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).
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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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# 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
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## 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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### 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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# 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#98bisWorking 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#99Agreement:* 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).

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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

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| **Definition** | The UE Rx – Tx time difference is defined as TUE-RX –TUE-TXWhere: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-frequencyRRC\_CONNECTED inter-frequency |

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

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# 5. Pathloss reference configuration

The following agreements have been made:

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| RAN1#98bisAgreement:* 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.
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## 5.1 Ability to measure pathloss reference

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| 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$ PL\_{b,f,c}\left(q\_{d}\right)$".**Proposal 3:** Inform RAN4 on the need to clarify the meaning of "the UE is not able to accurately measure$ PL\_{b,f,c}\left(q\_{d}\right)$" for SRS-Pos power control. |

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

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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 $b$ of carrier $f$ of serving cell $c$, the UE determines the SRS transmission power $P\_{SRS,b,f,c}\left(i,q\_{s}\right)$ in SRS transmission occasion $i$ as  [dBm]where, - $P\_{O,SRS,b,f,c}\left(q\_{s}\right)$ and $α\_{O,SRS,b,f,c}\left(q\_{s}\right)$ are provided by *p0* and *alpha* respectively, for active UL BWP $b$ of carrier $f$ of serving cell $c$, and SRS resource set $q\_{s}$ is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and- $PL\_{b,f,c}\left(q\_{d}\right)$ 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 $c$, using RS resource indexed $q\_{d}$ in a serving or non-serving cell for SRS resource set $q\_{s}$ [6, TS 38.214]. A configuration for RS resource index $q\_{d}$ associated with SRS resource set $q\_{s}$ 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 $PL\_{b,f,c}\left(q\_{d}\right)$ or the UE is not provided with *pathlossReferenceRS-Pos-r16*, the UE calculates $PL\_{b,f,c}\left(q\_{d}\right)$ 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 $b$ of carrier $f$ of serving cell $c$, the UE determines the SRS transmission power $P\_{SRS,b,f,c}\left(i,q\_{s}\right)$ in SRS transmission occasion $i$ as  [dBm]where, - $P\_{O,SRS,b,f,c}\left(q\_{s}\right)$ and $α\_{O,SRS,b,f,c}\left(q\_{s}\right)$ are provided by *p0* and *alpha* respectively, for active UL BWP $b$ of carrier $f$ of serving cell $c$, and SRS resource set $q\_{s}$ is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and- $PL\_{b,f,c}\left(q\_{d}\right)$ 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 $c$, using RS resource indexed $q\_{d}$ in a serving or non-serving cell for SRS resource set $q\_{s}$ [6, TS 38.214]. A configuration for RS resource index $q\_{d}$ associated with SRS resource set $q\_{s}$ 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 $PL\_{b,f,c}\left(q\_{d}\right)$, the UE calculates $PL\_{b,f,c}\left(q\_{d}\right)$ 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 $PL\_{b,f,c}(q\_{d})$ 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 $PL\_{b,f,c}(q\_{d})$ 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).

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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.

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| 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 $b$ of carrier $f$ of serving cell $c$, the UE determines the SRS transmission power $P\_{SRS,b,f,c}\left(i,q\_{s}\right)$ in SRS transmission occasion $i$ as  [dBm]where, - $P\_{O,SRS,b,f,c}\left(q\_{s}\right)$ and $α\_{O,SRS,b,f,c}\left(q\_{s}\right)$ are provided by *p0* and *alpha* respectively, for active UL BWP $b$ of carrier $f$ of serving cell $c$, and SRS resource set $q\_{s}$ is indicated by *SRS-ResourceSetId* from *SRS-ResourceSet*, and- $PL\_{b,f,c}\left(q\_{d}\right)$ 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 $c$, using RS resource indexed $q\_{d}$ in a serving or non-serving cell for SRS resource set $q\_{s}$ [6, TS 38.214], where $PL\_{b,f,c}\left(q\_{s}\right)$ is the smallest value of all measured non-serving cells. A configuration for RS resource index $q\_{d}$ associated with SRS resource set $q\_{s}$ 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.

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