**3GPP TSG RAN WG1 #105e R1-210zzzz**

**e-Meeting, May 10th – 27th, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Summary of Remaining Opens for Rel.16 NR Positioning Maintenance**

**Agenda item: 7.2.8**

**Document for:** **Discussion and Decision**

Introduction

In this contribution, we provide review of the remaining opens identified for Rel.16 NR positioning framework based on submitted contributions to RAN1#105e meeting.

The outline of the identified issues and draft CRs / TPs are summarized in this document. Finally, proposal for RAN WG1 e-mail discussion(s) on Rel.16 NR positioning maintenance is made.

# Remaining Opens

In this section, we summarize submitted TPs / draft CRs for identified open aspects on NR positioning maintenance based on review of contributions [1]-[7].

## Aspect #1: DL PRS processing priority

In [1], it is stated that UE behaviour on the PRS processing according to priority is not clear. The following clarifications are proposed

Clarify the priority sorting is based on the appearance in the list (the first entry in the list has the highest priority) or is based on the ID numbering

Clarify that the priority is only based on the assistance data indicated by *NR-DL-PRS-ProvideAssistanceData*, instead of *NR-SelectedDL-PRS-IndexList*

Discuss ambiguity for UE supporting two PRS resource sets per TRP per frequency layer, and network supporting two PRS resource sets per frequency layer. It is suggested not to pursue it in Rel-16.

Clarify motivation of defining priority i.e. applicable when the PRS resources provided in the assistance data exceeds UE reported capability

The following TP was provided to clarify DL PRS processing priority order by UE:

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| --- |
| 5.1.6.5 PRS reception procedure========================= Unchanged parts =========================Within a positioning frequency layer, the DL PRS resources are sorted in the decreasing order of priority for measurement to be performed by the UE, with the reference indicated by nr-DL-PRS-ReferenceInfo being the highest priority for measurement, and the following priority is assumed:- The first entry of the list provided by nr-DL-PRS-AssistanceDataPerFreq has the highest priority among the list, excluding the reference indicated by nr-DL-PRS-ReferenceInfo when applicable;- The first entry of the list provided by nr-DL-PRS-ResourceSetList has the highest priority among the list.The UE is only required to perform the measurement on the prioritized DL PRS resources within the capability indicated by the higher layer parameter NR-DL-PRS-ResourcesCapability.========================= Unchanged parts ========================= |

The relevant agreement is provided below for convenience

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| Agreement:* When a UE is configured in the assistance data of a positioning method with a number of PRS resources beyond its capability (FG 13-2,13-3,13-4 for AoD, TDOA, MRTT respectively), the UE assumes the DL-PRS Resources in the assistance data are sorted in a decreasing order of measurement priority. Specifically, according to the current RAN2 structure of the assistance data, the following priority is assumed:
	+ FFS: the 4 frequency layers are sorted according to priority,
	+ The 64 TRPs per frequency layer are sorted according to priority,
	+ The 2 sets per TRP of the frequency layer are sorted according to priority,
	+ FFS: The 64 resources of the set per TRP per frequency layer are sorted according to priority.
* The reference indicated by nr-DL-PRS-ReferenceInfo-r16 for each frequency layer has the highest priority at least for DL-TDOA
 |

**FL response:**

The decreasing priority order is mentioned in the main bullet. Irrespective of UE capability the list is constructed based on priority of reporting. Other aspects seem worthwhile to clarify in specification.

## Aspect #2: DL PRS numerology

In [2], it is proposed to clarify that 240kHz SCS is not applicable for DL PRS configuration according to RAN1 agreement below:

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| Agreement:The following periodicity values of DL PRS resource allocation are supported depending on SCS         {4, 5, 8, 10, 16, 20, 32, 40, 64, 80, 160, 320, 640, 1280, 2560, 5120, 10240} slots, µ = 0, 1, 2, 3 for SCS 15, 30, 60 and 120kHz respectively |

The following TP was provided to address it:

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| 5.1.6.5 PRS reception procedure*-----------------------------------------------------* unrelated part omitted *------------------------------------------------*The UE assumes that the following parameters for each DL PRS resource(s) are configured via higher layer parameters *NR-DL-PRS-PositioningFrequencyLayer, NR-DL-PRS-ResourceSet* and *NR-DL-PRS-Resource*.A positioning frequency layer is configured by *NR-DL-PRS-PositioningFrequencyLayer,* consists of one or more DL PRS resource sets and it is defined by:1. *- dl-PRS-SubcarrierSpacing* defines the subcarrier spacing for the DL PRS resource. All DL PRS resources and DL PRS resource sets in the same DL PRS positioning frequency layer have the same value of *dl-PRS-SubcarrierSpacing*. The supported values of *dl-PRS-SubcarrierSpacing* are given in Table 4.2-1 of [4, TS38.211], excluding the value of 240kHz.

 *-----------------------------------------------------* unrelated part omitted *------------------------------------------------* |

**FL response:**

It is proposed to discuss/clarify this aspect. In general, the supported set of subcarrier spacing for DL PRS can be directly understood from the *dl-PRS-SubcarrierSpacing.* According to the TS 37.355this field specifies the subcarrier spacing of the DL-PRS Resource. 15, 30, 60 kHz for FR1; 60, 120 kHz for FR2.

## Aspect #3: Clarification on UE Rx-Tx time difference measurements

In [3], two alternatives are proposed to clarify / complete the descriptions of UE Rx-Tx time difference measurements in clause 5.1.6.5 of TS 38.214.

***Alt.1:***

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| **5.1.6.5 PRS reception procedure**==================================**Unchanged parts omitted**=============================The UE may be configured to measure and report, subject to UE capability, up to 4 DL RSTD measurements per pair of *dl-PRS-ID* with each measurement between a different pair of DL PRS resources or DL PRS resource sets within the DL PRS configured for those *dl-PRS-ID*. The up to 4 measurements being performed on the same pair of *dl-PRS-ID* 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 associated with the same *dl-PRS-ID*. When the UE reports DL PRS-RSRP measurements from one DL PRS resource set, the UE may indicate which DL PRS-RSRP measurements associated with the same higher layer parameter *nr-DL-PRS-RxBeamIndex* [17, TS 37.355] have been performed using the same spatial domain filter for reception if for each *nr-DL-PRS-RxBeamIndex* reported there are at least 2 DL PRS-RSRP measurements associated with it within the DL PRS resource set.The UE may be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference measurements based on different DL PRS resources associated with the same *dl-PRS-ID* and the same positioning frequency layer, and corresponding to a single configured SRS resource or resource set for positioning. The UE may be configured to measure and report, subject to UE capability, UE Rx-Tx time difference measurements based on DL PRS resources or resource sets in different positioning frequency layers for SRS transmitted in a single carrier. ==================================**Unchanged parts omitted**============================= |

***Alt.2:***

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| --- |
| **5.1.6.5 PRS reception procedure**==================================**Unchanged parts omitted**=============================The UE may be configured to measure and report, subject to UE capability, up to 4 DL RSTD measurements per pair of *dl-PRS-ID* with each measurement between a different pair of DL PRS resources or DL PRS resource sets within the DL PRS configured for those *dl-PRS-ID*. The up to 4 measurements being performed on the same pair of *dl-PRS-ID* 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 associated with the same *dl-PRS-ID*. When the UE reports DL PRS-RSRP measurements from one DL PRS resource set, the UE may indicate which DL PRS-RSRP measurements associated with the same higher layer parameter *nr-DL-PRS-RxBeamIndex* [17, TS 37.355] have been performed using the same spatial domain filter for reception if for each *nr-DL-PRS-RxBeamIndex* reported there are at least 2 DL PRS-RSRP measurements associated with it within the DL PRS resource set.The UE may be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference measurements based on different DL PRS resources associated with the same *dl-PRS-ID* and the same positioning frequency layer, and 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. ==================================**Unchanged parts omitted**============================= |

**FL response:**

RAN1 to discuss proposed alternatives and decide

## Aspect #4: DL PRS Periodicity and Muting Repetition Factor

In [4], it is proposed to clarify in section 5.1.6.5 of TS 38.214, that the product of and dl-prs-MutingBitRepetitionFactor shall not be more than . Otherwise the configuration of DL PRS resouce would cause SFN ambiguity.

For NR DL PRS resource configruation, the DL PRS resource periodicity can take values slots and higher layer parameter dl-prs-MutingBitRepetitionFactor of consecutive instances of a DL PRS resource set can take values of {1, 2, 4, 8}.

The following TP is proposed to address the raised aspect.

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| 5.1.6.5 PRS reception procedure<Unchanged parts are omitted>A DL PRS resource set is configured by *NR-DL-PRS-ResourceSet*, consists of one or more DL PRS resources and it is defined by:*- nr-DL-PRS-ResourceSetID* defines the identity of the DL PRS resource set configuration. *- dl-PRS-Periodicity-and-ResourceSetSlotOffset* defines the DL PRS resource periodicity and takes values slots, where for *dl-PRS-SubcarrierSpacing*=15, 30, 60 and 120 kHz respectively and the slot offset for DL PRS resource set with respect to SFN0 slot 0. All the DL PRS resources within one DL PRS resource set are configured with the same DL PRS resource periodicity. The UE does not expect that the product of and higher layer parameter *dl-prs-MutingBitRepetitionFactor* exceeds , where for *dl-PRS-SubcarrierSpacing*=15, 30, 60 and 120 kHz respectively.<Unchanged parts are omitted> |

**FL response:**

It is recommended to discuss proposed TP.

## Aspect #5: Correction to DL PRS processing capability

In [5], it is noticed that based on current TS38.133[2], in RSTD/RSRP/Rx-Tx time difference measurement period requirements, it is described that if more than one PRS periodicities are configured in PRS frequency layer *i*, the least common multiple of PRS periodicities among all DL PRS resource sets is used to represent the periodicity of DL PRS resource on frequency layer *i* and further derive the measurement period of that PRS frequency layer *i*.

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| **TS38.214-g50**< Unchanged parts are omitted >For the case when measurement gap is configured, the UE DL PRS processing capability is defined in [TS 37.355]. For the purpose of DL PRS processing capability, the duration *K* msec of DL PRS symbols within *P* msec window corresponding to the ~~maximum PRS periodicity~~ least common multiple of PRS periodicities among all DL PRS resource sets in a positioning frequency layer, is calculated by…< Unchanged parts are omitted > |

**FL response**

It is unclear whether RAN4 assumed that UE DL PRS processing capability should be affected. To reach common understanding it seems worthwhile to discuss this aspect.

## Aspect #6: On MG request inside of the active DL BWP

In [6], it is proposed to remove the restriction for UE to request measurement gap only when outside current active DL BWP. The following TP was provided to address this aspect:

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| ---- Unchanged texts omitted ----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 the UE is expected to measure the DL PRS resource it may request a measurement gap via higher layer parameter *NR-PRS-MeasurementInfoList* [12, TS 38.331]. ---- Unchanged texts omitted ---- |

The related RAN1 agreement is provided below.

Agreement:

* RRC signalling should be introduced for a UE to request a measurement gap configuration when the UE is expected to measure the DL PRS resource outside the active DL BWP.

**FL response**

Considering that DL PRS processing w/o MG is mainly left up to UE implementation in Rel.16, it seems reasonable to extend the possibility to request the MG even for the DL PRS processing within active DL BWP.

## Aspect #7: On MG for NR Positioning

In [7], it is proposed to clarify that measurements gaps are always present when measuring PRS. The following TP was provided for this aspect:

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| --- |
| <unchanged part omitted>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 the UE is expected to measure the DL PRS resource, it may request a measurement gap via higher layer parameter *NR-PRS-MeasurementInfoList* [12, TS 38.331]. <unchanged part omitted> |

**FL response**

Please refer to response on Aspect#6.

# Proposal for E-Mail Discussion

Based on review of the submitted corrections, it is proposed to organize one or two e-mail discussion(s) (number of discussions is up to chair decision) to cover the following aspects:

Aspect #1: Clarification on DL PRS processing priority

Aspect #2: Clarification on DL PRS numerology

Aspect #3: Clarification on UE Rx-Tx time difference measurements

Aspect #4: Clarification on DL PRS periodicity and muting repetition factor

Aspect #5: Correction on DL PRS processing capability

Aspect #6 and #7: Clarification on MG request for NR positioning.

Companies are invited to provide comments in table below

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | OK to discuss the issues.For Aspect #4, the TP is technically incorrect, but it can be addressed later. |
| Nokia/NSB | Okay with the FL proposal for aspects to discuss during the meeting.  |
| CATT | Support the FL proposal on the email discussion of these issues. |
| QC | For **Aspect #1**, we can discuss but we have a different view in most of the issues: * Our understanding is that the prioritization is based on the *NR-SelectedDL-PRS-IndexList* since the agreement says:

When a UE is configured in the assistance data **of a positioning method**Either way, we are defining the UE capabilities in a per-PRS resource fashion (e.g. number of PRS resources, sets, PFL, TRPs), so it is unclear why the prioritization should be across all the assistance data. * We don’t see the issue with the “2 PFL per TRP”
* “The priority sorting based on the appearance in the list”, is already clearly captured.
* Prioritization is always defined, independent of UE capability.

For **Aspect #4**, we don’t see the ambiguity that OPPO is saying. What SFN ambiguity are we talking about? * If it is related to this:

- is bit in the bitmap given by the higher-layer parameter *dl-PRS-MutingOption1* where is the size of the bitmap; * We don’t really see a problem. Actually, even if, , then is always zero in the expression above; only one bit in the bitmap would used. Therefore, each PRS resource would be either muted or not muted in all PRS periods. It is clearly not a very useful case, because there are resources that are always muted, so then why configure them? Maybe this is a type-1 muting scenario that would be avoided by the network.

For **Aspect #5**, it is being discussed in RAN4. We don’t want to discuss it in RAN1 at the same time. To be more precise, the following agreements and open issues were captured in the WF (R4-2105851) in RAN4:* LPRS,i for PFL i should be calculated by aggregating the duration of all the PRS resources that fall within MGs and are not muted
* **Observation window for LPRS**
	+ Option 1: Tavailable\_PRS,i
	+ Option 2: TPRS,i. The observation window sizes for Lprs and for UE processing capability ‘N’ are identical.

What Aspect #5 is trying to address, is to discuss the observation window in RAN1, and using TPRS,i as the Observation window (proposed in this CR) is actually Option 2 in this RAn4 discussion.  |
| OPPO | Support the FL proposal on the email discussion of these issues.Re Aspect #4: the main purpose of the proposed TP is to clarify valid configuration of PRS periodicity and muting repetition factor. Please note LTE specify the same restriction on PRS configuration to provide valid PRS transmission and muting.

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| ***prsOccGroupLen***This field specifies the PRS occasion group length, defined as the number of consecutive PRS occasions comprising a PRS occasion group. Each PRS occasion of the PRS occasion group consists of *numDL-Frames* or *add-numDL-Frames* consecutive downlink subframes with positioning reference signals. Enumerated values define 2, 4, 8, 16, 32, 64 or 128 consecutive PRS occasions. If omitted, the PRS occasion group length is 1. The product of the PRS periodicity T\_PRS from the prs-ConfigurationIndex and the PRS occasion group length cannot exceed 1280. |

 |
| vivo | We’re okay with the FL proposal for aspects to be discussed during this meeting. Respond to QC’s comment w.r.t. Aspect #5. Regarding the quoted WF (R4-2105851) from RAN4 about "**Observation window for LPRS**”, we are not sure why QC thinks our proposed TP “is to discuss the observation window in RAN1”. The proposed changes are “For the purpose of DL PRS processing capability, the duration *K* msec of DL PRS symbols within *P* msec window corresponding to the ~~maximum PRS periodicity~~ least common multiple of PRS periodicities among all DL PRS resource sets in a positioning frequency layer, is calculated by…”. It has nothing to do with UE behaviour on observation window. Rather, it is to align PRS period assumption for PRS processing capability with RAN4’s agreement/specification in terms of measurement periods TPRS. Let me quote related RAN4’s agreements and specification below.**RAN4 agreements*** Use the least common multiple of PRS periodicities among all PRS resources in the PFL
* For the purpose of calculating TPRS,i, only the PRS resources fully or partially with the MG are considered

**TS38.133**9.9.2.5 Measurements Period Requirements (RSTD) is the periodicity of DL PRS resource on frequency layer *i*. If more than one PRS periodicities are configured in PRS frequency layer *i*, the least common multiple of PRS periodicities among all DL PRS resource sets is used to derive the measurement period of that PRS frequency layer *i*. …9.9.3.5 Measurement Period Requirements (PRS-RSRP)If frequency layer *i* has more than one DL PRS resource set with different PRS periodicities, is the least common multiple of PRS periodicities among the DL PRS resource sets on frequency *i*. …9.9.4.5 Measurement Period Requirements (UE Rx-Tx time difference measurement)If the frequency layer *i* has more than one DL PRS resource sets with different PRS periodicities, the least common multiple of PRS periodicities among DL PRS resource sets is used to derive the measurement period of that PRS frequency layer…In summary, Aspect #5 is not about Observation window for LPRS and RAN4’s discussion/decision on two options of observation window should not prevent RAN1’s discussion on whether to align with RAN4’s specification of TPRS for PRS processing capability assumption. |
| QC | To OPPO & Aspect 4: This constraint that you are referring to does not solve an SFN ambiguity problem from our understanding right? The CR description says is to avoid SFN ambiguity, but we are confused what we are trying to fix. The length of a PRS instance group (i.e. a collection of PRS instances ON/OFF-controlled by a single bit) can be of any length in current NR spec. In LTE, this was restricted to be 1280 subframes. Can it be clarified why such a constraint is needed or what does it simplify if we introduce it in NR? Since this is a CR phase, we need to agree on what we are trying to fix and why it is needed. To vivo & Aspect 5: We stand by our previous comment. Both your proposal and what RAN4 is discussing is HOW to interpret the window “P msec”. Unfortunately, we have been changing this “P msec window” too much without really doing the same level of technical discussion in RAN1 as RAN4 is doing in this topic, and what it affects with any of the options. Specifically, initially we had it as “any *P* *ms* window”, then we changed it to “maximum periodicity” and now it is proposed to change it to “LCM of periodicities” without RAN4 having finished the discussion. To be more precise, we believe that RAN1 ONLY worked on how to define the “duration” of a PRS (note that this paragraph is about the Type 1 & 2 UEs with regards to the duration), and RAN4 is working on the “P msec window” (for several meetings now). I see 2 ways around this: * Do not treat the issue until RAN4 finishes
* Change it to “described in 38.133 Section X” so that we just have a pointer. E.g.:

*For the case when measurement gap is configured, the UE DL PRS processing capability is defined in [TS 37.355]. For the purpose of DL PRS processing capability, the duration K msec of DL PRS symbols within a P msec window described in 38.133 Section X, is calculated by*We prefer to not treat it because we ll be repeating technical arguments that are happening in RAN4 and we risk confusing them even more, but we can live by just agreeing on a “adding a reference to RAN4 spec”.  |
| Apple | On Aspect#5, we also prefer to wait for RAN4. On Aspect 6 and 7, we think PRS measurement within active BWP can be left to UE implementation, i.e no spec change. On other aspects, we agree with FL’s assessment.  |
| Huawei, HiSilicon | Just reply to QC:On Aspect #1, * “2 PFL per TRP”: we do not propose anything that is relevant to “2 PFL per TRP”, is there any misunderstanding? The intention is to clarify on a PFL whether the first resource set across all TRPs has higher priority over the second resource set or the two resource sets in the first TRP has high priority over the other TRP. Can QC clarify whether the prioritization is depth first (blue) or width first (red)?

PFLTRP#0Resource set #0Resource set #1TRP#1Resource set #0Resource set #1TRP#2Resource set #0Resource set #1TRP#3Resource set #0Resource set #1* “Selected resource”: we think this can be discussed. In our view, a common PRS processing priority across different methods, but method-specific resource “selection” is more UE friendly. The method-specific resource selection already captured the method-specific assistance data.

To OPPO:On Aspect #4, we understand RAN4 is discussing issue, and we think that from RAN1 perspective, it is useful to clarify that the muting periodicity does not exceed SFN period. Given that we do not have hyper-SFN, we suggest to discuss it. On the incorrectness of OPPO’s proposal, we think it should be “the product of , higher layer parameter *dl-prs-MutingBitRepetitionFactor* and the length of the higher layer parameter *nr-option1-muting*” |
| ZTE | OK to discuss Aspect #1, we can further discuss how to correctly capture previous agreement.On Aspect#5, agree with QC and Apple, we should wait RAN4’s decision. According to R4-2105744 (CR on RSTD measurement requirements), LPRS,i is still in FFS.On Aspect#6 and 7, we think we don’t need to revert previous agreement. It’s up to UE implementation.OK with FL’s assessments on other aspects. |
| Nokia/NSB\_2 | To ZTE and Apple: The intention of Aspect #6/7 is not to revert any prior agreement. The measurement of DL PRS within the active BWP is still left to UE implementation. The spec is not clear if the UE is able to request a MG or not if the DL PRS is only in the active BWP however. If we leave the spec as is we actually restrict the UE implementation as it can only measure the DL PRS if it wants without MG but has no way to ask the network for the time to do so if it wants to measure with MG. In our understanding this was not the intention of the prior agreement and this small change makes that clear.  |
| Ericsson | OK to discuss the aspects proposed. Regarding aspect #2, we think it is sufficient to point to the parameter *dl-PRS-SubcarrierSpacing*, as the specs already does. Regarding aspect 6 and 7, the intention is not to modify the UE behaviour when the UE active DL BWP is used (requesting MG is still up to the UE), but rather to clarify that MGs *can* be requested for also when the UE active DL BWP is used. This is especially important when the UE measure a neighbour (non-serving) cell PRS while being scheduled with data in the serving cell.  |
| Futurewei | Ok with FL recommendation. On Aspect #5, the issues to avoid is duplication of discussion with RAN4. It is not a critical issues related to interoperability and for this reason, it can be deferred till after RAN4 discussion.  |
| QC | To HW: Thanks for the clarifying the intention related to the “2 sets per TRP” for Aspect 1. We can continue during the technical discussion about this, it seems companies are OK to discuss it. Regarding HW’s reply on Aspect 4: OK what HW proposes now is more related to an “SFN ambiguity problem”, and it was also tried to be clarified in LTE with the following text, if I have understood correctly the LTE-spec (btw I think the LTE text seems also wrong to me, since it is missing the length of occasion group in the product, we would need to have the product of all 3 as HW suggests no?) Either way though, the spec could allow the product of the 3 to be long, and just use the first n-bits, as LTE tried to clarify below. * When the UE receives a TREP-bit muting pattern together with a PRS periodicity TPRS for the same cell which exceeds 10240 subframes (i.e., TREP × TPRS > 10240 subframes), the UE shall assume an n-bit muting pattern based on the first n‑bits, where n = 10240/TPRS.
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| Lenovo, Motorola Mobility | Support the FL’s proposed aspects for discussion. |

Based on discussion so far, the following is observed:

# Conclusions

TBD

References

1. R1-2104276 Correction to PRS processing priority Huawei, HiSilicon
2. R1-2104483 Discussion and TP on remaining issues in NR positioning CATT
3. R1-2104584 Clarification on UE Rx-Tx time difference measurements ZTE
4. R1-2104738 Corrections on DL PRS resource configuration OPPO
5. R1-2105470 Maintenance on Rel-16 NR positioning vivo
6. R1-2105518 Draft CR on measurement gap description for positioning Nokia, Nokia Shanghai Bell
7. R1-2105907 Maintenance on Rel-16 NR positioning Ericsson