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.   V10: To Futurewei  We are OK with the change.  To Nokia  In our understanding, for DL-AoD, UE does not have to measure all PRS resources from a PRS resource set using the same Rx beam. Instead, UE tries its best effort to use the same Rx beam, and report a subset that was measured with the same Rx beam. “which” in the agreement was interpreted by RAN2, and commonly accepted within RAN2 during running CR review that to allow UE to report as many RSRP as possible, a group ID is introduced.  For example, RSRP1 – RSRP3 are measured using the Rx beam 1 for PRS resource 1 – 3, while RSRP4 – RSRP6 are measured using another Rx beam 2 for PRS resource 4 - 6 simply because the when UE performs the measurement, PRS resource 1-3 and PRS resource 4-6 are measured in different time that UE cannot guarantee the same Rx beam was used.  RAN1 agreed that UE should report RSRP1 – RSRP3, and indicate that they are measured using the same Rx beam, or UE should report RSRP1 – RSRP6, and indicate that they are not measured using the same Rx beam. While RAN2 says it is OK to report RSRP1-6, but indicate that RSRP1 – RSRP3 are measured using the same Rx beam, and RSRP4 – RSRP6 are measured using another same Rx beam, whicih we believe can work technically for the LMF to find the angle. To us, since spec does not break, and it is up to UE to select how many Rx beams (RSRP groups) are there in the measurement, we do not see any problem accepting the extension from RAN2.  [v17] Reply Ericssion, we suggest to be explicit in terms of RAN1 specification rather than implicitly based on the parameter name. |  |
| 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.  In response to HW:  We can not agree with the proposal. This was not the intention of the agreement in RAN1. Our understanding was that we agreed that if all the DL PRS-RSRP measurements within one resource set were made using the same Rx beam that this information could be signalled to the network. This was done so that in DL-AoD that the RSRP measurements within one set could be viewed on a “level playing field”. We need to keep this in mind. Reporting the index has no clear value for DL-AoD in our view. |  |
| 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.  To HW:  We have not explicitly defined this *RxBeamIndex* and the intention is to just use this parameter for certain purposes. For this reason, we would like to reflect this better in HW proposed text for agreement:   * When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report the *nr-DL-PRS-RxBeamIndex* to associate~~d~~ with each of the RSRP measurement in the report * The DL PRS-RSRP measurements for a TRP reported 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. |  |
| 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 |  |
| Ericsson | With the added text in the TP, we say ‘UE may indicate that the DL PRS RSRP measurements associated with the same *nr-DL-PRS-RxBeamIndex*’. But then the remaining part ‘have been performed using the same spatial domain filter for reception’ sounds a bit redundant. If we go for this TP, can we remove ‘have been performed using the same spatial domain filter for reception’? |  |
| Samsung | OK with the TP |  |
| Sony | Support the TP |  |
| LG | In our understanding, RAN1 agreed that UE is able to report whether the same beam was used while performing RSRP measurements for multiple PRS resources. In the current signal structure of 37.355, however, *nr-DL-PRS-RxBeamIndex-r16*, which might be interpreted as an RX beam index, is associated with a single RSRP (*nr-PRS-RSRP-Result-16* or *nr-PRS-RSRP-ResultDiff-r16*) regarding a PRS resource and/or a PRS resource set, so the UE is possible to report *nr-DL-PRS-RxBeamIndex-r16* for each RSRP measurements. For example, let us consider that the UE reports 2 RSRPs with 2 RX beam information for a TRP. Even if the UE reports *nr-DL-PRS-RxBeamIndex-r16=1* for *nr-PRS-RSRP-Result-16* and reports *nr-DL-PRS-RxBeamIndex-r16=2* for *nr-PRS-RSRP-ResultDiff-r16,* it is meaningless at the location server since the location sever does notknowRX beam direction of the UE.  We would like to suggest that the RAN1 agreement is correctly captured in TS 37.355 as the RAN1 originally intended. For example, when the UE reports RSRP measurements for multiple PRS resources, the UE can report 1 bit to inform whether the same RX beam was used. |  |

Interim Summary:

There is some support for the TP (10 companies; Huawei, CMCC, CATT, ZTE, Qualcomm, Fraunhofer, vivo, Intel, Samsung, Sony).

One company (OPPO) thinks the TP is not needed, since essentially a "signalling realization" of RAN1 agreement.

One company (MTK) thinks that RAN2 should be consulted before agreeing the TP.

One company (Nokia) cannot agree with the TP, and thinks this TP goes beyond the previous RAN1 agreement.

One company (LG) thinks that the *nr-DL-PRS-RxBeamIndex-r16* is meaningless for the location server, since the location sever does not know RX beam direction of the UE.

FL’s understanding is that the TP only specifies the previous RAN1 agreement more precisely, by clarifying how the "*which DL-PRS RSRP measurements*" has finally been realized in the signalling, but does not modify the previous agreement in any way.

Two companies (Qualcomm, Futurewei), suggest an additional agreement for the TP, which was then proposed by Huawei:

**Interim Proposal 1:**

* When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report the *nr-DL-PRS-RxBeamIndex* to associate with each of the RSRP measurement in the report.
* The DL PRS-RSRP measurements for a TRP reported 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.

**Interim Proposal 2:** Agree the TP shown below 2.2 above.

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| Company | Comments |
| Nokia/NSB | It seems that LG had a similar understanding as us for the RAN1 agreement and that RAN2 misinterpreted this which is now somehow being agreed in RAN1. For the sake of progress and as there is a clear majority we can compromise to a slightly modified agreement as proposed below. As some motivation for the suggested change, the UE should not be allowed to report the Rx beam index for every RSRP measurement if it is not informing the network that some measurements were done with the same beam as this was the motivation in the first place:   * When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report the *nr-DL-PRS-RxBeamIndex* to associate with each of the RSRP measurement in the report if for each *nr-DL-PRS-RxBeamIndex* reported there are at least 2 RSRP measurements associated with it within the DL PRS resource set.   If the proposed change is agreeable then we suggest not to directly agree to the TP here but wait for next week to finalize. |
| Ericsson | Although we preferred to remove ‘have been performed using the same spatial domain filter for reception’ from the TP as it is redundant text, for the sake of progress, we can be ok to agree to the TP if other companies are fine with it. We are ok with interim proposals 1 and 2. |
| Qualcomm | We are generally support of Proposal 1 & 2, but I am trying to understand Nokia’s intention above:  The *nr-DL-PRS-RxBeamIndex* is now mandatory in the *NR-DL-AoD-MeasElement-r16* . So, you are suggesting to make it optional, and if it is missing, then it means that this measurement has not be done with the same Rx beam an any other measurement? The intention of doing this change is to reduce reporting overhead? I don’t think this would reduce overhead in general, and I don’t think we should really optimize for these now. So, if that is not the intention, then why would be a problem if a UE reports X measurements, all of them with different beam ID?  To clarify also with regards to the “Note”: there is no intention to change the understanding that *nr-DL-PRS-RxbeamIndex is only reported for Dl-AoD measurement.* |
| Nokia/NSB\_2 | Our intention is not about reporting overhead. If we look back at the original RAN1 agreement it reads:  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.   This is saying that within one DL PRS resource set the NW wants to know the measurements performed using the same beam. We understood this to be a binary reporting field that was sent per DL PRS resources set -> yes the measurements used the same beam or no the measurements did not use the same beam. We remember the discussion in the room leading to this point was around this binary type of reporting as something similar was proposed for TX beam in the UL but was not agreed. In our view the agreement did not mandate that the UE would report a Rx beam ID at all. RAN2 then interpreted this differently and in our view changed the RAN1 agreement. We would actually prefer that we sent RAN2 an LS with the original RAN1 interpretation and ask if it was indeed their intention to change the meaning of the RAN1 agreement by adding RxBeamIndex (notice it says nothing about Index in the agreement). However, this seems like a battle we could not win as the majority seem to want to see this TP agreed. So, as we said above for the sake of progress, we can agree on the proposed compromise above. We would ask the proponents of having the index reported for every RSRP measurement what the advantage of the LMF knowing that for example, beam 3 was used for an DL PRS-RSRP if no other DL PRS-RSRP measurement within that set uses beam 3? We see no technical benefit of this and therefore propose the revision. |
| Samsung | We now understand Nokia’s concern and also would like to see some clarifications. |
| OPPO | Now we understand the intention of this “nr-DL-PRS-RxBeamIndex” by RAN2 is purly for signalling purpose. I understand that is one way to implement our RAN1 agreement to indicate if the RSRP is measured using the same Rx beam.  Since this parameter is used to indicate that information, we do not think the UE shall report it for every reported DL-PRS RSRP measurement. The rx beam Id is reported only for those DL PRS RSRP measurement that does share same Rx beam with at least another DL PRS RSRP measurement. For instance, there are 4 DL PRS RSRP measurement: RSRP #0~3. RSRP #0 and #1 use the same Rx beam and #2 and #3 uses different Rx beam. Then the UE only need to report Rx beam Id for RSRP #0 and 1 to indicate that they are measured with same Rx beam. But for RSRP #2 and #3, the UE does not need to report the beam #.  When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report the *nr-DL-PRS-RxBeamIndex* to associate with each of the RSRP measurement in the report if the RSRP measurement has been performed using the same spatial domain filter for reception as another RSRP measurement. |
| Huawei/HiSilicon | In our understanding, since the *nr-DL-PRS-RxBeamIndex* is mandatory for DL-AoD, for a RSRP measurement not received with the same Rx beam as the any other RSRP measurement for a TRP, UE simply not included it in any of the additional measurement list at all, which means that UE does not have report the RSRP and the associated with *nr-DL-PRS-RxBeamIndex*. Note that the additional measurements does not have to match exactly the same number as the requested maximum number of RSRP.  To be specific to Nokia’s example, UE simply does not report RSRP for beam 3.  Reply to Oppo, in your case, UE simply does not have to report RSRP#2 and RSRP#3 at all, as they have nothing to do DL-AoD positioning method.  Honestly speaking, UE can simply report a single group, i.e. all reported RSRP have the same *nr-DL-PRS-RxBeamIndex*, and we think that would be sufficient. However if UE would like to report RSRPs received with other Rx beams as well, and it is LMF’s discretion whether and how to use them.  RAN2 has the freedom to save the overhead by making the following changes.  NR-DL-AoD-SignalMeasurementInformation-r16 ::= SEQUENCE {  nr-DL-AoD-MeasList-r16 NR-DL-AoD-MeasList-r16,  ...  }  NR-DL-AoD-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs)) OF NR-DL-AoD-MeasElement-r16  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,  ...  }  NR-DL-AoD-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..7)) OF NR-DL-AoD-AdditionalMeasurementElement-r16  NR-DL-AoD-MeasurementElement-r16 ::= SEQUENCE {  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-ResultDiff-r16 INTEGER (FFS) OPTIONAL, -- Need RAN4 inputs on value range  nr-DL-PRS-RxBeamIndex-r16 INTEGER (1..8) OPTIONAL, -- Cond NotSameAsMain  ...  } |
| CATT | We support both proposal 1 and proposal 2. |
| Intel | We can accept the change if UE is not mandated to report the same *nr-DL-PRS-RxBeamIndex* for all measurements. i.e. different indexes can be reported as well. Hope it is a common understanding.If NW requests UE to perform measurements for any of methods or combination DL-AoD, DL-TDOA it should be up to UE which RX beam to use for each DL PRS resource measurements. |
| Fraunhofer | We support both interim proposals 1 and 2. |
| LG | We have similar understanding with Nokia/NSB. RAN1 agreed that UE is able to report whether the same beam was used while performing RSRP measurements for multiple PRS resources. However, it has not been captured in the current TS 37.355 as RAN1 intended. In the current phase, we think there are two options to address this issue. Firstly, a request for RAN2 spec modification might be considered. Secondly, RAN1 spec appropriately needs to be described based on the current TS 37.355.  In consideration of the second option based on the current structure of *NR-DL-AoDMeasElement-r16* described in TS 37.355, the UE should report a specific RX beam index for each RSRP measurement, so the reporting of the same RX beam index up to 8 RSRPs is one of the possible cases. Based on this, we may have the following TP of TS 38.214. 5.1.6.5 PRS reception procedure *---- Unchanged parts omitted ----*  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 report *nr-DL-PRS-RxBeamIndex* to associate with each of the DL PRS RSRP measurement in the report.~~the UE may indicate which DL PRS RSRP measurements have been performed using the same spatial domain filter for reception~~.  We also support that the original RAN1 agreement is appropriately captured with some modification of TS 37.355. |
| Sony | We are fine with both interim proposal 1 and proposal 2. |
| OPPO | We share the same understanding with Nokia and LGE, per our previous agreement:  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.   The indication of “using same Rx beam” is optional for UE and it is mandated for the UE to report indication of “using same Rx beam”. And it is not mandated to all the DL PRS-RSRP from one DL PRS resource set must be measured with one same Rx beam.  @HW: in my example, my understanding is UE can report RSRP#2 and RSRP#3 because the UE is not mandated to only report RSRP measurement using the same Rx beam.  We are fine with the TP proposed by LGE, we think it is aligned with our RAN1 agreement. |
| Huawei/HiSilicon | [v17]  I am confused what the TP from LG means if I replace the field name with xxx. How does that reflect RAN1 agreement?  *---- Unchanged parts omitted ----*  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 report [xxx] to associate with each of the DL PRS RSRP measurement in the report.  To be constructive, we propose the following TP that stick with RAN1’s original agreement.  […]  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 that DL PRS RSRP measurements not associated with the higher layer parameter [*notTheSameRxBeam*] have been performed using the same spatial domain filter for reception.  […]  And we send an LS to RAN2 to replace “nr-DL-PRS-RxBeamIndex” with “notTheSameRxBeam” as an optional field in *NR-DL-AoD-MeasurementElement-r16*.  NR-DL-AoD-SignalMeasurementInformation-r16 ::= SEQUENCE {  nr-DL-AoD-MeasList-r16 NR-DL-AoD-MeasList-r16,  ...  }  NR-DL-AoD-MeasList-r16 ::= SEQUENCE (SIZE(1..nrMaxTRPs)) OF NR-DL-AoD-MeasElement-r16  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-TimingMeasQuality-r16 NR-TimingMeasQuality-r16,  nr-DL-Aod-AdditionalMeasurements-r16 NR-DL-AoD-AdditionalMeasurements-r16,  ...  }  NR-DL-AoD-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..7)) OF NR-DL-AoD-AdditionalMeasurementElement-r16  NR-DL-AoD-MeasurementElement-r16 ::= SEQUENCE {  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-ResultDiff-r16 INTEGER (FFS) OPTIONAL, -- Need RAN4 inputs on value range  notTheSameRxBeam ENUMERATED {true} OPTIONAL, -- Need OP  ...  }   | *NR-DL-AoD-SignalMeasurementInformation* field descriptions | | --- | | ***nr-PRS-RSRP-Result***  This field specifies the reference signal received power (RSRP) measurement, as defined in TS 38.331 [35]. | | ***notTheSameRxBeam***  This field specifies whether *nr-PRS-RSRP-ResultDiff* is received with the same Rx beam as *nr-RSRP-RSRP-Result*. If this field is absent, *nr-PRS-RSRP-ResultDiff* is received with the same Rx beam as *nr-RSRP-Result*. | |
| Futurewei | Between Interim Proposal 1 and 2, we support only Proposal 1.  Regarding proposed changes from Nokia:   * When the UE reports DL PRS-RSRP measurement on DL PRS resources from one DL PRS resource set, the UE may report the *nr-DL-PRS-RxBeamIndex* to associate with each of the RSRP measurement in the report if for each *nr-DL-PRS-RxBeamIndex* reported there are at least 2 RSRP measurements associated with it within the DL PRS resource set.   We are ok with the addition of texts in red above but assuming that the original follow-up text is kept i.e.   * “The DL PRS-RSRP measurements for a TRP reported with the same *nr-DL-PRS-RxBeamIndex* have been received using the same Rx beam.”   At least from reading Nokia’s comment, they do not have a different understanding that if the same *nr-DL-PRS-RxBeamIndexi* is used, they are received with the same Rx Beam.  To LG:  Your proposed TP doesn’t address the central issue that we are trying to resolve here which is regarding the use of same Rx Beam. The sentence that was removed in your TP is needed. We cant agree with this TP unfortunately. |

## 2.3 Summary

6 companies are supportive of the Interim Proposals 1 and 2 (Ericsson, Qualcomm, CATT, Intel, Fraunhofer, Sony).

One company is supportive of only Interim Proposal 1 (Futurewei).

One company (Qualcomm) suggests clarifying the Note in Interim Proposal 1 that the understanding is that *nr-DL-PRS-RxbeamIndex* is only reported for DL-AoD measurement.

Concerns were raised by Nokia, Samsung, Oppo, LG which seems all related to the condition of when to report the field *nr-DL-PRS-RxBeamIndex.* E.g., the UE should not report the *nr-DL-PRS-RxBeamIndex* if none of the measurement in the set of measurements has been performed with the same RX beam.

One company (Nokia) suggests sending an LS to RAN2 with the "original" RAN1 interpretation.

However, there appears to be confusion on what the "original" RAN1 interpretation is.

**FL comment:**

The name "Beam Index" may be a potential source of confusion. One could name this field also "colour" with values ‘red’, ‘blue’, ‘green’, etc. From a signalling point of view, it appears simpler to just always report the "colour", instead of implementing some logic and structure to group the report. The use of the "colour" is anyhow up to the network.

However, companies with concerns think there should be no "colour" but rather "black or white" (binary yes/no), since this appears to be the intention of the original RAN1 agreement. This, however, seems to imply that a UE should not report any measurement if not at least two measurements in the set were made with the same RX beam.

On the other hand, it seems also Nokia’s understanding of the RAN1 agreement is "that within one DL PRS resource set the NW wants to know the measurements performed using the same beam" (Nokia’s 2nd comment above). According to FL understanding, this is exactly what the "colour" field is doing. Instead of sorting the measurements into "black and white" groups, all measurements are reported in a single group, which however, requires up to 8 "colours" to indicate which of the (up to 8) measurements were performed using the same RX beam.

FL believes, that a reporting in "black and white" groups would either require a restructuring of the measurement report (and therefore, a different reporting structure compared to other methods (e.g., RSTD)), or not reporting the measurements in case not at least two measurements were made with the same RX beam.

It seems Huawei also thinks the latter can be sufficient. I.e., all the reported RSRP measurements can have the same "colour", and therefore, a single "black or white" group seems to be acceptable. Huawei suggests a *notTheSameRxBeam* field in the additional measurement group. However, the provided example ASN.1 would still allow a different DL-PRS Resource Set ID in the *NR-DL-AoD-MeasurementElement-r16* group. FL believes a single "black or white" group would not require any explicit signalling indication, since the *NR-DL-AoD-MeasurementElement-r16* (without separate DL PRS Resource Set ID) need to be present if and only if at least one additional RSRP measurement of the same Resource Set is made with the same RX beam.

According to FL understanding, a TP for the "black or white" yes/no understanding would be as follows:

|  |
| --- |
| 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 that the DL PRS RSRP measurements have been performed using the same spatial domain filter for reception. |

Note, the up to 8 measurements are per cell/TRP, and the report indication is for a DL PRS Resource Set. Therefore, FL assumes that the above implies reporting measurements for a single set only.

Given the comments and different understandings, it seems difficult to converge on a particular TP at this meeting, but it seems there are three options available (so far):

**Option 1:** No TP is needed.

|  |
| --- |
| […]  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 DL PRS RSRP measurements have been performed using the same spatial domain filter for reception.  […] |

**Option 2:** Clarify that the "which measurement" is indicated with the *nr-DL-PRS-RxBeamIndex* field (original proposed TP):

|  |
| --- |
| […]  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.  […] |

**Option 3:** Clarify that a "which measurement" indication is not needed; an indication that the same beam has been used is sufficient:

|  |
| --- |
| […]  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 that the DL PRS RSRP measurements have been performed using the same spatial domain filter for reception.  […] |

Companies are requested to indicate which Option would be preferred (if any).

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| --- | --- |
| Company | Comments |
| CATT | After double-check the original RAN1 agreement related to “the same Rx beam” as follows:  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.   We recognized that what RAN1 had agreed was that UE may indicate whether the same Rx beam was used for RSRP measurements on multiple PRS resources in one PRS resource set, and not indicate the Rx beam index. Therefore, the updated TP from Nokia in below is reasonable as it accurately reflect the previous RAN1 agreements.  *[…]*  *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 DL PRS RSRP measurements associated with the higher layer parameter [TheSameRxBeam] have been performed using the same spatial domain filter for reception.*  *[…]*  However, we still have one concern on the updated TP with the updated parameter [TheSameRxBeam], as it cannot indicate two or more RSRP measurement groups with different Rx beam in the 8 RSRP measurements. For example, if RSRP 1~4 were measured using Rx beam 1 and RSRP 5~8 use Rx beam 2. If we use the updated parameter [TheSameRxBeam], which is a binary reporting field, it will be FALSE if it is sent per PRS resource set. And even it is sent per PRS resource, it can only indicate RSRP 1~4 were measured using the same RX beam, but cannot indicate RSRP 5~8 also used the same Rx beam. On the contrary, the original RAN2 parameter nr-DL-PRS-RxBeamIndex can indicate up to 8 RSRP groups with different RX beam. Whether it is the motivation of RAN2 to introduce the parameter nr-DL-PRS-RxBeamIndex? To answer the question, we suggest to send an LS to RAN2 to clarify the meaning of the original RAN1 agreements in above and ask their intention to adding the RxBeamIndex, before we try to agree any TP. |
| vivo | Thanks for FL’s summary on this issue. Looking at all three options, our preference is to take option 2 to align with RAN2’s CR/specification. Our concern is taking option 1 or option 3 may still leave different understanding and hence cause confusion regarding beam index between RAN1 and RAN2’s specification. |
| Huawei/HiSilicon | We support Option 2 (agree in RAN1 on the extension taken in RAN2) and Option 1. For Option 1, an LS should be sent to RAN2, to change the change the field name and type in LPP. |
| Nokia/NSB | We are supportive of Option 3.  We would also like to clarify that we do not have the understanding suggested by FL that “UE should not report any measurement if not at least two measurements in the set were made with the same RX beam.” We of course support the UE reporting the up to 8 DL PRS-RSRP measurements per DL PRS resource set regardless of this Rx beam issue we are discussing here. What we do not support is the UE reporting an Rx beam index on every DL PRS-RSRP measurement which is reported without restriction. While we do not support the idea of RxBeamIndex in general, our view is also that if this eventually is supported the UE should not report this beam index if only 1 measurement is made with a given beam within a report. Using the FL example of colors, if a UE reports only 1 RSRP measurement as “blue” and only 1 RSRP measurement as “orange” within a resource set this gives the LMF the same information as if the UE did not report the colors for those 2 RSRP measurements.  We also would like to note that other companies seem to feel that some “extension” of the original RAN1 agreement was made in RAN2 but our understanding is that RAN2 only attempted to capture the RAN1 agreement and was not intentionally modifying or adding to the RAN1 agreement. |
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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 |

## 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:

|  |  |
| --- | --- |
| 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).

|  |  |  |
| --- | --- | --- |
| 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 |  |
| Ericsson | We are ok with the TP1. |  |
| Samsung | Not crirical |  |
| Sony | Support TP#1 (It reflects RAN1 agreements). |  |
| LG | We also think that there might be confusions on the reference. In our understanding, Assistance data of *dl-PRS-ReferenceInfo-r16 (*TRP ID, resource set ID and/or resource IDs) is a recommandation by network to the UE to find reference timing for RSTD calculation, so additional TRP is not needed for reference. Huawei’s TP based on approach 2 seems reasonable. |  |

Interim Summary:

There seems to be no consensus on the need of these TPs and multiple modifications to the TPs are proposed.

3 companies (ZTE, Ericsson, Sony) support TP#1 as it is.

5 companies (Nokia, Futurewei, vivo, Intel, Samsung) see no need for the TPs.

2 companies (Huawei, Qualcomm) propose several modifications, where some of them go beyond the scope of the original TPs. However, some parts of the modifications may be supported by other companies as well.

In the following, an attempt is made to structure the various TP modification proposals to see if some parts of the modification proposals can be acceptable.

The TP#1 seems to clarify a potential misconnection between the last 3 sentences of the paragraph, namely:

(a) "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."

(b) "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."

(c) "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."

Therefore, the network can indicate an [ID], a Resource Set ID, a single Resource ID, a list of Resource IDs (sentence (a)).

The UE is expected to report (if different) the used [ID], a single Resource ID, a list of Resource IDs, a Resource Set ID (sentence (c)).

However, sentence (b) seems to allow choosing different Resource(s) or different Resource Set only, but does not mention the possibility of a different [ID].

According to TP#1, the UE may use a reference time for RSTD measurement as follows (extension of sentence (b)):

(i) different DL PRS resources within a single DL PRS resource set*;*

(ii) a different DL PRS resource set which can be any DL PRS resource set associated with the [ID]*;*

(iii)different DL PRS resources associated with an [ID] other than the [ID] provided;

(iv) different DL PRS resource sets associated with an [ID] other than the [ID] provided.

It was commented by Huawei that the above list of additions to sentence (b) are unnecessary, since it only lists all possible options, but does not preclude any of them.

A potential way forward could be to simplify sentence (b); i.e., there is no need to list any option, since all are possible:

**TP#A:**

|  |
| --- |
| 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 a different 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. |

**Q1:** Can companies agree on the simplified TP shown as TP#A above?

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Nokia/NSB | The TP is okay for us. |  |
| vivo | There’s a reason why we have that wording in the original agreement.  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  The network indicates an [ID], a Resource Set ID, a single Resource ID, a list of Resource IDs. The UE is expected to report (if different) the used [ID], a single Resource ID, a list of Resource IDs, a Resource Set ID. Let’s say, the UE report an [ID] and a list of Resource IDs when used different reference time. The deletion part in TP#A was meant to limit all those used and reported Resource IDs in that list belong to the same set.  As said early, we don’t see confusion from current specification. The wording “different DL PRS resources or a different DL PRS resource set” and “the DL PRS resources used belong to a single DL PRS resource set” does not limit to the TRP corresponding to the indicated [ID].  So we cannot agree TP#A. |  |
| Ericsson | TP#A is ok with us. |  |
| Qualcomm | We are OK |  |
| Samsung | We still do see the need for the TP. |  |
| Huawei/HiSilicon | We are OK, except for the small changes to the right-handed column  In reply to vivo, when UE reports the selected reference in the reporting (i.e. report the [ID], the DL PRS resource ID(s) or the DL PRS resource set ID), such a structure would mandate UE to use DL PRS resource IDs within a single set. | 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 a different 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 set ID, and optionally the DL PRS resource ID(s) used to determine the reference. |
| CATT | We support the TP. |  |
| Intel | The proposed text is confusing and open for interpretations “The UE may use a different reference time for the RSTD measurement”  Propose to update on the text in right column  Regarding proposal from Huawei we suggest to remove “optionally” | “The UE may select any option to acquire a single reference time for RSTD measurements” |
| Huawei/HiSilicon | [v10] Reply to Intel:  We think that being optional allows UE to report the *prs-Id*, and *nr-DL-PRS-ResourceSetId* only, simply because the reference time is consolidated from multiple resources within the set. This is especially important when a single timing is requested per TRP, even for the reference TRP.  Note that it is the same as what UE received in the assistance data. |  |
| LG | We have same similar view on removing “optionally”, since the reference time does not need to be always determined from all resources of a resource set. It might be up to UE implementation. For example, a certain resource could be excluded when determining reference time if the measurement quality is not guaranteed. Based on this, we have a modified TP in the right column. | The UE may be indicated by the network that ~~a~~ DL PRS resource(s) 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 a different 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 set ID, and ~~optionally~~ the DL PRS resource ID(s) used to determine the reference. |
| Sony | We support TP#A. |  |
| CMCC | We understand HW’s update is to provide the option that UE can only report with [ID] and set ID, correct me if I got it wrong, but this is just what I can read from TP#A. So far, we think TP#A is fine. |  |
| Futurewei | Don’t see the need for the TP |  |

From the other potential issues mentioned by different companies above, it seems there may be a consensus possible that the current wording of “indicated reference time” is not appropriate (comment made by Qualcomm).

A potential way forward may be to simply delete the “time”:

**TP#B:**

|  |
| --- |
| 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 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 to be indicated whenever it is expected to receive the DL PRS. 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. The UE may use different DL PRS resources or a different DL PRS resource set to determine the reference 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 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. |

**Q2:** Can companies agree to remove the "time" from "reference time" as shown as TP#B above?

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Nokia/NSB | Support the TP. |  |
| Vivo | OK with TP#B. |  |
| Ericsson | Support the TP. | If agreeable, TP#A and TP#B can be merged. |
| Qualcomm | We are OK |  |
| Samsung | OK |  |
| Huawei | Support. |  |
| CATT | We support the TP. |  |
| Intel | Agree time was confusing. In the following sentence “time” seems needed. We can consider change to “timing”  The UE may use different DL PRS resources or a different DL PRS resource set to determine the reference 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. |  |
| LG | Support only removing “time” from “reference time”. |  |
| Sony | Support TP#B |  |
| CMCC | We support TP#B. |  |

Regarding the first sentence of the TPs, a question remains on the purpose of the reference for RSRP and RxTx measurements.

Vivo clarified that the text highlighted in turquois in TP#2 was agreed to be added to 38.214 in RAN1#100-e. The reason was to reflect the agreement in RAN1#99 on the definition of the time stamp. The time stamp can include the SFN/slot number which is derived from the provided reference. Therefore, the reference does apply to all measurements, not just RSTD, (comment made by vivo).

However, this aspect/agreement seems to be captured in a separate paragraph anyhow:

|  |
| --- |
| “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*.” |

Additional comments were made on the structure/ordering of the text. Huawei suggested the following general structure:

- NW🡪 UE:

The reference is provided for PRS search window (to support any type of PRS measurements), a.k.a. assistance data reference

The structure/definition of the reference

- UE🡪NW:

The reference should also be used for RSTD measurement report, a.k.a. RSTD reference (recommendation)

The UE may select a different reference for the RSTD measurement report, a.k.a. RSTD reference that UE actually selects.

The provided TP modification proposals from Huawei and Qualcomm, together with TP#A and TP#B above could be combined as follows:

**TP#C:**

|  |  |
| --- | --- |
| The UE may be indicated by the network that DL PRS resources can be used as reference in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The UE expects the reference to be indicated whenever it is expected to receive the DL PRS. 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.  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.  For DL RSTD measurements, the UE may use a different reference than indicated by *DL-PRS-RstdReferenceInfo*. If the UE chooses to use a different reference than indicated by *DL-PRS-RstdReferenceInfo*, 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.  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  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.  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 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 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.  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. | Introduction of the reference: The reference serves multiple purposes, not only for measurements.  One purpose of reference (moved here from above).  The remaining part is specific to RSTD  Another purpose of the reference. |

**Q3:** Assuming the principles of TP#A and TP#B can be agreed, can companies agree to the restructuring/clarifications as shown in TP#C above?

|  |  |  |
| --- | --- | --- |
| Company | Comments | Proposed Modifications (if any) |
| Nokia/NSB | We don’t really see this change as critical. |  |
| vivo | Given we disagree on TP#A, we cannot accept TP#C. |  |
| Ericsson | This is not a critical change, but we can consider it if time allows. |  |
| Qualcomm | OK |  |
| Samsung | We do not see the need for re-structuring |  |
| Huawei/HiSilicon | OK |  |
| CATT | OK |  |
| Intel | OK |  |
| LG | After discussion TP#A and TP#B, support re-structuring. |  |
| Sony | OK |  |
| CMCC | Fine to us. |  |
| Futurewei | DO not see the need, not critical |  |

#### 3.2.2.1 Summary

**TP#A**

6 companies support TP#A (Nokia, Ericsson, Qualcomm, CATT, Sony, CMCC).

3 companies suggest modifications to TP#A (Huawei, Intel, LG).

2 companies see no need for the TP#A (Samsung (FL assumption, since comment is inconsistent), Futurewei), but seems would also not object to it.

1 company (vivo) cannot agree to TP#A.

The reason why vivo cannot accept the TP is because all reported Resource IDs in the list of reported Resource IDs need to belong to the same set (this part was deleted in the proposed TP#A). However, Huawei clarified that the reporting structure (i.e. report the [ID], the DL PRS resource ID(s) or the DL PRS resource set ID) does imply DL PRS resource IDs within a single set.

Intel suggested to add that "the UE may select any option to acquire a single reference for RSTD measurements". However, FL believes this may create confusion, since one may ask what these options are when they are not listed.

Huawei proposed that the reporting of the DL PRS Resource IDs can be optional. I.e., with the Resource IDs being optional would allow reporting of the [ID] and DL PRS Resource Set ID only. However, this seems not agreeable to Intel and LG. However, FL thinks that the current text does already imply this "optionality", since there is an "or": "…report the [ID], the DL PRS resource ID(s) **or** the DL PRS resource set ID…". This seems also the understanding of CMCC. Therefore, it is suggested to leave the last sentence of this paragraph unmodified.

**Proposal 1:** Agree the following TP:

|  |
| --- |
| 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 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 a different 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.  […] |

Companies are requested to indicate whether the Proposal 1 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | This TP should be merged with TP#C. |
| Ericsson | We are fine to support proposal 1. |
| vivo | We still think the “issue” corrected by proposal 1 is non-essential.  It removes explicit conditions for UE to obey when choosing different reference than indicated by the network while relies on implicit UE reporting structure to imply such restriction. We don’t think this clarifies the specification. |
| Huawei/HiSilicon | We are OK with the proposal as long as it is common understanding that UE may report either   * PRS-ID + PRS resource set ID, or * PRS-ID + PRS resource ID(s). |
| Nokia/NSB | We are okay with the proposal. |
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**TP#B**

All interested companies can agree on removing the "time".

One company (Intel) suggest changing "time" to e.g. "timing" at one place. However, FL believes that "reference timing" for an RSTD is equally confusing, since the RSTD is a time difference.

Proposal 2: Agree the following TP:

|  |
| --- |
| 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 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 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 to be indicated whenever it is expected to receive the DL PRS. 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. The UE may use different DL PRS resources or a different DL PRS resource set to determine the reference 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 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.  […] |

Companies are requested to indicate whether the Proposal 2 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | This TP should be merged with TP#C. |
| Ericsson | Support Proposal 2 |
| vivo | OK with proposal 2. |
| Huawei/HiSilicon | Support, and to be implemented in TP#C if TP#C is agreed. |
| Nokia/NSB | We are okay with the proposal. |
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**TP#C**

7 companies (Qualcomm, Huawei, CATT, Intel, LG, Sony, CMCC) would be O.K. with the TP.

4 companies (Nokia, Ericsson, Samsung, Futurewei) consider this TP not critical.

One company (vivo) cannot agree the TP, since they also cannot agree TP#A.

Given that this paragraph is probably being changed already for the second meeting in series, FL believes that even if these clarifications may be considered non-critical, it could help improving clarity of the specification.

**Proposal 3:** Agree the following TP:

|  |
| --- |
| TP for clause 5.1.6.4 (PRS reception procedure) of TS 38.214:  […]  The UE may be indicated by the network that DL PRS resources can be used as reference in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The UE expects the reference to be indicated whenever it is expected to receive the DL PRS. 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.  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.  For DL RSTD measurements, the UE may use a different reference than indicated by *DL-PRS-RstdReferenceInfo*. If the UE chooses to use a different reference than indicated by *DL-PRS-RstdReferenceInfo*, 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: If Proposal 3 is agreed, Proposals 1 and 2 are not needed.

Companies are requested to indicate whether the Proposal 3 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | We support Proposal 3, and it had merged TP#A and TP#B, it is fine for us. |
| Ericsson | TP is not critical. |
| vivo | Proposal 3 is not simply a merge of proposal 1 and 2 to our understanding. We don’t support proposal 3. |
| Huawei/HiSilicon | Support. |
| Nokia/NSB | We do not see this as a simple merge of the other TPs and do not think it is critical. |
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### 3.2.2 Absence of reference IDs

|  |  |
| --- | --- |
| 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.

|  |  |  |
| --- | --- | --- |
| 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 |  |
| Ericsson | Similar to the views expressed by other companies above, we also do not support this TP. |  |
| Samsung | No need. |  |
| Sony | We do not support this TP |  |
| LG | Sorry for late response.  We fully agree that the UE needs to use a reference and it should be indicated in order to determine search window using DL-PRS-expectedRSTD and DL-PRS-expectedRSTD-uncertainty unless there is no additional signaling, but it should be noted that the reference provided by *dl-PRS-ReferenceInfo-r16* is an **optionally** configured while reference cell is always provided in LTE.  NR-DL-PRS-AssistanceData-r16 ::= SEQUENCE {  nr-DL-PRS-ReferenceInfo-r16 DL-PRS-IdInfo-r16 OPTIONAL, -- Need ON  We would like to suggest that the reference configuration *dl-PRS-ReferenceInfo-r16* should be madatory present. In our understanding, If it is optional, we need to define UE behavior including how to determine search window by UE when the reference is not configured by the network. |  |

Interim Summary:

There is no support for the TP.

**Interim Proposal 3:** The TP below 3.2.2 above is not pursued at RAN1#100bis-e.

# 4. UE Rx-Tx Time Difference Measurements

## 4.1 Multiple Rx–Tx time difference measurements

The following agreements have been made:

|  |
| --- |
| 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"

|  |  |
| --- | --- |
| 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

|  |  |
| --- | --- |
| 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. |  |
| 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 |  |
| Ericsson | We are ok to go with TP2 |  |
| Samsung | TP2 |  |
| Sony | Support TP#2 |  |
| LG | Fine with TP2. |  |

Interim Summary:

12 companies support TP#2 (Huawei, OPPO, CATT, Nokia, Qualcomm, Fraunhofer, vivo, MTK, Ericsson, Samsung, Sony, LG).

3 companies support both, TP#1 and TP#2 (CATT, Nokia, MTK).

3 companies suggest waiting for the UE feature discussion to stabilize (Huawei, Nokia, Futurewei).

1 company suggest that the removal of UE Rx-Tx Time-MeasRequestInfo should not be done as RAN2 may add it (Intel).

**Interim Proposal 4:** Agree the TP#2 below 4.1.1 above.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia/NSB | Support interim proposal 4. |
| vivo | OK |
| Ericsson | Support. |
| Qualcomm | Support. Not very important but there is a typo: can be in differen**t**~~ce~~ positioning frequency layers. |
| Samsung | OK |
| OPPO | Ok |
| Huawei/HiSilicon | Support Qualcomm’s revision. |
| CATT | OK |
| Intel | We can accept it if missing parameter *UE Rx-Tx Time-MeasRequestInfo* is added back. In addition, we do not see the need to add word “measure and”. It is up to UE what and how to measure. Report wording is sufficient in our view.  The UE can be configured by higher layer parameter *UE Rx-Tx Time-MeasRequestInfo* to 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. |
| Huawei/HiSilicon | [v10] Reply to Intel:  What you want is already captured in the previous paragraph. Correct me if I miss anything.  And please note that “*UE Rx-Tx Time-MeasRequestInfo*” as captured in the higher layer parameter, is only used to request resource ID reporting, instead of number of measurement per TRP. I know that is confusing, but the parameter name is not an ideal choice of course.  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. |
| Sony | Support (including the typo correction proposed by QC above) |
| CMCC | We support interim proposal 4 with QC’s revision. |

### 4.1.2 Summary

All contributing companies support the Interim Proposal 4 (with the typo correction as pointed out by Qualcomm).

Intel suggest keeping the *UE Rx-Tx Time-MeasRequestInfo* in "The UE can be configured by higher layer parameter *UE Rx-Tx Time-MeasRequestInfo* to report,… ". Huawei pointed out that this is anyhow mentioned in the first paragraph of the TP (existing specification):

"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 e.g., *DL-PRS-RstdMeasurementInfo* is then also not repeated in the following paragraphs, and therefore, the proposed TP would be a better alignment of the RSTD, RSRP and RxTx measurement paragraphs.

FL suggest changing the "The UE **can** be configured…" in the UE Rx-Tx time difference measurement paragraph to "The UE **may** be configured…" to be better aligned with the corresponding RSTD and RSRP measurement paragraphs.

**Proposal 4:** Agree the following TP:

|  |
| --- |
| 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 may 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 different 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 requested to indicate whether the Proposal 4 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | We support Proposal 4. |
| Ericsson | Support Proposal 4. |
| vivo | We support proposal 4. |
| Huawei/HiSilicon | Support. |
| Nokia/NSB | Support. |
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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.  [v12] to QC:  We don’t understand this argument. Why would the neighrobing cell send to the LMF that they are OK with an SRS configuration in a band that they are not receiving. If they have a concern in this aspect, it would make sense to bring up to Ran3 and not in RAN1. If a TRP cannot receive in a band, it should not participate in a positioning procedure that a UE can transmit in that band. Can be addressed in Ran3 if needed.  Here is our understanding,  The case QC mentioned does not exist all, please see the following example.  Why would the neighrobing cell send to the LMF that they are OK with an SRS configuration in a band that they are not receiving.  Example: For capability, TRP1 support TRx in band 1, and TRP support TRx in band 2, UE supports TRx in both bands in a band combination, LMF knows it, and TRPs also know that LMF knows its capability.  Scenario 1:   * LMF triggers multi-RTT positioning in band 1 and band 2, and provides PRS configuration in TRP1 and TRP2 in the multi-RTT assistance data * LMF requests SRS configuration from gNB for the UE in both bands * gNB configures SRS in both bands to the UE and returns SRS configuration to the LMF * LMF sends the SRS configuration in band 1 to TRP1, and SRS configuration in band 2 to TRP2, and requests gNB Rx – Tx time difference measurement. * LMF requests UE to perform UE Rx – Tx time difference measurement in multi-RTT request location information (no link between PRS and SRS at all) * UE does the following pairing in the measurement.   SRS  SRS  PRS  PRS  2nd band  1st band  Scenario 2:   * LMF triggers multi-RTT positioning in band 1, and UL RTOA in band 2, and provides PRS configuration in TRP1 in the multi-RTT assistance data * LMF requests SRS configuration from gNB for the UE in both bands * gNB configures SRS in both bands to the UE and returns SRS configuration to the LMF * LMF sends the SRS configuration in band1 to TRP1, requesting gNB Rx – Tx time difference measurement, and sends the SRS configuration in band 2 to TRP 2, requesting UL RTOA measurements. * LMF requests UE to perform UE Rx – Tx time difference in multi-RTT request location information (no link between PRS and SRS at all) * UE does the following pairing in the measurement   SRS  SRS  PRS  2nd band  1st band  With the following proposal:  Proposal: UE can report an additional Index associated with an Rx-Tx measurement:   * Alt. 1: UE reports a CC Index * Alt. 2: UE reports a band index * Alt. 3: SRS resource set/resource ID   This only gives a chance to invalidate some UE measurement, but the measurement has been done and wasted.  What we proposed is to correct that in the beginning, and to our understanding it is natural to restrict that the same band. One extreme case is that we do not actually want to UE Rx – Tx time difference to be measured based on PRS from FR2 and SRS in FR1, correct?  [v17] In response to Sony, I guess the question should be rephrase as Need further discussions. From HW discussions, it seems the issue is for the case of inter-CA. How about intra-band CA case?  Our understanding is that for intra-band CA, only co-located deployment is specified, which means that CC for intra-band CA is likely to be in the same TAG. Then which SRS is used to associate PRS does not matter, as they have the same UL timing. |  |
| 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?**  **Qualcomm2:**  **To HW: “**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.**”**  We don’t understand this argument. Why would the neighrobing cell send to the LMF that they are OK with an SRS configuration in a band that they are not receiving. If they have a concern in this aspect, it would make sense to bring up to Ran3 and not in RAN1. If a TRP cannot receive in a band, it should not participate in a positioning procedure that a UE can transmit in that band. Can be addressed in Ran3 if needed.  With regards to the ambiguity of the Rx-Tx measurement, the simplest thing is to just add a CC index or band index association that corresponds to which band the UE Rx-Tx is associated to.  RAN2 is still doing a lot of changes, and the simplest is to add:  Proposal: UE can report an additional Index associated with an Rx-Tx measurement:   * Alt. 1: UE reports a CC Index * Alt. 2: UE reports a band index * Alt. 3: SRS resource set/resource ID |  |
| 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 |  |
| Samsung | Support |  |
| Sony | Need further discussions. From HW discussions, it seems the issue is for the case of inter-CA. How about inter-CA case? |  |

Interim Summary:

7 companies support the TP (Huawei, OPPO, CATT, ZTE, Futurewei, MTK, Samsung).

1 company thinks this issue is related to the UE feature group discussion (vivo), and may depend on whether a FG for this will be introduced or not.

It seems some discussion is still needed/ongoing (Qualcomm, Intel, Sony). There is still time left to continue the discussion.

**Interim Proposal 5:** Agree the TP below 4.2 above.

|  |  |
| --- | --- |
| Company | Comments |
| vivo | In today’s UE feature discussion, the following FG is agreed.   * Inter-frequency measurement for [Multi-RTT]   We don’t think the restriction of the same band of PRS and SRS is a proper way to go. |
| Ericsson | We can support this proposal in principle for the case when SRS resource set ID is not provided in UE Rx-Tx time difference measurement configuration.  But for the case when an SRS resource set ID is given in the UE Rx – Tx time difference measurement configuration, SRS shall be on the be the band on which the SRS Resource set is transmitted. For this 2nd case, we would like to remove the problem with UE autonomous timing adjustments as well. For instance, a UE could calculate the UE Rx-Tx time difference based on the TX timing at the SRS transmission and thus compensate for the timing adjustment. Please see our revised proposal below.  **Revised Proposal:**  If an SRS resource set ID is given in the UE Rx – Tx time difference measurement configuration, then TUE-TX is the UE transmit timing of uplink subframe #*j* that is closest in time to the subframe #i as estimated based on transmission timing of the SRS resource set with the given ID transmitted closest in time to the downlink subframe #i. TUE-TX shall be measured on the band on which the SRS Resource set is transmitted.  If an SRS resource set ID is not given in the UE Rx – Tx time difference measurement configuration, then 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. |
| Qualcomm | To E//: Which SRS resource ID are they referring to ? In the Rx-Tx measurement report there is no SRS resource ID, am I missing something?  NR-Multi-RTT-AdditionalMeasurementElement-r16 ::= SEQUENCE {  nr-DL-PRS-ResourceId-r16 NR-DL-PRS-ResourceId-r16 OPTIONAL,  nr-DL-PRS-ResourceSetId-r16 NR-DL-PRS-ResourceSetId-r16 OPTIONAL,  nr-PRS-RSRP-ResultDiff-r16 INTEGER (FFS) OPTIONAL, -- FFS, value range to be decided in RAN4.  nr-UE-RxTxTimeDiffAdditional-r16 INTEGER (0..ffs) OPTIONAL, -- FFS on the value range  nr-AdditionalPathList-r16 NR-AdditionalPathList-r16 OPTIONAL,  nr-TimeStamp-r16 NR-TimeStamp-r16,  ...  }  Also, is the proposal, the UE to change the timing of the SRS transmission? I thought the agreement is the UE is not adjusting the timing of SRS for the purpose of positioning.  To HW: We thank HW for the analysis. We understand that there can be some configurations that might result to ambiguities, which is because of the non-existence of PRS/SRS association in Rx-Tx reporting.  However, as vivo also pointed out, this is supposed to be part of inter-frequency MRTT and I specifically remember spending some online/offline time discussing this, and, one of the results of that effort was the agreement that vivo recited above. Also, the UE is reporting already a lot of measurements, and clearly we don’t know which are being used and which are being invalidated, so the argument that a network may invalidate some measurement is not very strong. For example, a simple case with just one PRS in one band and another PRS in another band, likely of the same FR:  SRS  PRS  2nd band  1st band  Another simple case that may be useful (A DL+UL in one band, and a DL-only in another band):  SRS  PRS  PRS  2nd band  1st band  The above case is also part of the spec **here**. The UE is allowed to report 2 Rx-Tx measurements:  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.**  I am not saying that this should be considered basic feature (its clearly not an intra-frequency measurement), but why not allow this option as part of the inter-frequency MRTT feature, when we already have support in the spec and have already discussed it? We don’t see the urgency of removing these features, when they can be simple to fix.  **For example, can we consider the following proposal to fix the issue:**  **Proposal:**   * For each UE Rx-Tx measurement, a UE may report, subject to UE capability, the band indices associated with the PRS and SRS that were used for the measurement, unless both the PRS and SRS were measured on the same band. * If a UE is configured with SRS for positioning and PRS in a same band, the UE shall report in the *nr-UE-RxTxTimeDiff* IE the measurement derived with the SRS and PRS configured in this band; the UE can also report, subject to UE capability, in the *nr-Multi-RTT-AdditionalMeasurements* IE additional UE Rx-Tx measurements derived from SRS and PRS of different bands. * Send LS to RAN2.   So, in the Scenario 1 below, the UE would report the Rx-Tx for the PRS/SRS of a same band (either band 1 or band 2, but it will be the same band) in the *nr-UE-RxTxTimeDiff*, no additional band indeces are needed, and if the UE supports it, it will report additional measurements which can be same-band or cross-bands together with their indeces in the *nr-Multi-RTT-AdditionalMeasurements.*  SRS  SRS  PRS  PRS  2nd band  1st band  In Scenario 2 below, the UE would report the Rx-Tx in *nr-UE-RxTxTimeDiff* using PRS/SRS of band 1, and if the UE supports it, it will report an additional measurement together with the indeces for the second cross-band Rx-Tx.  SRS  SRS  PRS  2nd band  1st band  In Scenario 3 below, since there is no SRS/PRS on the same band, the UE which supports this feature, can report Rx-Tx using these 2 bands in the *nr-UE-RxTxTimeDiff* together with the indices.  SRS  PRS  2nd band  1st band |
| Huawei/HiSilicon | Support.  To vivo: It could be inter-frequency within a band.  To QC: we do not know whether it is too late to introduce this higher layer parameter, and so far as I know, QC’s proposal is OK. However to be clear when we say band index, it is not the real band index, but rather a logical band identifier, similar to *nr-DL-PRS-RxBeamIndex-r16*, is it correct? |
| CATT | Support. |
| Intel | We can support it only if clear and unambiguous association between DL PRS and SRS is defined. The direction proposed by QC seems a right way but more time is needed to check and conclude. We can accept it as a working assumption. |
| Huawei/HiSilicon | [v10] Reply to Intel  Based on our understanding, it is not a clear and unambiguous association in the configuration (LMF 🡪 UE); instead it is a supplementary procedure that is clear and unambiguous association in the report (UE 🡪 LMF). It gives the LMF to check if UE Rx – Tx time difference and gNB Rx – Tx time difference are actually based on the same pair of DL PRS and UL SRS.  Literally LMF can do nothing but drop the measurement if UE Rx – Tx time difference and gNB Rx – Tx time difference are not based on the same PRS and SRS. |
| Fraunhofer | We support the proposal proposed by Qualcomm:  **Proposal:**   * For each UE Rx-Tx measurement, a UE may report, subject to UE capability, the band indices associated with the PRS and SRS that were used for the measurement, unless both the PRS and SRS were measured on the same band. * If a UE is configured with SRS for positioning and PRS in a same band, the UE shall report in the *nr-UE-RxTxTimeDiff* IE the measurement derived with the SRS and PRS configured in this band; the UE can also report, subject to UE capability, in the *nr-Multi-RTT-AdditionalMeasurements* IE additional UE Rx-Tx measurements derived from SRS and PRS of different bands. * Send LS to RAN2. |
| Sony | Based on the current understanding of the issue, we need to cover all cases, including the cases described by QC. Hence, we support the latest QC proposal above. |
| CMCC | We support the TP. |
| Ericsson | [v14] to QC  Thanks for the reply, let us rephrase our comment.  Our preference would be introduce an indication of which SRS should be used as a reference for Tx in the UE RxTx in the measurement configuration/request. As a second preference, if we cannot agree to introduce an SRS indication in the measurement configuration sent to the UE, we prefer introducing the restriction proposed in the TP from Huawei.  One of the benefit we could see if an indication of the SRS to be used in the UE RxTx measurement is present in the configuration is that the UE could take the indication into account and compensate for the timing adjustments the UE may have done between the beginning of the subframe where UE RxTx is referenced and the time of the SRS transmission in the subframe. As QC mentioned we have agreed that “No adjustment is made to the configured TA”, which just says that the timing advance procedure is not extended for the purpose of positioning. But the network does not know when the UL timing is changed by the UE and thus there might be timing adjustment between the beginning of he UL subframe and the transmission of the SRS used as reference for UE RxTx. With our proposal the UE could calculate the UE Rx-Tx time difference based on the TX timing at the SRS transmission and thus compensate for the timing adjustment to reflect the timing at the time where the SRS is transmitted and create a measurement coherent with the gnB RxTx that the network will measure on the SRS.  Regarding the indication of the band by the UE: Even if the UE reports which band was used to measure the UE RxTx, this will only tell the LMF receiving the measurement report that the measurement is either useful (same band between PRS and SRS) or to be discarded (different band between SRS and PRS). We don’t see the value in a solution that doesn’t prevent the transmission of information that does not seem useful. Therefore we cannot support the solution based on inclusion of the SRS information in the report. |
| Qualcomm2 | To HW:  I was initially referring to this one that already exists in RRC, but it seems you are referring to sth else, and we obviously totally fine for another similar solution? Could you be more specific? Wondering though if we could have next week to finish the discussion on the indeces.  ***FreqBandIndicatorNR* information element**  -- ASN1START  -- TAG-FREQBANDINDICATORNR-START  FreqBandIndicatorNR ::= INTEGER (1..1024)  -- TAG-FREQBANDINDICATORNR-STOP  -- ASN1STOP   * The LMF might drop measurements already that are made too far apart. The LMF could drop (effectively) a measurement if the UE says it is a very bad quality metric, or very low RSRP, in AoD if the RSPRS are with different beams, etc, there are many reasons already, based on LFM’s implementation for which an LFM might drop the measurement. In the above proposal, at least in PRS/SRS exist in a same band, the UE should report those “first” (in the nr-UE-RxTxTimeDiff ).   To Intel: We are OK with the Working Assumption.  Overall, we have preference to have a constructive discussion to fix the issue and not just precluding it. We spent so much time trying to preclude it, which we should have just used to fix the issue. Since it requires High layer parameter, we prefer to have a Working Assumption now, to notify RAN2 that there is a change that would affect them (as it is the case of the UL RTOA discussion which has high layer impact), than delaying it for next meeting.  To E//:  The 2 bands are in different TAGs. So PRS in TAG1 and SRS in TAG2.  Are you saying the UE will transmit the SRS earlier or later than it is supposed to, so that it aligns with the timing of the other band? But then, this means that the UE for SRS for positioning in one band did not follow the serving cell TA, but some other TA. This is not the definition of TAGs, not the understanding of the agreement, that the SRS for positioning is assocated with a CC which is part of a TAG and follows the TA of that serving cell.  In other words, are you suggesting, the UE would transmit the SRS in TAG2 as if it was in TAG1? I don’t see how this would make sense.  You are also saying:  “*But the network does not know when the UL timing is changed by the UE and thus there might be timing adjustment between the beginning of he UL subframe and the transmission of the SRS used as reference for UE RxTx.”*  A UE would not do a change in UL timing between the subframe and the SRS, and that is the assumption here; such changes would be avoided by the UE’s implementation (up to group delay calibration errors discussed in RAN4). We are talking about a period of 1 msec, that the UE should try to not change the timing right? That should not be too hard, but we can leave RAN4 to discuss the details on these.  If we assume that the timing of the SRS is the same as the timing of the subframe #j, which is the one associated with the TAG that the serving cell belongs to, how could your proposal help? |
| Futurewei | Support |

## 4.3 Summary

5 companies support Interim Proposal 5 (Huawei, CATT, CMCC, Ericsson, Futurewei).

vivo points out that a FG for Inter-frequency measurement for Multi-RTT has been agreed, and therefore, the restriction of the same band of PRS and SRS may not be the proper way to go. Huawei clarified that it could also be inter-frequency within a single band.

Qualcomm points out that the possibility of different bands may already be part of the specification, since a UE can be configured to measure up to 4 UE Rx-Tx time difference measurements and each measurement corresponds to a single received DL PRS resource or resource set which can be in different positioning frequency layers, and suggest fixing any potential issues instead of removing the feature.

Ericsson supports the Interim Proposal 5 for the case when SRS resource set ID is not provided in UE Rx-Tx time difference measurement configuration. However, this is currently the case anyhow. A revised proposal was provided by Ericsson incl. the possibility of providing a SRS Resource Set ID in the measurement configuration for the UE to indicate which SRS should be used as a reference for Tx in the UE RxTx measurement. Ericsson thinks that this would also allow the UE to compensate for any timing adjustments the UE may have done between the beginning of the subframe where UE RxTx is referenced and the time of the SRS transmission in the subframe. This, however, was challenged by Qualcomm since the different bands may be in different TAGs. Qualcomm thinks that Ericsson’s proposal may imply that the SRS for positioning in one band does not follow the serving cell TA, which however, would not be in line with previous agreements.

Qualcomm proposed that for each UE Rx-Tx measurement, the UE may report in addition the band indices associated with the PRS and SRS that were used for the measurement. It seems this can in principle also be supported by Huawei, Intel, Fraunhofer, Sony. Intel thinks more time is needed to check and conclude and suggested that Qualcomm’s proposal could be a working assumption.

Therefore, there are 3 Proposals available for this issue:

**Proposal 4.2-1:** Limit UE Rx – Tx time difference only to PRS and SRS in the same band.

Proposal 4.2.-1 is the original proposal and TP in section 4.2 above.

**Proposal 4.2-2:** If an SRS resource set ID is given in the UE Rx-Tx time difference measurement configuration, then TUE-TX is the UE transmit timing of uplink subframe #j that is closest in time to the subframe #i as estimated based on transmission timing of the SRS resource set with the given ID transmitted closest in time to the downlink subframe #i. TUE-TX shall be measured on the band on which the SRS Resource set is transmitted.  
If an SRS resource set ID is not given in the UE Rx-Tx time difference measurement configuration, then 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.

Proposal 4.2.-2 was suggested by Ericsson.

**Proposal 4.2-3:** For each UE Rx-Tx measurement, a UE may report, subject to UE capability, the band indices associated with the PRS and SRS that were used for the measurement, unless both the PRS and SRS were measured on the same band.   
If a UE is configured with SRS for positioning and PRS in a same band, the UE shall report in the nr-UE-RxTxTimeDiff IE the measurement derived with the SRS and PRS configured in this band; the UE can also report, subject to UE capability, in the nr-Multi-RTT-AdditionalMeasurements IE additional UE Rx-Tx measurements derived from SRS and PRS of different bands.

Proposal 4.2.-3 was suggested by Qualcomm.

Companies are requested to indicate which Option would be preferred (if any).

|  |  |
| --- | --- |
| Company | Comments |
| CATT | We prefer Proposal 4.2-3.  In our point of view, the reporting of Band indices associated with the PRS and SRS together with UE Rx-Tx time difference measurement looks like one reasonable solution to solve the issue. It can be the working assumption at current stage. |
| Ericsson | Our preference is either Proposal 4.2-1 or 4.2-2.  We have concerns with Proposal 4.2-3. As we commented earlier, reporting of band indices as proposed in 4.2-3 will only tell the LMF receiving the measure report whether the measurement is useful or not. We don’t see much value in a solution that doesn’t prevent the transmission of information that is not useful. So, we cannot accept proposal 4.2-3 at this stage.  We suggest to further discuss this issue at next meeting. |
| vivo | As we commented earlier, in our understanding, FG for Inter-frequency measurement for Multi-RTT covers both within a band and across different bands for inter-frequency measurement. Therefore, restricting the definition of UE Rx-Tx time difference to be always in the same band (proposal 4.2-1) is not correct.  Between proposal 4.2-2 and 4.2-3, our preference is the latter. |
| Huawei/HiSilicon | We prefer Proposal 4.2-1.  Proposal 4.2-2 will not work, as CC index should be needed as well, and once CC index is included, there is even no need to include SRS resource set ID at all, since all SRS resources on a carrier should have the same Tx timing.  Proposal 4.2-3 may work as a way to rule out error measurements. However, we do not know whether a CC index is more efficient than reporting band index, which may be 10 bits based on clarification from Qualcomm. Also NR-Multi-RTT-AdditionalMeasurementElement is introduced for the purpose of reporting measurement based on additional PRS resources, rather than measurement based on additional SRS resources.  That being said, if Proposal 4.2-1 is not agreeable, we suggest not to agree anything anymore and conclude this issues to be UE implementation in Rel-16. |
| Nokia/NSB | If the rest of the group is okay with Proposal 4.2.1 that is okay for us. Otherwise we suggest to discuss the other proposals at the next meeting. |
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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 |
| Ericsson | We are ok with proposal 3. |
| Samsung | Proposal 3 |
| Sony | This issue should be discussed with RAN4, we support Proposal 3 |
| LG | Support proposal 3 |

Interim Summary:

2 companies support Proposal 1 (Huawei, CMCC)

1 company supports Proposal 2 (OPPO)

11 companies support proposal 3 (Huawei, CATT, ZTE, Nokia, Qualcomm, Fraunhofer, MTK, Ericsson, Samsung, Sony, LG).

**Interim Proposal 6:** Inform RAN4 on the need to clarify the meaning of "the UE is not able to accurately measure" for SRS-Pos power control.

|  |  |
| --- | --- |
| Company | Comments |
| Nokia/NSB | Support the interim proposal. |
| vivo | Although not our preference, we are okay for this interim proposal 6. |
| Ericsson | Support interim proposal 6. |
| Qualcomm | Support Interim proposal 6 |
| Samsung | Support P6 |
| OPPO | Ok with the interim proposal 6 |
| Huawei/HiSilicon | OK with the interim proposal 6 |
| CATT | We support Interim proposal 6. |
| Intel | We prefer to simply conclude on RAN1 understanding that the meaning of "the UE is not able to accurately measure" for SRS-Pos power control is to be clarified by RAN4. We believe companies can inform RAN4 colleagues. |
| Fraunhofer | Support interim proposal 6 |
| LG | Support this proposal. |
| Sony | Support |
| CMCC | We support interim proposal 6. |

### 5.1.1 Summary

All interested companies support Interim Proposal 6.

One company (Intel) suggests that we only need a conclusion in RAN1, and interested companies can take the issue to RAN4 also without an official LS.

**Proposal 5:** 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 requested to indicate whether the Proposal 5 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | We support Proposal 5.  The participation of RAN4 is very important for us to solve this issue. |
| Ericsson | Support Proposal 5. |
| vivo | We support proposal 5. |
| Huawe/HiSilicon | Support. |
| Nokia/NSB | Support. |
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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 |  |
| Ericsson | We are ok with TP1 with the modifications proposed by QC. |  |
| Samsung | TP1 |  |
| Sony | TP#1 and the additional text proposals by QC. |  |
| LG | TP2 is our proposal, and we understand that even if we agree with TP2, there are some remaining issues need to be addressed. However, we need to consider that spatial relation information can be configured with a specific target neighbor cell, then its appropriate transmission power needs to be used. We understand the clear majority, and we hope that this could be discussed in future release. |  |

Interim Summary:

There is no support for TP#2.

Modifications to TP#1 are proposed by Huawei and Qualcomm, which seems generally acceptable.

Intel support the first change in TP#1, but consider the second change a capability discussion.

**Interim Proposal 7:** Support the following TP:

|  |
| --- |
| 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 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.  […] |

|  |  |
| --- | --- |
| Company | Comments |
| Nokia/NSB | Support. |
| vivo | OK |
| Ericsson | Support (there is a need for IE name alignment. In the current TP contains both old RRC parameter names and latest RRC parameter names from 331. which needs to be fixed) |
| Qualcomm | Support |
| Samsung | OK |
| OPPO | Support.  Editorial change suggestion: In “that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions”. It is better to update “*SRS*” to “SRS configured by *SRS-Config* ” to clarify that this SRS only means the legacy SRS. |
| Huawei/HiSilicon | Support. Agree with E///, and we think that the change can be fixed in the editor CR. |
| CATT | Support. |
| Intel | OK. Suggest to add change proposed by Ericsson |
| Fraunhofer | Support interim proposal 7 with the changes proposed by OPPO |
| Sony | Support |
| CMCC | We support interim proposal 7 with Ericsson’s comments. |
| Futurewei | Support |

### 5.2.1 Summary

All interested companies support Interim Proposal 7.

Ericsson suggests fixing the IE names according to latest RRC specification.

OPPO suggests updating "*SRS*" to "*SRS configured by SRS-Config*" to clarify that this SRS only means the legacy SRS. However, all SRS are configured by *SRS-Config*, including the SRS for positioning.

FL updated the RRC parameter names in the TP for Proposal 6, shown in blue.

**Proposal 6:** Agree the following TP:

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| --- |
| 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-r16* and *alpha-r16* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-PosResourceSetId-r16* from *SRS-PosResourceSet-r16*, 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-Pos-r16*  - if a *ssb-IndexNcell-r16* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower-r16*  - if a *dl-PRS-ResourceId-r16* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower-r16*  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 in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions.  […] |

Companies are requested to indicate whether the Proposal 6 can be supported.

|  |  |
| --- | --- |
| Company | Comments |
| CATT | We support Proposal 6.  IE name alignment with latest version of TS 38.331 in this TP is also fine for us. |
| Ericsson | Ok. |
| vivo | We support proposal 6. |
| Huawei/HiSilicon | Support. |
| Nokia/NSB | Support. |
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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 |  |
| Ericsson | Do not support. |  |
| Samsung | It is to clarify the UE behavior when transmitting SRS to multiple non-serving cells. However, if all companies see no confusion, we are fine with no further clarification. |  |
| Sony | The motivation is unclear. We do not support. |  |
| LG | We understand the motivation of this proposal, but the number of path-loss reference is one for each set, so we do not support. |  |

Interim Summary:

There is no support for the TP.

**Interim Proposal 8:** The TP below 5.3 above is not pursued at RAN1#100bis-e.

# 6. Summary

**Proposal 1:** Agree the following TP:

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| --- |
| 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 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 a different 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.  […] |

Proposal 2: Agree the following TP:

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| --- |
| 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 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 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 to be indicated whenever it is expected to receive the DL PRS. 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. The UE may use different DL PRS resources or a different DL PRS resource set to determine the reference 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 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.  […] |

**Proposal 3:** Agree the following TP:

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| --- |
| TP for clause 5.1.6.4 (PRS reception procedure) of TS 38.214:  […]  The UE may be indicated by the network that DL PRS resources can be used as reference in a higher layer parameter *DL-PRS-RstdReferenceInfo*. The UE expects the reference to be indicated whenever it is expected to receive the DL PRS. 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.  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.  For DL RSTD measurements, the UE may use a different reference than indicated by *DL-PRS-RstdReferenceInfo*. If the UE chooses to use a different reference than indicated by *DL-PRS-RstdReferenceInfo*, 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: If Proposal 3 is agreed, Proposals 1 and 2 are not needed.

**Proposal 4:** Agree the following TP:

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| --- |
| 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 may 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 different 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.  […] |

**Proposal 5:** Inform RAN4 on the need to clarify the meaning of "the UE is not able to accurately measure" for SRS-Pos power control.

**Proposal 6:** Agree the following TP:

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| --- |
| 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-r16* and *alpha-r16* respectively, for active UL BWP of carrier of serving cell , and SRS resource set is indicated by *SRS-PosResourceSetId-r16* from *SRS-PosResourceSet-r16*, 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-Pos-r16*  - if a *ssb-IndexNcell-r16* is provided, *referenceSignalPower* is provided by *ss-PBCH-BlockPower-r16*  - if a *dl-PRS-ResourceId-r16* is provided, *referenceSignalPower* is provided by *dl-PRS-ResourcePower-r16*  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 in addition to the up to four pathloss estimates that the UE maintains per serving cell for the PUSCH/PUCCH/SRS transmissions.  […] |