3GPP TSG-RAN WG1 Meeting #100bis-e***R1-200xxxx***

e-Meeting, April 20 – 30, 2020

**Agenda item:** 7.2.8.4

**Source:** Moderator (Qualcomm Incorporated)

**Title:** Summary of Email Discussion [100b-e-NR-Pos-04]

**Document for:**  Discussion and Decision

# 1. Introduction

This document summarizes the following email discussion:

[100b-e-NR-Pos-04] Email discussion/approval on the following issues by 4/24; if necessary, followed by endorsing the corresponding TPs by 4/29 – Sven (Qualcomm)

* Physical layer procedures
  + UE RX beam indication for DL-AoD positioning
  + RSTD/timing reference info clarifications
  + UE Rx-Tx Time Difference measurements configuration
  + Pathloss reference configuration
* Inter-frequency UE Rx – Tx time difference measurements

# 2. UE RX beam indication for DL-AoD positioning

## 2.1 Introduction

At RAN1#99, the following agreement was made:

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| Agreement:   * When the UE reports DL-PRS RSRP measurements on DL-PRS resources from one DL-PRS Resource Set, the UE may indicate in the measurement report for each TRP which DL-PRS RSRP measurements, if any, have been measured using the same Rx beam. * Note: As previously agreed, to support Option 3 of multi-beam operation, the NW may configure DL-PRS Resources as source RS for QCL Type D for a target DL-PRS Resource. That is, Option 3 can be achieved by Option 1 with a DL-PRS as source RS for QCL Type D (Options 3/1 from previous related agreement in RAN1#97). |

To enable a UE to indicate the RSRP measurements which have been made with the same RX beam, RAN2 introduced a *nr-DL-PRS-RxBeamIndex* as INTEGER (1..8) (for up to 8 measurements per TRP) [TS 37.355]. Each RSRP measurement made with the same RX beam can get the same value/label of *nr-DL-PRS-RxBeamIndex* in the measurement report*.* In this way, the location server is able to determine which of the UE RSRP measurements in the report have been made with the same UE RX beam:

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| NR-DL-AoD-MeasElement-r16 ::= SEQUENCE {  trp-ID-r16 TRP-ID-r16 OPTIONAL,  nr-DL-PRS-ResourceId-r16 NR-DL-PRS-ResourceId-r16 OPTIONAL,  nr-DL-PRS-ResourceSetId-r16 NR-DL-PRS-ResourceSetId-r16 OPTIONAL,  nr-TimeStamp-r16 NR-TimeStamp-r16,  nr-PRS-RSRP-Result-r16 INTEGER (FFS) OPTIONAL,  -- Need RAN4 inputs on value range  nr-DL-PRS-RxBeamIndex-r16 INTEGER (1..8),  nr-TimingMeasQuality-r16 NR-TimingMeasQuality-r16,  nr-DL-Aod-AdditionalMeasurements-r16  NR-DL-AoD-AdditionalMeasurements-r16,  ...  } |

## 2.2 Text Proposal

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| References | Specification Text Proposal |
| Issue #3 (section 2.3, item#3,4)  in R1-2002713 | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  The UE may be configured to measure and report up to 8 DL PRS RSRP measurements on different DL PRS resources from the same cell. When the UE reports DL PRS RSRP measurements from one DL PRS resource set, the UE may indicate ~~which~~that the DL PRS RSRP measurements associated with the same *nr-DL-PRS-RxBeamIndex* have been performed using the same spatial domain filter for reception.  […] |

Companies are invited to provide their views on the TP using the Table below.

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| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | Support.  The introduction of *nr-DL-PRS-RxBeamIndex* was driven by the following RAN1 agreement in RAN1#99.  Agreement:   * When the UE reports DL-PRS RSRP measurements on DL-PRS resources from one DL-PRS Resource Set, the UE may indicate in the measurement report for each TRP **which** DL-PRS RSRP measurements, if any, have been measured using the same Rx beam. * Note: As previously agreed, to support Option 3 of multi-beam operation, the NW may configure DL-PRS Resources as source RS for QCL Type D for a target DL-PRS Resource. That is, Option 3 can be achieved by Option 1 with a DL-PRS as source RS for QCL Type D (Options 3/1 from previous related agreement in RAN1#97).   RAN1 intention may be that the RSRP measured using a single Rx beam (single group) is sufficient, which means that RSRP measured using Rx beams other than the selected one is not required to be reported. RAN2 signaling design introduced multiple groups of RSRP report for DL-AoD, which may also be helpful in our understanding. That is reason why we think clarification in RAN1 spec is needed, but the new parameter introduced by RAN2 does not need any change.  Reply to all:  In case we need an explicit agreement, there is our proposal.  Proposal for agreement   * When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report *nr-DL-PRS-RxBeamIndex* associated with each RSRP measurement in the report * The DL PRS-RSRP measurements for a TRP with the same *nr-DL-PRS-RxBeamIndex* have been received using the same Rx beam * Note: In the current LPP spec, *nr-DL-PRS-RxbeamIndex* is only reported for DL-AoD measurement. |  |
| CMCC | We think it is necessary to do some further clarifications to align the RAN1 and RAN2 specifications. We are fine with the TP. |  |
| OPPO | The TP is not necessary.  The parameter “*nr-DL-PRS-RxBeamIndex*”is the signaling tool the UE uses to indicate whether same Rx beam is used to measure the RSRPs.  The current wording 38.214 clearly specify that the UE can indicate the RSRPs are measured with same Rx beam. We do not need to repeat the description of higher layer parameter *nr-DL-PRS-RxBeamIndex* here. |  |
| CATT | Support this TP.  For the parameter *“nr-DL-PRS-RxBeamIndex”* in the IE “*NR-DL-AoD-SignalMeasurementInformation-r16”,* which introduced by RAN2,has not been discussed in RAN1 scope yet. We support to clarity the meaning of this new parameter in RAN1 specifications. In our point of view, RSRP measurements with the same “*nr-DL-PRS-RxBeamIndex*” in the UE report of DL-AoD means that UE indicate that these DL PRS RSRP measurements are received with the same Rx beam. |  |
| ZTE | Support. The parameter is to inform the beam pair of RX beam and Tx beam for a better DL-AOD measurement. |  |
| Nokia/NSB | We think that there have been multiple interpretations of the RAN1 agreement. Our understanding was that the UE would send one single bit to the network during a DL-PRS-RSRP report per resource set to indicate if the measurements were performed using the same RX beam or not. Do other companies see this differently? We think we may need to make a clarifying agreement before moving directly to TPs here. |  |
| Futurewei | We think it is needed to at state in RAN1 what this RxBeamIndex means so that the setting of it has a consistent meaning. However, the TP as proposed in the TP doesn’t define or explain what it is. |  |
| Qualcomm | We are OK with the TP, and it can be a separate agreement. We don’t think that there is a need for additional meaning. It says clearly that the UE groups the RSRP measurements according to the “same spatial domain filter for reception”.  When the UE reports DL PRS RSRP measurements from one DL PRS resource set, the UE may indicate ~~which~~that the DL PRS RSRP measurements associated with the same *nr-DL-PRS-RxBeamIndex* have been performed using the same spatial domain filter for reception. |  |
| Fraunhofer | Support the TP.  One remark: according to the RAN1 agreement above “…to support Option 3 of multi-beam operation, the NW may configure DL-PRS Resources as source RS for QCL Type D for a target DL-PRS Resource.“ in this case the UE may not to need report a nr-DL-PRS-RxBeamIndex-r16. This implies that this field needs to be optional; however this can to be addressed in RAN2. |  |
| vivo | Support this TP as it is. |  |
| Intel | Support TP in principle. Clarification can be done by RAN2 as well. |  |
| mtk | In our view, it is needed to signal whether to use same RX beam for AOD measurement, but to report which RX beam index is not needed  Maybe we should check with RAN2 why the “index” is so needed before agreeing this TP |  |

# 3. RSTD/timing reference info clarifications

## 3.1 Introduction

At RAN1#96bis, the following agreements were made:

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| Agreement:   * The network can indicate one or more of the following for the UE to use to determine a reference (reference time based on the DL PRS Resource ID(s)) for DL RSTD measurements.   + A DL PRS Resource ID   + A subset of DL PRS Resource IDs from a single DL PRS Resource set   + A DL PRS Resource set   Agreement:   * The UE may use different DL PRS Resource ID(s) (with the condition that the multiple DL PRS Resource IDs belong to a single DL PRS Resource set) or a different DL PRS Resource set for determining the reference for the RSTD measurement, and if it chooses to do so, it should report the DL PRS Resource ID(s) and/or the information on the DL PRS Resource set used to determine the reference |

## 3.2 Text Proposals

### 3.2.1 Clarification of reference IDs

#### TP#1:

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| References | Specification Text Proposal |
| Issue #4 (section 2.4, item#5)  in R1-2002713 | TP for clause 5.1.6.4 (PRS reception procedure) of TS 38.214:  […]  The UE may be indicated by the network that a DL PRS resource can be used as the reference for the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The reference time indicated by the network to the UE can also be used by the UE to determine how to apply higher layer parameters DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty. The UE expects the reference time to be indicated whenever it is expected to receive the DL PRS. This reference time provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a DL PRS resource set ID, and optionally a single DL PRS resource ID or a list of PRS resource IDs from a single DL PRS resource set. The UE may use different DL PRS resources within a single DL PRS resource set provided by *DL-PRS-RstdReferenceInfo* or a different DL PRS resource set which can be any DL PRS resource set associated with the [ID] provided by *DL-PRS-RstdReferenceInfo* ordifferent DL PRS resources associated with a [ID] other than the [ID] provided by *DL-PRS-RstdReferenceInfo* or different DL PRS resource sets associated with a [ID] other than the [ID] provided by *DL-PRS-RstdReferenceInfo* to determine the reference time for the RSTD measurement. If the UE chooses to use a different reference time than indicated by the network, then it is expected to report the [ID], the DL PRS resource ID(s) or the DL PRS resource set ID used to determine the reference.  […] |

#### TP#2:

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| References | Specification Text Proposal |
| Issue #4 (section 2.4, item#7)  in R1-2002713 | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  The UE may be indicated by the network that a DL PRS resources can be used as the reference for the ~~DL~~ RSTD~~, DL PRS-RSRP, and UE Rx-Tx time difference~~ measurement~~s~~ in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The reference time indicated by the network to the UE can also be used by the UE to determine how to apply higher layer parameters DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty. The UE expects the reference time to be indicated whenever it is expected to receive the DL PRS. This reference time provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a PRS resource set ID, and optionally a single PRS resource ID or a list of PRS resource IDs. The UE may use different DL PRS resources within a single DL PRS resource set ~~or a different DL PRS resource set~~ to determine the reference time for the RSTD measurement where the DL PRS resource set can be any DL PRS resource set associated with the [ID] provided by *DL-PRS-RstdReferenceInfo* ~~as long as the condition that the DL PRS resources used belong to a single DL PRS resource set is met~~. If the UE chooses to use a different reference time than indicated by the network, then it is expected to report ~~the [ID],~~ the DL PRS resource ID(s) or the DL PRS resource set ID used to determine the reference.  […] |
| NOTE: This text highlighted in turquois in the first and last sentence is not shown as deletion in the TP source ([R1-2002623](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100b_e/Docs/R1-2002623.zip)). It is assumed the deletion is intentional and part of the TP. | |

Companies are invited to provide their views on the TPs using the Table below; incl. which of the two TPs is preferred (if any).

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| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | For the TP proposed in item 5, we do not think the long text to guide UE to reselect another reference is needed, as it does not preclude anything.’  For the TP proposed in item 7, we think that changing the reference TRP should be allowed. The agreement we made during RAN1#96b does not assume the presence of ID, and reselected the DL PRS resource set ID does not have to be from the same TRP. This is similar to LTE RSTD reference cell reselection.  Agreement:   * The UE may use different DL PRS Resource ID(s) (with the condition that the multiple DL PRS Resource IDs belong to a single DL PRS Resource set) or a different DL PRS Resource set for determining the reference for the RSTD measurement, and if it chooses to do so, it should report the DL PRS Resource ID(s) and/or the information on the DL PRS Resource set used to determine the reference   Also, we would like to mention that the current LPP, the reference reporting is mandatory, regardless of whether UE reselects the reference in the report.  NR-DL-TDOA-SignalMeasurementInformation-r16 ::= SEQUENCE {  dl-PRS-ReferenceInfo-r16 DL-PRS-IdInfo-r16,  nr-DL-TDOA-MeasList-r16 NR-DL-TDOA-MeasList-r16,  ...  }  In response to vivo, we think this is way of writing a spec. The current spec is written in the following way (Approach 1)  🡪 The reference is provided for RSTD measurement report configuration (based on recommendation from item#7), a.k.a. RSTD reference (recommendation)  🡪 The reference can also be used for PRS search window (to support any type of PRS measurement), a.k.a. assistance data reference  🡪 The structure of the reference  🡪 UE reselection of the reference in the report, a.k.a. RSTD reference that UE actually selects  Another way of writing the spec should be (Approach 2)  🡪 The reference is provided for PRS search window (to support any type of PRS measurements), a.k.a. assistance data reference  🡪 The structure of the reference  🡪 The reference will also be used for RSTD measurement report configuration (network recommendation of RSTD reference), a.k.a. RSTD reference (recommendation)  🡪 UE reselection of the reference in the report, a.k.a. RSTD reference that UE actually selects  We think in general, the spec should go with Approach 2, which is natural procedure of LPP.  In response to QC, we do not think adding additional reference TRP is needed. It is our understanding when we precluded that the search window is configured via SFN initialization time difference (RTD) and propagation delay difference and agreed on expected RSTD similar to LTE that   * Assistance data reference (ID+set ID+resource ID list) is the same as the network recommendation of RSTD reference.   It means that in the current LPP structure, the TRP with nr-PRS-ID in trp-ID of nr-DL-PRS-ReferenceInfo-r16 is the assistance data reference TRP. In addition, the current structure allows providing reference resource set/reference resource within the reference TRP.  Our proposed change is updated in the right-handed column, where we completely rewrite the section. | The UE may be indicated by the network that a DL PRS resources can be used as the reference for the ~~DL~~ RSTD~~,~~~~DL PRS-RSRP, and UE Rx-Tx time difference~~ measurement~~s~~ in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The reference time indicated by the network to the UE can also be used by the UE to determine how to apply higher layer parameters nr-*DL-PRS-expectedRSTD-r16* and *nr-DL-PRS-expectedRSTD-uncerainty-r16*. The UE expects the reference time to be indicated whenever it is expected to receive the DL PRS. This reference time provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a DL PRS resource set ID, and optionally a single DL PRS resource ID or a list of PRS resource IDs. For reporting DL RSTD, the UE may use a different reference time than indicated by the network.  =============== Updated based on Approach 2 =============  The UE expects to be indicated by the network with a reference for receiving PRS to perform DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The reference indicated by the network to the UE can be used by the UE to determine how to apply higher layer parameters DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty. This reference provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a PRS resource set ID, and optionally a single PRS resource ID or a list of PRS resource IDs. For reporting DL RSTD, the UE shall indicate a reference for the reported DL RSTD measurement, and the UE may use a different reference than indicated by the network.  The UE expects to be configured with higher layer parameter *DL-PRS-expectedRSTD*, which defines the time difference with respect to the received DL subframe timing the UE is expected to receive DL PRS, and *DL-PRS-expectedRSTD-uncertainty*, which defines a search window around the expectedRSTD.  The UE may be configured to report quality metrics corresponding to the RSTD and UE Rx-Tx time difference measurements which include the following fields:  *- TimingMeasQuality-Value* which provides the best estimate of the uncertainty of the measurement  *- TimingMeasQuality-Resolution* which specifies the resolution levels used in the Value field |
| CATT | There are two agreements in RAN1#96bis related to the above two TPs. Huawei/HiSilicon had mentioned one of them in the above, and another one is listed as follows:  Agreement:   * The network can indicate one or more of the following for the UE to use to determine a reference (reference time based on the DL PRS Resource ID(s)) for DL RSTD measurements.   + A DL PRS Resource ID   + A subset of DL PRS Resource IDs from a single DL PRS Resource set   + A DL PRS Resource set   The two TPs want to solve different issues. In order to make TS 38.214 can completely and accurately catch the two agreements, we suggest merging the two TPs together for further discussion. |  |
| ZTE | Support item#5. We suggest to capture all possible options we already agreed. |  |
| Nokia/NSB | We think the agreements are clear and that the text captures this already, so we don’t really see the need for these TPs. |  |
| Futurewei | We don’t see this as critical corrections. |  |
| Qualcomm | We think there is confusion in the meaning of reference time. There is no time provided to the UE. We also think there is confusion between expected RSTD and reported RSTD measurements. In our understanding, the expected RSTD and uncertainty is always needed when DL-PRS assistance data are provided to the UE (i.e., for DL-TDOA, DL-AoD, and Multi-RTT positioning). However, **the reporting of used IDs** (and therefore, most parts of the existing specification text) is only needed for RSTD measurements (and therefore, DL-TDOA positioning only).  We understand the early agreement made at RAN1#96bis is only related to the RSTD measurements reported by the UE, since the issue of expected RSTD and uncertainty was discussed much later in RAN1.  The DL-PRS assistance data include always the expected RSTD and uncertainty. Therefore, a reference TRP is always needed to indicate the meaning of expected RSTD. An [ID] (TRP) is sufficient for the indication of a reference for the expected RSTD. In RAN2 specifications for LTE-OTDOA, this reference is referred to as “assistance data reference TP”.  For the RSTD measurements, RAN1 agreed that the UE can be instructed to use certain Resource candidate(s) as a reference for the RSTD measurements. **However, this reference is not necessarily the same as the expected RSTD reference, and – as the name DL-PRS-RstdReferenceInfo suggests – only needed for RSTD measurements (DL-TDOA positioning).** In RAN2 specification for LTE-OTDOA, this reference is referred to as “RSTD reference TP”.  In our view, the current specification text mixes the two issues above. We suggest the modification shown to the right, using Huawei version as baseline. | The UE may be indicated by the network that a DL PRS resources can be used as the reference for the ~~DL~~ RSTD~~,~~~~DL PRS-RSRP, and UE Rx-Tx time difference~~ measurement~~s~~ in a higher layer parameter *DL-PRS-RstdReferenceInfo*. This reference provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a DL PRS resource set ID, and optionally a single DL PRS resource ID or a list of PRS resource IDs. For reporting DL RSTD, the UE may use a different reference than indicated by the network.  **The UE expects the higher layer parameter *DL-PRS-expectedRSTD* and *DL-PRS-expectedRSTD-uncertainty* whenever it is expected to receive the DL PRS.** |
| vivo | First of all, we think current specification is clear and no need for either TP.  On text highlighted in turquois, deletion part of the sentence “The UE may be indicated by the network that a DL PRS resources can be used as the reference for the ~~DL~~ RSTD~~,~~~~DL PRS-RSRP, and UE Rx-Tx time difference~~ measurement~~s~~ in a higher layer parameter *DL-PRS-RstdReferenceInfo*. “and “then it is expected to report ~~the [ID],~~ “ in TP2, as well as Huawei/Qualcomm’s proposed modifications, we have the following comment.  The text highlighted in turquois was agreed to be added to 38.214 in RAN1#100-e as summarized in R1-2001364 section 2.7. The reason was to reflect this agreement in RAN1#99  Agreement:  Modify the previous agreement on the definition of the time stamp as follows:  A UE measurement can be associated with a time stamp. For UE RSTD, DL PRS RSRP and UE Rx-Tx time difference measurement report, the time stamp can include the SFN, as well as the slot number for a subcarrier spacing. These values correspond to the reference provided by the DL-PRS-RstdReferenceInfo.  So this reference does apply to all measurements, not just RSTD.  This exact issue has already been extensively discussed in RAN1#100-e, we see no reason to revert previous agreement. |  |
| Intel | In our view current spec text is quite clear, except the part on “reference time indicated by network”. We do not see the strong need to revise text but are open to change “reference time” on “[ID] indicated as a reference”. |  |
| mtk | Using the “reference to determine the reference time”, which is clear from the earlier agreement. So the wording “reference time” should be modified as “reference”.. We agree on QC’s modification |  |
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### 3.2.2 Absence of reference IDs

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| References | Specification Text Proposal |
| Issue #4 (section 2.4, item#6)  in R1-2002713 | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  The UE may be indicated by the network that a DL PRS resources can be used as the reference for the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The reference time indicated by the network to the UE can also be used by the UE to determine how to apply higher layer parameters DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty. ~~The UE expects the reference time to be indicated whenever it is expected to receive the DL PRS.~~ This reference time provided by *DL-PRS-RstdReferenceInfo* may include an [ID], a PRS resource set ID, and optionally a single PRS resource ID or a list of PRS resource IDs. The UE may use different DL PRS resources or a different DL PRS resource set to determine the reference time for the RSTD measurement as long as the condition that the DL PRS resources used belong to a single DL PRS resource set is met. If the UE chooses to use a different reference time than indicated by the network, then it is expected to report the [ID], the DL PRS resource ID(s) or the DL PRS resource set ID used to determine the reference. In case that the reference time is not indicated by the network, the UE can select a TRP or a TRP including a PRS resource set and/or PRS resource(s) to determine a reference time, and it is expected to report the TRP ID and it is expected to optionally report the PRS resource set ID and/or the PRS resource ID(s).  […] |

Companies are invited to provide their views on the TP using the Table below.

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| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | It does not work, as there is no reference to apply the expected RSTD and expected RSTD uncertainty. |  |
| CATT | We do not support this TP.  As the UE should use the reference time indicated by the network to determine the search window (DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty), if UE determine the reference time autonomously, it will cause the mismatch between reference time selected by UE with the parameters of (DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty) configured by network. |  |
| ZTE | Agree with Huawei and CATT. |  |
| Nokia/NSB | Agree with above. Do not support this TP. |  |
| Qualcomm | Wrong TP, please see our reply in the previous question |  |
| vivo | No need for this TP. |  |
| Intel | Do not support. UE can select reference even if the reference is not indicated by the network |  |
| mtk | Don't need this TP. Just use the QC version in previous one |  |
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# 4. UE Rx-Tx Time Difference Measurements

## 4.1 Multiple Rx–Tx time difference measurements

The following agreements have been made:

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| RAN1#98bis  Working assumption:   * A UE can be configured to report multiple Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning with each measurement corresponding to a single DL PRS resource/resource set. The DL PRS resource/resource sets can be in different positioning frequency layers   + FFS: Reporting of SRS for positioning resource/resource set ID corresponding to a UE Rx-Tx time difference measurement   + Note: This agreement does not introduce any new behavior for the transmission of SRS for positioning.   RAN1#99  Agreement:   * Confirm the working assumption from RAN1#98bis on reporting of multiple Rx–Tx time difference measurements corresponding to a single SRS resource/resource set for positioning. The FFS item in the working assumption is removed.   In the parameter list discussions for RAN2, the "multiple" was fixed to "4" (same as RSTD). |

### 4.1.1 Text Proposals

#### TP#1: Clarification of "multiple"

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| References | Specification Text Proposal |
| Issue #6 (section 2.9, item#12)  in R1-2002713 | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  The UE can be configured in higher layer parameter *UE Rx-Tx Time-MeasRequestInfo* to report, subject to UE capability, up to 4 ~~multiple~~ UE Rx-Tx time difference measurements corresponding to a single configured SRS resource or resource set for positioning. Each measurement corresponds to a single received DL PRS resource or resource set which can be in difference positioning frequency layers.  […] |

#### TP#2: Clarification of "multiple" together with text alignments

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| References | Specification Text Proposal |
| Issue #6 (section 2.9, item#13)  in R1-2002713 | TP for Clause 5.1.6.5 (PRS reception procedure) of TS 38.214:  […]  For DL UE positioning measurement reporting in higher layer parameters *DL-PRS-RstdMeasurementInfo or DL-PRS-UE-Rx-Tx-MeasurementInfo* the UE can be configured to report the DL PRS resource ID(s) or the DL PRS resource set ID(s) associated with the DL PRS resource(s) or the DL PRS resource set(s) which are used in determining the UE measurements DL RSTD, UE Tx-Rx time difference or the DL PRS-RSRP.  ~~The UE can be configured in higher layer parameter~~ *~~UE Rx-Tx Time-MeasRequestInfo~~* ~~to report multiple UE Rx-Tx time difference measurements corresponding to a single configured SRS resource or resource set for positioning. Each measurement corresponds to a single received DL PRS resource or resource set which can be in difference positioning frequency layers.~~  For the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements the UE can report an associated higher layer parameter *Timestamp*. The *Timestamp* can include the SFN and the slot number for a subcarrier spacing. These values correspond to the reference which is provided by *DL-PRS-RSTDReferenceInfo*.  The UE is expected to measure the DL PRS resource outside the active DL BWP or with a numerology different from the numerology of the active DL BWP if the measurement is made during a configured measurement gap. When not configured with a measurement gap, the UE is only required to measure DL PRS within the active DL BWP and with the same numerology as the active DL BWP. When the UE is expected to measure the DL PRS resource outside the active DL BWP it may request a measurement gap in higher layer parameter [XYZ].  The UE assumes that the DL PRS from the serving cell is not mapped to any symbol that contains SS/PBCH block from the serving cell. If the time frequency location of the SS/PBCH block transmissions from non-serving cells are provided to the UE then the UE also assumes that the DL PRS from a non-serving cell is not mapped to any symbol that contains the SS/PBCH block of the same non-serving cell.  The UE may be configured to measure and report, subject to UE capability, up to 4 DL RSTD measurements per pair of cells with each measurement between a different pair of DL PRS resources or DL PRS resource sets within the DL PRS configured for those cells. The up to 4 measurements being performed on the same pair of cells and all DL RSTD measurements in the same report use a single reference timing.  The UE may be configured to measure and report, subject to UE capability, up to 8 DL PRS RSRP measurements on different DL PRS resources from the same cell. When the UE reports DL PRS RSRP measurements from one DL PRS resource set, the UE may indicate which DL PRS RSRP measurements have been performed using the same spatial domain filter for reception.  The UE can be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference measurements corresponding to a single configured SRS resource or resource set for positioning. Each measurement corresponds to a single received DL PRS resource or resource set which can be in difference positioning frequency layers.  If the UE is configured with *DL-PRS-QCL-Info* and the QCL relation is between two DL PRS resources, then the UE assumes those DL PRS resources are from the same cell. If *DL-PRS-QCL-Info* is configured to the UE with ‘QCL-Type-D’ with a source DL-PRS-Resource then the *DL-PRS-ResourceSetId* and the *DL-PRS-ResrouceId* of the source DL-PRS-Resource are expected to be indicated to the UE.  The UE does not expect to process the DL PRS in the same symbol where other DL signals and channels are transmitted to the UE when there is no measurement gap configured to the UE.  […] |

Companies are invited to provide their views on the TPs using the Table below; incl. which of the two TPs is preferred (if any).

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | Support TP#2.  The text related to capability of RSRP may be changed subject to UE feature discussion. |  |
| OPPO | Support TP2 |  |
| CATT | Support both TP1 and TP2. |  |
| CATT | Support both TP1 and TP2. |  |
| Nokia/NSB | In principle we support both TPs. We agree with Huawei that it may be better to wait for UE feature to stabilize before adopting the text related to capabilities. |  |
| Futurewei | Ok with waiting after UE features discussions/decisions |  |
| Qualcomm | TP#2 is more complete. |  |
| Fraunhofer | Support TP2 |  |
| vivo | OK with TP2. |  |
| Intel | The parameter *UE Rx-Tx Time-MeasRequestInfo* was missing in RAN2 spec and is likely to be fixed this or next meeting. Therefore, it is better to keep it. The capability related change seems also not critical. We think that some cleanup is needed but it is not critical at this stage as may not be accurate at the end. |  |
| mtk | Fine for both TPs |  |
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## 4.2 Inter-Frequency UE Rx–Tx time difference measurement

**Proposal:** Limit UE Rx – Tx time difference only to PRS and SRS in the same band.

#### TP:

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| --- | --- |
| References | Specification Text Proposal |
| Issue #2.4 in R1‑2002716 | TP for Clause 5.1.30 of TS 38.215: 5.1.30 UE Rx – Tx time difference  |  |  | | --- | --- | | **Definition** | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TX  Where:  TUE-RX is the UE received timing of downlink subframe #*i* from a positioning node, defined by the first detected path in time.  TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i received from the positioning node.  TUE-RX and TUE-TX shall be measured on the same band.  Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the positioning node.  For frequency range 1, the reference point for TUE-RX measurement shall be the Rx antenna connector of the UE and the reference point for TUE-TX measurement shall be the Tx antenna connector of the UE. For frequency range 2, the reference point for TUE‑RX measurement shall be the Rx antenna of the UE and the reference point for TUE‑TX measurement shall be the Tx antenna of the UE. | | **Applicable for** | RRC\_CONNECTED intra-frequency  RRC\_CONNECTED inter-frequency | |

Companies are invited to provide their views on the TP using the Table below.

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | Support the TP.  We discussed this issue a couple of meetings ago when the higher layer specification was not ready.  Now given PRS and SRS are configured in different protocols, there is no way explicitly associating PRS with SRS.  The following cases in R1-2001560 show that it is allowed by specification that UE pairs PRS with a wrong SRS in case two SRSs are from different TAGs (bands).  SRS  SRS  PRS  PRS  2nd band  1st band  SRS  SRS  PRS  2nd band  1st band  In response to QC, it would have been good if the TRP transmitting PRS could receive both SRS, but in reality, TRP might only receive a single SRS, which is not the same as the one UE selects. In our understanding, different bands may have different RF chains and may not be not co-located (e.g. inter-band CA), and it may not be good if PRS is transmitted in one RF chain and SRS is received in another one.  For the time stamp reporting, we understand for DL-only positioning it should be OK, but for multi-RTT, which time should selected for the time stamp reporting? Should it be SRS Tx time or PRS Rx time? We understand that RAN4 is also proposing to limit PRS and SRS within a window, but the window is too large for the slot-level time stamp reporting. |  |
| OPPO | Support the TP |  |
| CATT | Support the TP. It is reasonable to limit UE Rx – Tx time difference only to DL-PRS and SRS-Pos in the same band. |  |
| ZTE | Support the TP. |  |
| Nokia/NSB | We see the point Huawei is bringing up and agree we should consider this issue. One question for clarification: We say that “Multiple DL PRS resources can be used to determine the start of one subframe of the first arrival path of the positioning node.” Does the proposed TP then mean we are restricting this to only DL PRS resources in the same band? |  |
| Futurewei | Support |  |
| Qualcomm | We agree that if the UE has one PRS in band1 and two different SRS in band1 and band2, if the two bands are in different TAGs, and a TRP receives the 2 SRS, the TRP would not know whether the reported Rx-Tx is for the SRS in the first band or the second band.  • However, the ambiguity would ha**ppen only if the 2 SRS are in the same slot, because if the SRS are in different slot, then the UE would report an Rx-Tx with a specific slot timestamp, so the LMF would know which SRS was used for reporting Rx-Tx.**  If indeed this case of ambiguity (i.e., when the 2 SRS of different bands appear on the same symbol) is problematic, we can fix it by just introducing a CC index or SRS index in the report, without having to restrict it.  **Is it common understanding that the issue exists only if the 2 SRS of different bands are in the same slot?** |  |
| Fraunhofer | We prefer resolving this issue without restricting the UE Rx-Tx measurement. |  |
| vivo | We think this issue is related to UE feature for positioning discussion. In particular, the original component “Support of UE Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing  Note: Covers scenario when DL PRS are processed across different DL PRS frequency layers associated with a given component carrier used for SRS for positioning” for Multi-RTT and now as FG [Support of Rx-Tx time difference measurements across different positioning frequency layers for DL PRS processing for Mult-RTT (Inter-frequency Multi-RTT )].  If UE capability indicating support of the above FG, we don’t think the restriction of the same band of PRS and SRS is correct.  We’re open to solve this issue without put a hard constraint in UE Rx-Tx measurement definition. |  |
| Intel | In our view, if there is no explicit association mechanism of DL PRS and SRS for positioning across different bands, which seems to be the case now, then it is better to drop support of this functionality in R16. We are also open to establish this association but it should not be ambiguous.  Further discussion is needed to conclude on the TP. |  |
| MTK | HW’s argument is reasonable to us. So we support TP |  |
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# 5. Pathloss reference configuration

The following agreements have been made:

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| RAN1#98bis  Agreement:   * Only open loop power control mechanism is supported. If the UE is provided a pathloss reference from the serving or a neighbouring cell in the SRS for positioning configuration but is not able to successfully measure the pathloss for the pathloss reference provided, use a RS resource obtained from the SSB that the UE uses to obtain MIB as the pathloss reference signal. |

## 5.1 Ability to measure pathloss reference

|  |  |
| --- | --- |
| References | Proposals |
| Issue #10 (section 3.2, item#19,20)  in R1-2002713 | **Proposal 1:** Reuse the side conditions for SS-RSRP and potentially PRS-RSRP in RAN4 specification for determining whether UE is not able to accurately measure the PL.  **Proposal 2:** A criterion which based on RSRP threshold or other solution is needed to clarify the meaning of "the UE is not able to accurately measure".  **Proposal 3:** Inform RAN4 on the need to clarify the meaning of "the UE is not able to accurately measure" for SRS-Pos power control. |

Companies are invited to provide their views on the Proposals in the Table below.

|  |  |
| --- | --- |
| Company | Comments |
| Huawei/HiSilicon | Agree with Proposal 1.  We cannot support Proposal 2 as providing such possible RSRP criterion would be the in RAN4 domain and Proposal 1 and 3 would take care of this issue.  OK with Proposal 3, with an LS to RAN4 to clarify. |
| CMCC | In our view, the criteria of the pathloss RS measurement failure is in RAN4 scope, therefore, we prefer proposal 1. |
| OPPO | Ok with proposal 2 to clarify the condition in 38.213 |
| CATT | Agree with Proposal 3.  Both Proposal 1 and Proposal 2 should be the solutions to clarify the meaning of "the UE is not able to accurately measure" for SRS-Pos power control. However, RAN4 need to be involved for both the solutions and an LS should be sent to RAN4 to inform this issue and solutions. |
| ZTE | Prefer proposal 3. Give RAN4 the full power to tackle the issue. |
| Nokia/NSB | Given the above discussion perhaps we should agree to send an LS to RAN4 asking for them to solve this issue and if necessary involve RAN1? |
| Qualcomm | Proposal 1 is a RAN4 topic. We are OK to inform RAN4 that RAN1 expects RAN4 to add criterial for determining whether UE is not able to accurately measure the PL. |
| Fraunhofer | Proposal 3 |
| vivo | We don’t see this issue is critical. Without any input from RAN1, we believe RAN4 will and can still do their work. |
| Intel | Issue was discussed at the last meeting. The proposal #1 was supported by majority. Currently, we assume RAN4 will work on that. |
| MTK | Prefer proposal 3 |
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## 5.2 Absence of a pathloss reference

#### TP#1:

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| --- | --- |
| References | Proposals |
| Issue #10 (section 3.2, item#21)  in R1-2002713 | TP for Clause 7.3.1 (Sounding reference signals - UE behaviour) TS 38.213:  […]  If a UE transmits SRS based on a configuration by IE *SRS-Positioning-Config* on active UL BWP of carrier of serving cell , the UE determines the SRS transmission power in SRS transmission occasion as  [dBm]  where,  - and are provided by *p0* and *alpha* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and  - is a downlink pathloss estimate in dB calculated by the UE, as described in Clause 7.1.1 in case of an active DL BWP of a serving cell , using RS resource indexed in a serving or non-serving cell for SRS resource set [6, TS 38.214]. A configuration for RS resource index associated with SRS resource set is provided by *pathlossReferenceRS*  - if a *ssb-Index* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower*  - if a *dl-PRS-ResourceId* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower*  If the UE determines that the UE is not able to accurately measure or the UE is not provided with *pathlossReferenceRS-Pos-r16*, the UE calculates using a RS resource obtained from the SS/PBCH block of the serving cell that the UE uses to obtain *MIB*  The UE indicates a capability for a number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource set configured through *SRS-PosResourceSet-r16* in all the serving cells.  […] |

#### TP#2:

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| --- | --- |
| References | Proposals |
| Issue #10 (section 3.2, item#22)  in R1-2002713 | TP for Clause 7.3.1 (Sounding reference signals - UE behaviour) TS 38.213:  […]  If a UE transmits SRS based on a configuration by IE *SRS-Positioning-Config* on active UL BWP of carrier of serving cell , the UE determines the SRS transmission power in SRS transmission occasion as  [dBm]  where,  - and are provided by *p0* and *alpha* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and  - is a downlink pathloss estimate in dB calculated by the UE, as described in Clause 7.1.1 in case of an active DL BWP of a serving cell , using RS resource indexed in a serving or non-serving cell for SRS resource set [6, TS 38.214]. A configuration for RS resource index associated with SRS resource set is provided by *pathlossReferenceRS*  - if a *ssb-Index* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower*  - if a *dl-PRS-ResourceId* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower*  If the UE determines that the UE is not able to accurately measure , the UE calculates using a RS resource obtained from the SS/PBCH block of the serving cell that the UE uses to obtain *MIB*  The UE indicates a capability for a number of pathloss estimates that the UE can simultaneously maintain.  If the UE is not provided with *pathlossReferenceRS-Pos-r16*, the UE calculates using a RS resource configured within *SRS-SpatialRelationInfoPos-r16.* If the RS resource configured within *SRS-SpatialRelationInfoPos-r16* is a SRS resource or the *SRS-SpatialRelationInfoPos-r16* is not configured, the UE calculates using a RS resource obtained from SS/PBCH block of the serving cell that the UE uses to obtain MIB.  […] |

Companies are invited to provide their views on the TPs using the Table below; incl. which of the two TPs is preferred (if any).

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | Support TP#1 with slight editorial changes.  TP#2 is problematic and we cannot support it since SRS resources in an SRS resource set may have different DL RS as the spatial relation, but they should have a common Tx power (same PL estimates). It is not clear which DL RS as the spatial relation will be used for the entire SRS resource set. also please note that spatialRelation RS is also an optional field and, if we agree on this TP, we need to have yet another fallback mode discussion for the case that neither pathlossReference nor spatialRelation RS are configured.  In response to QC’s comments: We support QC’s proposal of change. | TP #1  […]  If a UE transmits SRS based on a configuration by IE *SRS-Positioning-Config* on active UL BWP of carrier of serving cell , the UE determines the SRS transmission power in SRS transmission occasion as  [dBm]  where,  - and are provided by *p0* and *alpha* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and  - is a downlink pathloss estimate in dB calculated by the UE, as described in Clause 7.1.1 in case of an active DL BWP of a serving cell , using RS resource indexed in a serving or non-serving cell for SRS resource set [6, TS 38.214]. A configuration for RS resource index associated with SRS resource set is provided by *pathlossReferenceRS*  - if a *ssb-Index* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower*  - if a *dl-PRS-ResourceId* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower*  If the UE determines that the UE is not able to accurately measure or the UE is not provided with *pathlossReferenceRS-Pos-r16*, the UE calculates using a RS resource obtained from the SS/PBCH block of the serving cell that the UE uses to obtain *MIB*  The UE indicates a capability for a number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets configured by *SRS-PosResourceSet-r16* across all serving cells. |
| CMCC | We are fine with TP#1 |  |
| CMCC | For TP#2, it is a little bit confused. We got the intention of the TP is an optimization of the pathloss fallback mechanism. In case that the *pathlossReferenceRS-Pos-r16* is not configured for an SRS resource set, instead of fallback to RS obtaining MIB, the UE can use a RS configured with *SRS-SpatialRelationInfoPos-r16* as a substitute fallback RS.  Note that the pathloss RS is configured per resource set, on the other hand, the spatial relation info is a per resource indication. Suppose that a UE is configured with 1 SRS for POS resource set, within which there are 4 SRS for POS resources configured with *SRS-SpatialRelationInfoPos-r16*, then which resource is chosen as the one to calculate the pathloss? Another thing is that even if it is up to UE implementation to select one resource, without the configured transmission power of the pathloss RS, how does the UE calculate the pathloss using the spatial relation info source RS? |  |
| OPPO | Support TP#1 |  |
| CATT | Support TP#1.  For TP#2, it is a good idea to extend the pathloss reference RS to spatial relation information for fallback mechanism. However, as pointed out by Huawei/HiSilicon and CMCC, there are some issues when spatial relation information is used for the pathloss reference RS and we need carefully check the potential issues. |  |
| ZTE | Support TP#1. Prefer Huawei’s version. |  |
| Nokia/NSB | Support TP#1, we can agree with Huawei’s change as well.  We do not support TP#2 at this time. We do agree it may point out a good issue of what to do if pathloss RS is not configured but agree with above discussion that there may be further issues due to configuration level of PL RS and spatialRelationInfo among other things. Perhaps we should postpone the discussion to Rel-17 on this issue where we can treat it properly. |  |
| Qualcomm | Not OK with TP#2 at this stage and consider it as potential enhancement for Rel-17. We can be OK with the first change in TP#1,  But regarding the 2nd change, the agreement and capability is about “additional pathloss references” on top of those maintained already for PUSCH/PUCCH/SRS. So it should be:  The UE indicates a capability for a number of pathloss estimates that the UE can simultaneously maintain for all the SRS resource sets configured by *SRS-PosResourceSet-r16* across all serving cells **in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions.** |  |
| Fraunhofer | Support TP#1. |  |
| vivo | OK with Huawei’s or Qualcomm’s version for TP1.  Do not support TP2. |  |
| Intel | OK with the first change in TP1. Do not see the need for the second change (it is capability discussion). If companies strongly want to see it then our suggestion is:  “The UE indicates a capability for a number of pathloss estimates that the UE can simultaneously maintain for all configured *SRS-PosResourceSet-r16“*  TP2 is an enhancement which is not critical at this stage |  |
| mtk | TP1+ further modification by QC |  |
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## 5.3 Multiple neighbour cells

**Proposal:** UE should identify the weakest link quality and transmit based on the weakest link quality as long as it is lower than the maximum allowed transmit power per carrier to ensure successful reception of SRS by the non-serving cells. The following TP should be captured in TS 38.213.

|  |  |
| --- | --- |
| References | Proposals |
| Issue #10 (section 3.2, item#23)  in R1-2002713 | TP for Clause 7.3.1 (Sounding reference signals - UE behaviour) TS 38.213:  […]  If a UE transmits SRS based on a configuration by IE *SRS-Positioning-Config* on active UL BWP of carrier of serving cell , the UE determines the SRS transmission power in SRS transmission occasion as  [dBm]  where,  - and are provided by *p0* and *alpha* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and  - is a downlink pathloss estimate in dB calculated by the UE, as described in Clause 7.1.1 in case of an active DL BWP of a serving cell , using RS resource indexed in a serving or non-serving cell for SRS resource set [6, TS 38.214], where is the smallest value of all measured non-serving cells. A configuration for RS resource index associated with SRS resource set is provided by *pathlossReferenceRS*  - if a *ssb-Index* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower*  - if a *dl-PRS-ResourceId* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower*  […] |

Companies are invited to provide their views on the Proposal/TP using the Table below.

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Huawei/HiSilicon | We do not support.  First this proposal has been discussed before and was not agreed.  Second, similar to SRS for MIMO usages and also based on what we agreed in Rel-16 that is already reflected in 38.331, “There is at most one pathloss reference per SRS resource set configured (RAN1 97)”. It is not clear how the power of each SRS resource set can be based on the weakest link that is determined from measurements on multiple pathlossReference RS unless each SRS resource set is configured with multiple pathlossReference signals from multiple different cells.  Finally, agreeing on this proposal means reverting Rel-16 agreements without any clear justification. |  |
| CMCC | Not sure if we understand the motivation and scenario of the TP. For instance, there are 3 neighboring cells around a UE. Suppose that the UE is able to transmit SRS towards each neighboring cell, then the NW can configure 3 SRS resource sets to the UE, each with a pathloss RS from that specific cell. In such a case, there is no weakest link. On the other hand, considering the case that a UE can only transmit SRS omnidirectionally, which I think is more like the case described in the TP (i.e., the SRS can be received by several neighboring cells). In such a case, it is possible that the NW configures one SRS resource set for the UE, with only one pathloss RS is associated with this set and therefore only one possible transmit power. Even if multiple SRS resource sets are configured, and UE could select the weakest one to determine the transmit power, one potential issue is that the SRS may cause interference to other UEs in neighboring cells.  So far, we do not think this TP is necessary. |  |
| OPPO | Understand the motivation but only one pathloss RS is configured to the SRS resource set in rel16, so there does not exist the “smallest values” |  |
| CATT | In our point of view, the power control of SRS-Pos should be based on the pathloss of the cell which SRS-Pos is intended to send to. Therefore, we do not think should be the smallest value of all measured non-serving cells. |  |
| ZTE | Not supportive. From my understanding, path loss reference RS is common for a set, if we agree the TP, which means each resource within a set may have different transmission power. What if the set is used for UL beam sweeping? |  |
| Nokia/NSB | We do not support this TP. We think this would be an additional enhancement which would need consensus first and should be brought to Rel-17 as it is non-critical from our view. |  |
| Qualcomm | Not support |  |
| Fraunhofer | We do not support. |  |
| vivo | No support. |  |
| Intel | Do not support. Do not see the motivation behind. |  |
| mtk | Can’t understand the real benefit and impact. So we don't support |  |
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