating support for i) UE Tx TEG IDs and UE Rx TEG IDs, ii) UE RxTx TEG IDs for Multi-RTT positioning
* UE capabilities indicating support for LoS/NLoS indication

Apple in R2-2201104 [9] propose the following capability LPP signalling:

* The maximum number of UE RxTEGs [for UE-assisted DL TDOA and/or Multi-RTT]
* The maximum number of UE TxTEGs [for UL-TDOA and/or Multi-RTT]
* The maximum number of UE-RxTx TEGs
* Capability to provide the association information of UL SRS resources for positioning with UE Tx TEGs ID
* Capability to measure the same DL PRS resource with N different UE Rx TEGs and report the corresponding multiple RSTD measurements
* Capability to measure the same DL PRS resource with N different UE Rx TEGs and report the corresponding multiple UE Rx-Tx time difference
* Capability to measure the same DL PRS resource with N different UE RxTx TEGs with the same UE Tx TEG, and report the corresponding multiple UE Rx-Tx time difference measurements
* The maximum number of DL PRS RSRPP
* Capability to receive an indication for each PRS resource, of a subset of PRS resources for the purpose of prioritization of DL-AOD reporting
* Capability to receive an indication for each PRS resource, of the boresight direction information

### 2.3.2 Discussion

**Question 2.3-1: Do you agree to introduce support for multiple UE Tx TEGs for UL TDOA capability in RRC?**

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel |  | RAN1 is discussing UE feature lists. For these RAN1 led items, final capabilities shall be decided by RAN1. In general, we agree that we need to introduce TEG capability in RRC.  |
| Huawei, HiSilicon | Yes, but | We think this issue is lower priority for this meeting. |
| CATT |  | UE TxTEG for UL TDOA capability should report to gNB. |
| Ericsson |  | Agree with CATT |
| InterDigital | Yes |  |
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**Question 2.3-2: which of the following LPP capability signalling you agree to introduce?**

1. The maximum number of UE RxTEGs [for UE-assisted DL TDOA and/or Multi-RTT]
2. The maximum number of UE TxTEGs [for UL-TDOA and/or Multi-RTT]
3. The maximum number of UE-RxTx TEGs
4. Capability to provide the association information of UL SRS resources for positioning with UE Tx TEGs ID
5. Capability to measure the same DL PRS resource with N different UE Rx TEGs and report the corresponding multiple RSTD measurements
6. Capability to measure the same DL PRS resource with N different UE Rx TEGs and report the corresponding multiple UE Rx-Tx time difference
7. Capability to measure the same DL PRS resource with N different UE RxTx TEGs with the same UE Tx TEG, and report the corresponding multiple UE Rx-Tx time difference measurements
8. The maximum number of DL PRS RSRPP
9. Capability to receive an indication for each PRS resource, of a subset of PRS resources for the purpose of prioritization of DL-AOD reporting
10. Capability to receive an indication for each PRS resource, of the boresight direction information
11. Support for LoS/NLoS indication

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel |  | RAN1 is discussing UE feature lists. For these RAN1 led items, final capabilities shall be decided by RAN1. In general, we agree that we need to introduce TEG capability, LOS/NLOS in LPP.  |
| Huawei, HiSilicon | Yes, but | We think that those features are under discussion by RAN1, and RAN2 should implement the signaling once RAN1 has stabilized the UE feature list. |
| CATT |  | The capabilities of TEG related looks good, i.e. a) – g). |
| Ericsson |  | Agree with Intel and Huawei |
| InterDigital |  | We think the following can be introduced in LPP capability: (e) (f) (g) (i) (j) (k) |
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### 2.3.3 Conclusions

## 2.4 Stage-2

### 2.4.1 Background

The following papers contain stage-2 TPs:

* CATT in R2-2200297 [1]
* CATT in R2-2200299 [2]
* Huawei in R2-2200429 [6]

### 2.4.2 Discussion

**Question 2.4-1: Please provide your comments on the following stage-2 TPs**

1. CATT in R2-2200297 [1]
2. CATT in R2-2200299 [2]
3. Huawei in R2-2200429 [6]

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel |  | R2-2200297 is for TRP beam/antenna information. In general it is ok. But for the information from gNB to the LMF, RAN1 left it to RAN3, we may change nothing depends on RAN3 decision. * Note: up to RAN3 to decide how the TRP beam information is provided to the LMF for both UE-assisted and UE-based

R2-2200429 and R2-2200299 are both for TEG, and changed different sections. We can combine them together.  |
| Huawei, HiSilicon | Partly Yes | We think TPs in a) and c) can be agreeable. For the TP in b), especially on the section 8.10, 8.12, and 8.13, it can be discussed when stage-3 specification is stable, and on the section 7.4.1.2, it should be discussed whether the procedure is captured in RRC or stage-2. |
| CATT |  | Agree with Intel. R2-2200299 shows all the potential stage-2 impacts of TEG which can be the baseline for further discussion. |
| Ericsson |  | Yes, we can have CATT R2-2200297 as baseline |
| InterDigital |  | We think CATT TP at least in (a) can be used as baseline |
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### 2.4.3 Conclusions

## 2.5 Other

### 2.5.1 Background

CATT in R2-2200300 [3] propose send an LS to RAN1 asking to delete the duplicated parameters, srs-PosResourceSetId associated with ueTxTEG-ID and update the value range of maxNumOfUE-RxTEG.

Ericsson in R2-2201066 [13] propose send an LS to RAN1 requesting about the resolution of the angular grid, in zenith and azimuth, over which the relative power of PRS Resources should be reported. Further, it provides configurable quantization levels that RAN2 can review and confirm if that is ok. If from RAN2, it is agreeable the conformed values can be sent to RAN1.

### 2.5.2 Discussion

**Question 2.5-1: Do you support sending LS to RAN1 asking to delete the duplicated parameters, srs-PosResourceSetId associated with ueTxTEG-ID and update the value range of maxNumOfUE-RxTEG, as proposed in R2-2200300 [3]**?

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| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | Yes |  |
| Huawei, HiSilicon | Yes | OK with the clarification. |
| CATT | Yes | These parameters are supposed to be captured by RAN2. So RAN2 would like to confirm with RAN1 before capturing these parameters. |
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**Question 2.5-2: Do you support sending LS to RAN1 requesting about the resolution of the angular grid, in zenith and azimuth, over which the relative power of PRS Resources should be reported as proposed in R2-2201066 [13] Or the text proposal with quantization levels if agreeable from RAN2 perspective and sending the RAN2 agreed parameters to RAN1**?

|  |  |  |
| --- | --- | --- |
| Company | Yes/No | Comments |
| Intel | No | The issue should be discussed in RAN1 directly, but it is too late. RAN2 should avoid the duplicated discussion.  |
| Huawei, HiSilicon | No | No need for the LS. RAN2 can directly design the related signaling. |
| CATT | Yes |  |
| Ericsson | Yes | OPTION 1:RAN2 thanks RAN1 for the status update on AoD discussions and agreements. RAN2 would like to point RAN1 attention to the following:If RAN1 has evaluated and can provide inputs on:* The resolution of the angular grid in azimuth and zenith dimensions,
* the quantization/resolution needed for the relative powers and

From RAN2 perspective, this selection would impact the LPP signalling overhead. In order to identify the LPP signalling configurations, RAN2 would like to understand the resolution (in angle, power and time) that is needed.OPTION 2:RAN2 thanks RAN1 for the status update on AoD discussions and agreements. RAN2 has discussed and concluded to use below quantization intervals can be configured. RAN2 would like RAN1 to check and confirm if this is fine.

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| stepOfAzimuth                                                            ENUMERATED {d01, d02, d05, d1, d2, d3, d4, d5}                                                                                                                                                                                     stepOfElevation                                                          ENUMERATED {d01, d02, d05, d1, d2, d3, d4, d5}Per Angle DL-PRSBeamGainDiff                  INTEGER (0..30) |

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### 2.5.3 Conclusions

# 4. Proposed Conclusion

TBD

# 5. TPs

TBD