**3GPP TSG RAN WG1 Meeting #104-E R1-2101836**

**e-Meeting, January 25th – February 5th, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Summary of E-mail Discussion [104-e-NR-Pos-01]**

**Agenda item: 7.2.8**

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

Introduction

In this document, we provide summary and outcome of the RAN WG1 e-mail discussion [104-e-NR-Pos-01] organized based on review of submitted contributions [1]-[8] as captured in [10].

# Overview of Remaining Opens

## Change of Cell on DL PRS ID (TP#1 and TP#2)

In [CATT, [3]] it is pointed out that there is no higher layer parameter to indicate the serving or non-serving cell for DL-PRS in the activation command. According to description in section 6.1.3.36 of the TS 38.321, the *DL-PRS ID* field is used to indicate the DL-PRS resource, when a UE receives an activation command of semi-persistent *SRS-Pos*. The following changes are suggested in text proposal provided below:

**Text proposal #1**

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| 6.2.1 UE sounding procedure*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*For a UE configured with one or more SRS resource configuration(s), and when the higher layer parameter *resourceType* in *SRS-Resource* or *SRS-PosResource-r16* is set to 'semi-persistent':- when a UE receives an activation command, as described in clause 6.1.3.17 or 6.1.3.36 of [10, TS 38.321], for an SRS resource, and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command is transmitted in slot n, the corresponding actions in [10, TS 38.321] and the UE assumptions on SRS transmission corresponding to the configured SRS resource set shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. The activation command also contains spatial relation assumptions provided by a list of references to reference signal IDs, one per element of the activated SRS resource set. When the SRS is configured with the higher layer parameter *SRS-ResourceSet*, each ID in the list refers to a reference SS/PBCH block, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, or SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise. When the SRS is configured with the higher layer parameter *SRS-PosResourceSet-r16*, each ID in the list of reference signal IDs may refer to a reference SS/PBCH block on a serving or non-serving cell indicated by *PCI* field in the activation command, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, ~~or~~ SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise, or DL PRS resource associated with a *dl-PRS-ID* ~~of a serving or non-serving cell~~ indicated by *DL-PRS ID* field in the activation command if present, same serving cell as the SRS resource set otherwise ~~a higher layer parameter~~.*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*  |

**Text proposal #2**

In [Nokia, [5]], it is proposed to remove the term cell in the TS 38.214 Section “5.6.1.5 PRS reception procedure”. During RAN1#103-e some instances of this term were changed but others were missed.

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| ---- Unchanged texts omitted ----5.6.1.5 PRS reception procedure---- Unchanged texts omitted ----The UE expects that it will be configured with *dl-PRS-ID-r16* each of which is defined such that it may be associated with multiple DL PRS resource sets. ---- Unchanged texts omitted ---- |

### Initial Round #1

Companies are invited to provide their views on text proposal(s) in section 2.1.

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | For TP#1, we disagree with the change, as according to MAC specification, the field DL-PRS ID should always be present. In addition, we do not think using serving/non-serving cell for this case needs fixing, if the intention is to fix it.For TP#2, we have similar proposal in R1-2101731, in which we suggest to change “cell” to “point”.

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| The UE expects that it will be configured with *dl-PRS-ID* each of which is defined such that it is associated with multiple DL PRS resource sets from the same point. The UE expects that one of these *dl-PRS-ID* along with a *nr-DL-PRS-ResourceSetID* and a *nr-DL-PRS-ResourceID* can be used to uniquely identify a DL PRS resource.  |

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| CATT-1 | We support TP#1. For Huawei’s comments, we want to clarify that according to 38.321, in section 6.1.3.36(SP Positioning SRS Activation/Deactivation MAC CE), there is the following text:*- PI: This field indicates whether the field DL-PRS ID is present within the Spatial Relation for Resource IDi with DL-PRS. If the field is set to 1, the octet containing the field DL-PRS ID is present; otherwise, the octet is omitted;*Therefore, DL-PRS ID should not be always present. Moreover, we want to explain the intention of this TP, in fact, for the DL PRS configuration, the use of “cell” to refer to the TRP where the DL PRS is configured is incorrect. There is no higher layer parameter to indicate the serving or non-serving cell for DL-PRS in the activation command. Instead, as described in section 6.1.3.36 of TS 38.321[3], the *DL-PRS ID* field is used to indicate the DL-PRS resource, when a UE receives an activation command of semi-persistent SRS-Pos. Therefore, the descriptions here needs to be updated to make the indication of DL PRS correct. |
| Nokia/NSB | To Huawei’s comments: we think removing “from the same cell” is a better way to clarify the issue, especially given the agreed CRs from RAN1#103-e, but open to discussion if all other companies prefer the term “point”. We would like to highlight that the change from “is” to “may be” is also important as in our understanding it is not required to have multiple DL PRS resource sets for every TRP.  |
| Qualcomm | We don’t think the word “point” is correct, assuming the intention was “geographic point”. Strictly speaking in 37.355, each PRS resource may even have a different location:TRP-LocationInfoElement-r16 ::= SEQUENCE { **dl-PRS-ID-r16 INTEGER (0..255),** nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, -- Need ON nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, -- Need ON nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, -- Need ON associated-DL-PRS-ID-r16 INTEGER (0..255) OPTIONAL, trp-Location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP trp-DL-PRS-ResourceSets-r16 SEQUENCE (SIZE(1..nrMaxSetsPerTrp-r16)) OF DL-PRS-ResourceSets-TRP-Element-r16 OPTIONAL, -- Need OP ...}**DL-PRS-ResourceSets-TRP-Element-r16 ::= SEQUENCE {** **dl-PRS-ResourceSetARP-r16 RelativeLocation-r16 OPTIONAL, -- Need OP** dl-PRS-Resource-ARP-List-r16 SEQUENCE (SIZE(1..nrMaxResourcesPerSet-r16)) OF DL-PRS-Resource-ARP-Element-r16 OPTIONAL, -- Need OP ...}**DL-PRS-Resource**-ARP-Element-r16 ::= SEQUENCE { **dl-PRS-Resource-ARP-location-r16 RelativeLocation-r16 OPTIONAL, -- Need OP** ...}So, agreeing with the initial proposal from Nokia seems more consistent.  |
| Vivo | For TP#1, we share the understanding as Huawei that the field DL-PRS ID is always present according to RAN2’s specification. In that sense, no need to have TP#1.Seems the quoted specification from CATT is not the latest version. We copied from TS 38.321 v16.3.0Figure 6.1.3.36-5: Spatial Relation for Resource IDi with DL-PRS in TS 38.321- PI: This field indicates whether the field DL-PRS resource ID is present within the Spatial Relation for Resource IDi with DL-PRS. If the field is set to 1, the octet containing the field DL-PRS resource ID is present; otherwise, the octet is omitted;For TP#2, given that “*dl-PRS-ID-r16* each of which is defined …” we are okay to remove ‘the same cell’ and go with TP#2.  |
| Apple | Support both TPs. On TP1, we share similar view as CATT (to vivo: the field S indicates whether or not the fields Spatial Relation for Resource IDi is present…) |
| CATT-2 | For comments from Huawei and vivo about whether the field of “DL-PRS ID should be always present”, we realized that this field should be always present in the latest version of 38.321 g30. Therefore, we changed the TP as follows. Moreover, we want to explain the intention of this TP, in fact, for the DL PRS configuration, the use of “cell” to refer to the TRP where the DL PRS is configured is incorrect. There is no higher layer parameter to indicate the serving or non-serving cell for DL-PRS in the activation command. Instead, the *DL-PRS ID* field is used to indicate the DL-PRS resource, when a UE receives an activation command of semi-persistent SRS-Pos. Therefore, the descriptions here need to be updated to make the indication of DL PRS correct.

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| 6.2.1 UE sounding procedure*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*For a UE configured with one or more SRS resource configuration(s), and when the higher layer parameter *resourceType* in *SRS-Resource* or *SRS-PosResource-r16* is set to ‘semi-persistent’:- when a UE receives an activation command, as described in clause 6.1.3.17 or 6.1.3.36 of [10, TS 38.321], for an SRS resource, and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command is transmitted in slot n, the corresponding actions in [10, TS 38.321] and the UE assumptions on SRS transmission corresponding to the configured SRS resource set shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. The activation command also contains spatial relation assumptions provided by a list of references to reference signal IDs, one per element of the activated SRS resource set. When the SRS is configured with the higher layer parameter *SRS-ResourceSet*, each ID in the list refers to a reference SS/PBCH block, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, or SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise. When the SRS is configured with the higher layer parameter *SRS-PosResourceSet-r16*, each ID in the list of reference signal IDs may refer to a reference SS/PBCH block on a serving or non-serving cell indicated by *PCI* field in the activation command, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, ~~or~~ SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise, or DL PRS resource associated with a *dl-PRS-ID* ~~of a serving or non-serving cell~~ indicated by *DL-PRS ID* field in the activation command ~~a higher layer parameter~~.*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*  |

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| Huawei/HiSilicon2 | On TP#1To CATT (updated TP):In our understanding, we have the following features that more or less require UE to identify whether the PRS-TRPs are from the serving cell or from the non-serving cell.* TS 38.211 on PRS symbol mapping

- the symbol $l$ is not used by any SS/PBCH block used by a serving cell for downlink PRS transmitted from the same serving cell or any SS/PBCH block from a non-serving cell whose time frequency location is provided to the UE by higher layers for downlink PRS transmitted from the same non-serving cell;* SRS Power control UE feature
	+ *olpc-SRS-PosBasedOnPRS-Serving-r16* indicates whether the UE supports OLPC for SRS for positioning based on PRS from the serving cell in the same band. The UE can include this field only if the UE supports *NR-DL-PRS-ProcessingCapability-r16* defined in TS 37.355 [22], and *srs-PosResources-r16*. Otherwise, the UE does not include this field;
	+ *olpc-SRS-PosBasedOnPRS-Neigh-r16* indicates whether the UE supports OLPC for SRS for positioning based on PRS from the neighbouring cell in the same band. The UE can include this field only if the UE supports *olpc-SRS-PosBasedOnPRS-Serving-r16*. Otherwise, the UE does not include this field;
* SRS spatial relation info UE feature
	+ *spatialRelation-SRS-PosBasedOnPRS-Serving-r16* indicates whether the UE supports spatial relation for SRS for positioning based on PRS from the serving cell in the same band. The UE can include this field only if the UE supports any of DL PRS Resources for DL AoD, DL PRS Resources for DL-TDOA or DL PRS Resources for Multi-RTT defined in TS37.355 [22], or *srs-PosResources-r16*. Otherwise, the UE does not include this field;
	+ *spatialRelation-SRS-PosBasedOnPRS-Neigh-r16* indicates whether the UE supports spatial relation for SRS for positioning based on PRS from the neighbouring cell in the same band. The UE can include this field only if the UE supports *spatialRelation-SRS-PosBasedOnPRS-Serving-r16*. Otherwise, the UE does not include this field;

How UE can do that could be that UE uses *dl-PRS-ID* to associate the TRP in the assistance data if the *dl-PRS-ID* is received from the MAC CE, and use the PCI/CGI to identify whether the concerned TRP (identified by the *dl-PRS-ID*) is the serving cell or the non-serving cell. So technically, the current text in TS 38.214 is correct, which simply says that the spatial relation indication the SP-SRSp activation MAC CE can indicate the source PRS that can be either from the serving cell or from the non-serving cell.It looks that we are losing the original intention of the text by the proposed update changes from CATT.On TP#2We are fine with Nokia’s suggestions.In reply to QC, the “point” from our original intention should be interpreted as the same “point” from the terminology “TP/RP/TRP”, which has its own ARP, and may have resource-specific ARP that is delta-signaled. |
| ZTE | TP#1: Agree with Huawei and vivo, original wording is clear enough.Support TP#2. To Huawei’s change, we agree with Qualcomm’s response.  |
| OPPO | We are fine to keep the current spec or approve TP#1. In some sense, TP#1 is more suitable for readers. We are fine with TP#2 |
| LG | For TP#1, we prefer to keep the current description, but we now have a minor question on whether the UE can identify a TRP (*dl-PRS-ID*) is from the serving or non-serving cell. In our understanding, the same TRP ID (*dl-PRS-ID*) can be used for different PCI in the assistance data configuration.We are fine with TP#2. |
| Huawei/HiSilicon3 | To LGEIn our understanding, within the assistance data, *dl-PRS-ID* should be used for uniquely identifying a TRP. This allows one *dl-PRS-ID* to associate multiple cells (and also allows one cell to associate with multiple *dl-PRS-IDs*/TRPs).For example, for collocated CA deployment, where each CC has its own PCI, and those CCs can be grouped under the same *dl-PRS-ID*, which appear in different positioning frequency layers. We had proposed to have some discussion on *dl-PRS-ID* reuse a couple of meetings ago, but it was not agreed. This also means that for a TRP deployed across CCs, PRS transmitted on one CC is not affected by the SSB transmitted on another CC, even though the *dl-PRS-ID* for the PRS on those two CCs can be the same.Things may be complicated if the assistance data is broadcast cell-specifically, or unicast+broadcast, which can be handled by RAN2. |
| CATT-3 | About TP#1, for the comments from Huawei, we agree that “serving or non-serving cell” can be used in the sentence, but the description in the sentence is not clear, since there is no detailed name of “a higher layer parameter”. It will be better to mention the name of parameter in the sentence.Therefore, we changed the TP as follows.

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| 6.2.1 UE sounding procedure*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*For a UE configured with one or more SRS resource configuration(s), and when the higher layer parameter *resourceType* in *SRS-Resource* or *SRS-PosResource-r16* is set to ‘semi-persistent’:- when a UE receives an activation command, as described in clause 6.1.3.17 or 6.1.3.36 of [10, TS 38.321], for an SRS resource, and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command is transmitted in slot n, the corresponding actions in [10, TS 38.321] and the UE assumptions on SRS transmission corresponding to the configured SRS resource set shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. The activation command also contains spatial relation assumptions provided by a list of references to reference signal IDs, one per element of the activated SRS resource set. When the SRS is configured with the higher layer parameter *SRS-ResourceSet*, each ID in the list refers to a reference SS/PBCH block, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, or SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise. When the SRS is configured with the higher layer parameter *SRS-PosResourceSet-r16*, each ID in the list of reference signal IDs may refer to a reference SS/PBCH block on a serving or non-serving cell indicated by *PCI* field in the activation command, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, ~~or~~ SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise, or DL PRS resource of a serving or non-serving cell associated with a *dl-PRS-ID* indicated by *DL-PRS ID* field in the activation command ~~a higher layer parameter~~.*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*  |

About TP#2, or the TP#2, we prefer to remove the “from the same cell”, and add the text “one or” to address the concern that maybe only one DL PRS resource set is configured in certain TRP. The modified TP as follows,

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| ---- Unchanged texts omitted ----5.6.1.5 PRS reception procedure---- Unchanged texts omitted ----The UE expects that it will be configured with *dl-PRS-ID-r16* each of which is defined such that it is associated with one or multiple DL PRS resource sets. ---- Unchanged texts omitted ---- |

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| LG | To HuaweiThanks to the answer for our question. In our understanding, TP ID was introduced in LTE to identify different TP(s) (considering RRH unit) in a geometric/physical cell, and TRP ID in NR was introduced with the similar reason. It seems that the UE is not possible to clearly identify a TRP is serving cell or non-serving cell, and we think that it is aligned with the current specification.For the modified proposal by CATT, we would like to suggest remove “indicated by *DL-PRS ID* field in the activation command ~~a higher layer parameter~~”, as follows: … , or DL PRS resource of a serving or non-serving cell associated with a *dl-PRS-ID* indicated by *DL-PRS ID* ~~field in the activation command a higher layer parameter~~. |

### Round #2

For TP#1, there was no comments received on the latest update from CATT, therefore it is proposed to discuss it further.

For TP#2 it seems the latest proposal from CATT is accurate and can be agreeable for the group. Therefore, it is proposed to agree on it.

**Proposal 1 (Round #2):**

* **Companies are invited to provide views on the latest update of TP#1 from CATT-3 (copied below as Text Proposal#1 (Revision #1))**
* **Endorse revised text proposal # 2 as provided below (please refer to Text Proposal #2 (Revision #1))**

**Text Proposal #1 (Revision #1)**

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| 6.2.1 UE sounding procedure*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*For a UE configured with one or more SRS resource configuration(s), and when the higher layer parameter *resourceType* in *SRS-Resource* or *SRS-PosResource-r16* is set to ‘semi-persistent’:- when a UE receives an activation command, as described in clause 6.1.3.17 or 6.1.3.36 of [10, TS 38.321], for an SRS resource, and when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command is transmitted in slot n, the corresponding actions in [10, TS 38.321] and the UE assumptions on SRS transmission corresponding to the configured SRS resource set shall be applied starting from the first slot that is after slot $n+3N\_{slot}^{subframe,µ}$ where ** is the SCS configuration for the PUCCH. The activation command also contains spatial relation assumptions provided by a list of references to reference signal IDs, one per element of the activated SRS resource set. When the SRS is configured with the higher layer parameter *SRS-ResourceSet*, each ID in the list refers to a reference SS/PBCH block, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, or SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise. When the SRS is configured with the higher layer parameter *SRS-PosResourceSet-r16*, each ID in the list of reference signal IDs may refer to a reference SS/PBCH block on a serving or non-serving cell indicated by *PCI* field in the activation command, NZP CSI-RS resource configured on serving cell indicated by *Resource Serving Cell ID* field in the activation command if present, same serving cell as the SRS resource set otherwise, ~~or~~ SRS resource configured on serving cell and uplink bandwidth part indicated by Resource *Serving Cell ID* field and *Resource BWP ID* field in the activation command if present, same serving cell and bandwidth part as the SRS resource set otherwise, or DL PRS resource of a serving or non-serving cell associated with a *dl-PRS-ID* indicated by *DL-PRS ID* field in the activation command ~~a higher layer parameter~~.*-----------------------------------------------------* Unchanged part omitted *------------------------------------------------*  |

**Text Proposal #2 (Revision #1)**

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| ---- Unchanged texts omitted ----5.6.1.5 PRS reception procedure---- Unchanged texts omitted ----The UE expects that it will be configured with *dl-PRS-ID-r16* each of which is defined such that it is associated with one or multiple DL PRS resource sets. ---- Unchanged texts omitted ---- |

Companies are invited to provide comments on revised TPs:

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| **Company Name** | **Comments** |
| Nokia/NSB | Support the TPs.  |
| Ericsson | Support both TPs.  |
| vivo | OK |
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## Misalignment of ‘*nr-TimeStamp*’ with TS37.355

In [vivo, [4]], the misalignment b/w RAN1 (TS 38.214) and RAN2 (TS 37.355) specifications is discussed with respect to *nr-TimeStamp* parameter. The values of the time stamp correspond to the reference provided by *nr-DL-PRS-ReferenceInfo*, which is associated with the reference TRP.In the TS37.355 [2], the descriptions are written as:

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| NR-TimeStamp-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, -- Need ON nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, -- Need ON nr-ARFCN-r16 ARFCN-ValueNR-r15 OPTIONAL, -- Need ON nr-SFN-r16 INTEGER (0..1023), nr-Slot-r16 CHOICE { scs15-r16 INTEGER (0..9), scs30-r16 INTEGER (0..19), scs60-r16 INTEGER (0..39), scs120-r16 INTEGER (0..79) }, …} |
| ***dl-PRS-ID***This field specifies the DL-PRS ID of the TRP for which the *nr-SFN* is applicable. |

It is observed that from RAN2’s perspective, the ‘*nr-TimeStamp*’ for each measurement is associated with the TRP indicated by ‘dl-PRS-ID’.

The following text proposal is provided for the TS 38.214 to align it with the TS 37.355.

**Text Proposal**

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| **TS38.214-g40**< Unchanged parts are omitted >For the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements the UE can report an associated higher layer parameter *nr-TimeStamp*. The *nr-TimeStamp* can include the SFN and the slot number for a subcarrier spacing. These values correspond to the *dl-PRS-ID* for which *nr-TimeStamp* is applicable ~~the reference which is provided by~~ *~~nr-DL-PRS-ReferenceInfo~~*~~.~~ < Unchanged parts are omitted > |

### Initial Round #1

Companies are invited to provide their views on text proposal(s) in section 2.2.

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| **Company Name** | **Comments** |
| Huawei/HiSilicon | We have concern on the changes.First, RAN1 made the following agreement in RAN1#99, and the changes are reverting it without clear justification.

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| 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. |

Second, RAN2 added *dl-PRS-ID* to the *NR-TimeStamp* IE as the result of the TRP ID email discussion in RAN2#110-e, in which the *dl-PRS-ID* is justified for the usage in *NR-TimeStamp* for UE-based positioning.[R2-2004701](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2004701.zip) Report on TRP-ID structure Ericsson report Rel-16[R2-2004704](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2004704.zip) Summary and Text Proposal on TRP-ID structure Ericsson discussion Rel-16[R2-2005894](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2005894.zip) Report on TRP-ID continuation Ericsson report Rel-16[R2-2005904](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2005904.zip) [AT110-e][612][POS] Report on TRP-ID continuation email discussion (Ericsson) Ericsson report Rel-16The summary from R2-2004701 is attached below.

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| Table 2.5 Need for additional TRP identifiers in *NR-TimeStamp-r16* |
| Company | Comments |
| Huawei/HiSilicon | No need to include TRP ID or PCI, as it was agreed in RAN1 and captured in RAN1 specification, that the assistance data reference is used to identify the time stamp timing.Agreement (RAN1#99):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.TS 38.214For 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*.  |
| Qualcomm | The proposed *NR-PhysCellId-r16* in the ASN.1 above is included in IE *TRP-ID-r16*, so no change is needed.The *NR-TimeStamp-r16* can also provide the time stamp for the location estimate (UE-based); e.g., IE *NR-DL-TDOA-LocationInformation,* for which the RAN1 agreement cited by Huawei above seems not applicable (i.e., the *TRP-ID* is optional present). |
| OPPO | We are not sure about the necessity of PCI/Arfcn/CGI information here in timestamp.If take DL TDOA as an example:1. For the time stamp included in *NR-DL-AoD-MeasElement-r16,* we assume the agreement cited by Huawei is applicable, so no need for additional information at all (not even PCI);
2. For the time stamp included in *NR-DL-TDOA-LocationInformation*, if Qualcomm comment is correct, and thus cell information is needed, we wonder if PCI is enough, considering the possible PCI confusion issue. As commented above, So to uniquely identify a TRP, either the combination of *nr-PhysCellId/nr-ARFCN* or *nr-CellGlobalId* can work, by assuming no local PCI confusion at a same local area for a same frequency. May be the latter one, i.e., *nr-CellGlobalId*, is safer. This applies to both UL and DL.
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| Ericsson | In response to the QC comment about this already being present in a complex IE:The clear majority of companies from the RAN2#109bis email discussion were in favor of splitting the TRP ID of the baseline into separate fields, so TRP ID (or another name) in this context is 0..255 and not including PCI.We agree with QC on the necessity to ensure that SFN is well-defined in all cases. |
| CATT | Agree with Qualcomm. |
| Intel | Agree with Huawei view, i.e. TRP-ID, PCI are not needed since it is based on reference cell.  |

In our view, if it is common understanding that UE can reselect the TRP for time stamp reporting associated with DL measurement and/or location fix (UE-based) in case of cell change during the LPP session, broadcast assistance data, etc., we should make our own agreement reverting the RAN1#99 agreement.In addition, if we open the discussion, we should discuss whether the *dl-PRS-ID* in the timestamp should be the same across all TRPs for UE-assisted positioning measurement report. |
| Nokia/NSB | We don’t think the change is needed.  |
| Qualcomm | Our understanding of the previous RAN1 agreement was that the UE would still be able to change the reference for timestamp in a similar way that the UE can change the reference for RSTD measurements. Note that the Agreement was made in #99, when it was still confusing the difference between the reference in the assistance data and the reference that the UE selects for measurement reporting. That is why we also had, if my recollection is correct, another related TP change in a recent meeting, to clarify the difference between the “reference in the assistance data” and the “reference in the measurement report”.Technically speaking, the UE maintains the SFN of the serving cell (single SFN), and asking a UE to report according to the SFN of some other cell is an unnecessary complication/requirement that does not provide a gain to the network: The network has knowledge of the SFN of all TRPs, so there is not really a need to ask a UE to maintain the SFN for both the chosen reference cell and a configured reference cell. Therefore, we are supportive of the clarification from vivo.  |
| Vivo | Support.The proposed change is meant to align RAN1 with RAN2’s specification. We’re aware of previous RAN1#99 agreement. One follow-up question from our side if we don’t make this change. How to interpret NR-TimeStamp-r16 if the reported dl-PRS-ID in it is not that same as that corresponding to DL-PRS-RstdReferenceInfo contained in assistance data?  |
| Apple | Support. Our understanding is given that UE can change the reference PRS for measurements, then the time stamp should be tied to that reference.  |
| Huawei/HiSilicon2 | Thanks for QC/vivo’s reply.If we assume that UE can anyway select the *dl-PRS-ID* for time stamp reporting, the question from our side is that which one should be specified or the selection can be rather random by UE implementation, e.g. for measurement for the TRP with *dl-PRS-ID*=1, UE can use the time stamp associated with TRP with *dl-PRS-ID*=2, while for measurement for TRP with *dl-PRS-ID*=2, UE can use the time stamp associated with the TRP with *dl-PRS-ID*=255? Or are we assuming a reasonable UE behavior that is different from the current one, but we are not willing to specify it?To Apple, for DL-AoD and Multi-RTT, there is no reference reselection. |
| ZTE | Support in principle. But the spec should be clear the time stamp is the time instance of a TRP at which the measurement is performed. Suggest the following wording, < Unchanged parts are omitted >For the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements the UE can report an associated higher layer parameter *nr-TimeStamp*. The *nr-TimeStamp* can include the SFN and the slot number for a subcarrier spacing. The *nr-TimeStamp* can include the SFN and the slot number for a subcarrier spacing.The *nr-TimeStamp* is the time instance associated with a *dl-PRS-ID* at which the measurement is performed . < Unchanged parts are omitted > |
| OPPO | Support in principle. We prefer ZTE’s version since it specifies a practical UE implementation and may address Huawei’s concern that the *dl-PRS-ID* in *nr-TimeStamp* is not related to the measurement. |
| LG | We prefer to keep the current specification without reverting RAN1 agreement, unless there is a critical problem.  |
| CATT | In our point of view, current specifications match previous RAN1 agreements, we prefer not to change it. |

Based on discussion it seems

* 4 companies (Huawei, LG, CATT, Nokia) do not see the need for change
* 3 companies (Apple, Qualcomm, vivo) support the change
* 2 companies propose the change that “time stamp is the time instance of a TRP at which the measurement is performed”

### Round #2

It seems further discussion and change is needed. To reach common understanding on the raised issue and facilitate further discussion please provide answers on the following questions:

* **Q1**: Whether UE can change the reference for timestamp in measurement report or should always follow reference provided by the DL-PRS-RstdReferenceInfo, i.e. indicated in DL PRS assistance information?
* **Q2**: Whether it needs to be specified how UE is expected to select reference for timestamp in measurement report (e.g. timestamp of serving gNB) or it can be left up to UE implementation?
* **Q3**: How to interpret timestamp in current specification if the reported dl-PRS-ID in measurement report is not the same as that corresponding to DL-PRS-RstdReferenceInfo contained in assistance data and whether it is a valid scenario from RAN1 perspective?
* **Q4:** Is there any technical issue in proposed correction?

Note: Q1-Q3 may require change of RAN1#99 agreement on timestamp reference.

Companies are invited to provide brief answers on Q1-Q4 and indicate acceptable way forward:

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Nokia/NSB | **Q1:** As this relates to a timestamp and is just about the relative value we don’t see why this is such a big discussion. The prior agreement is quite clear and we don’t really see the value in allowing the UE to change the reference. Our understanding is that in the vast majority (if not all) cases the reference provided in DL-PRS-RstdReferenceInfo will be from the serving cell which the UE should have the timing for. So, no. **Q2:** Not needed. **Q3:** Our understanding is that UE should select dl-PRS-ID to algin with DL-PRS-RstdReferenceInfo. If we think this may be an issue then we should send LS to RAN2 to change to algin with RAN1 agreement. We doubt their intention was to overturn a prior RAN1 agreement. **Q4:** See above.  |
| Ericsson | Q1: in our view, the answer to the question is no. however, it seems that the paragraph in 214 does not includes cases where the ue did *not* receive a reference, which RAN2 specs also cover. **Q2:** not needed (based on our answer on Q1) at least when the UE has a specific LPP configuration. We could extend the text to cover the case where the UE did not receive a reference. **Q3:** similar view as nokia. If the UE got a reference, it should follow it. Note that in 355, the reference information is mandatory, while in 214, the specs say “can include”. Maybe better to align the language and remove “can” from 214.**Q4:**  see the other answers above.  |
| vivo | **Q1:** Our understanding of current specification is that it is not prevented for UE to choose a different reference for timestamp report. **Q2:** Not needed as long as UE report the used reference dl-PRS-ID in timestampe report. **Q3:** Our understanding is that LMF should take the dl-PRS-ID reported in UE timestamp report. **Q4:** No issue. See our above answers to Q1/2/3.We’re okay to go with the understanding that the dl-PRS-ID indicated in DL-PRS-RstdReferenceInfo is always used for UE as reference for timestamp report as long as that is clear from the specification. In this case, we propose the following TP for 38.214 so that the relationship of the dl-PRS-ID reported in timestamp is clear.< Unchanged parts are omitted >For the DL RSTD, DL PRS-RSRP, and UE Rx-Tx time difference measurements the UE can report an associated higher layer parameter *nr-TimeStamp*. The *nr-TimeStamp* can include the *dl-PRS-ID*, the SFN and the slot number for a subcarrier spacing. These values correspond to the reference which is provided by *nr-DL-PRS-ReferenceInfo*.< Unchanged parts are omitted > |
|  |  |

## Ambiguity for Measurement Gap Request

In [vivo, [4]], it is noticed that according to the TS 38.331, for ‘measurement gap request’, the related higher layer parameter should be ‘*LocationMeasurementIndication*’.

|  |
| --- |
| * *LocationMeasurementIndication*

The *LocationMeasurementIndication* message is used to indicate that the UE is going to either start or stop location related measurement which requires measurement gaps.Signalling radio bearer: SRB1RLC-SAP: AMLogical channel: DCCHDirection: UE to Network*LocationMeasurementIndication message*-- ASN1START-- TAG-LOCATIONMEASUREMENTINDICATION-STARTLocationMeasurementIndication ::= SEQUENCE { criticalExtensions CHOICE { locationMeasurementIndication LocationMeasurementIndication-IEs, criticalExtensionsFuture SEQUENCE {} }}LocationMeasurementIndication-IEs ::= SEQUENCE { measurementIndication SetupRelease {LocationMeasurementInfo}, lateNonCriticalExtension OCTET STRING OPTIONAL, nonCriticalExtension SEQUENCE{} OPTIONAL}-- TAG-LOCATIONMEASUREMENTINDICATION-STOP-- ASN1STOP |

The following TP is provided for the TS 38.214 to resolve ambiguity with respect to measurement gap request between specifications (TS 38.214 and TS 38.331).

**Text Proposal 2.3-1**

|  |
| --- |
| **TS 38.214-g40**< Unchanged parts are 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 outside the active DL BWP it may request a measurement gap ~~in~~ via higher layer parameter *LocationMeasurementIndication ~~MeasGapConfig~~* [12, TS 38.331]. < Unchanged parts are omitted > |

### Initial Round #1

Companies are invited to provide their views on text proposal(s) in section 2.3.

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei/HiSilicon | *LocationMeasurementIndication* also includes the following types of requesting measurement gap, which may not be accurate.* NR Measurement gap for inter-RAT E-UTRA PRS measurement
* Fine LTE timing detetion for inter-RAT E-UTRA PRS measurement

It reads like when we want to describe the higher layer parameter, we are using RRCReconfiguration, which is too general. Suggest to change the parameter name to “NR-PRS-MeasurementInfoList”. |
| Nokia/NSB | We are okay with the change proposed by Huawei above.  |
| vivo | Support.To Huawei’s comment, I don’t understand what’s the issue of using *LocationMeasurementIndication.* In TS 38.214, it says “When the UE is expected to measure the DL PRS resource outside the active DL BWP it may request a measurement gap via higher layer parameter LocationMeasurementIndication [12, TS 38.331].” It mentions nothing about inter-RAT E-UTRA. Where’s the confusion and/or inaccuracy coming from?On the suggested parameter “NR-PRS-MeasurementInfoList” from Huawei, the following is quoted from TS 38.331. NR-PRS-MeasurementInfoList-r16 ::= SEQUENCE (SIZE (1..maxFreqLayers)) OF NR-PRS-MeasurementInfo-r16NR-PRS-MeasurementInfo-r16 ::= SEQUENCE { dl-PRS-PointA-r16 ARFCN-ValueNR, nr-MeasPRS-RepetitionAndOffset-r16 CHOICE { ms20-r16 INTEGER (0..19), ms40-r16 INTEGER (0..39), ms80-r16 INTEGER (0..79), ms160-r16 INTEGER (0..159), ... }, nr-MeasPRS-length-r16 ENUMERATED {ms1dot5, ms3, ms3dot5, ms4, ms5dot5, ms6, ms10, ms20}, ...}We don’t see how this indicate measurement gap request. |
| Huawei/HiSilicon2 | To vivo:*LocationMeasurementIndication* is as the same level of *RRCReconfiguration*, which are RRC messages that serves various functionalities. The hierarchical representation of *LocationMeasurementIndication* and *NR-PRS-MeasurementInfoList* is shown as follows.LocationMeasurementIndication> locationMeasurementIndication (LocationMeasurementIndication-IEs)>> measurementIndication (LocationMeasurementInfo)>>> eutra-RSTD (EUTRA-RSTD-InfoList)>>> eutra-FineTimingDetection (NULL)>>> nr-PRS-Measurement-r16 (NR-PRS-MeasurementInfoList)I think the intention of vivo’s CR is to use the IE of *NR-PRS-MeasurementInfoList* under the RRC Message *LocationMeasurementIndication*, as other information is not concerned in the context.We are confused by vivo’s confusion on how to use NR-PRS-MeasurementInfoList to request measurement, the structure of which has been used since Rel-9. |
| ZTE | Agree with Huawei, the DL PRS resource is indeed for 5G NR. |
| OPPO | We share the same understanding of Huawei. Thus, we support Huawei’s proposal as it is more accurate |
| CATT | Support the change from Huawei, since *LocationMeasurementIndication* may be general, the alternative parameter “NR-PRS-MeasurementInfoList” from Huawei’s suggestion will be better. |
|  |  |

### Round #2

Based on discussion, majority of companies support TP with modifications suggested by Huawei. Therefore, it is proposed to agree on the revised TP below:

**Proposal 3 (Round #2)**

* **Endorse revised text proposal as provided below**

**Text Proposal**

|  |
| --- |
| **TS 38.214-g40**< Unchanged parts are 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 outside the active DL BWP it may request a measurement gap ~~in~~ via higher layer parameter *NR-PRS-MeasurementInfoList ~~MeasGapConfig~~* [12, TS 38.331].< Unchanged parts are omitted > |

Companies are invited to provide comments:

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Nokia/NSB | Support |
| Ericsson | Support |
| vivo | OK |
|  |  |

## DL PRS Resource / Resource Set IDs Reporting for DL-AOD

For the UE performing measurement reporting, it can be configured to report related IDs as following [vivo, [4]].

|  |
| --- |
| For DL UE positioning measurement reporting in higher layer parameters *NR-DL-TDOA-SignalMeasurementInformation* or *NR-Multi-RTT-SignalMeasurementInformation* 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 Rx-Tx time difference. |

In specification TS 37.355, the related IDs are also applicable to the DL-AOD method.

|  |
| --- |
| NR-DL-AoD-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 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-DL-PRS-RSRP-Result-r16 INTEGER (0..126), nr-DL-PRS-RxBeamIndex-r16 INTEGER (1..8) OPTIONAL, -- Cond SameRx nr-DL-AoD-AdditionalMeasurements-r16 NR-DL-AoD-AdditionalMeasurements-r16 OPTIONAL, …} |

The following text proposal is suggested for the TS 38.214 to align it with the TS 37.355.

|  |
| --- |
| **TS 38.214-g40**< Unchanged parts are omitted >For DL UE positioning measurement reporting in higher layer parameters *NR-DL-TDOA-SignalMeasurementInformation* or *NR-Multi-RTT-SignalMeasurementInformation or NR-DL-AoD-SignalMeasurementInformation* 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 Rx-Tx time difference, DL RSRP.< Unchanged parts are omitted > |

### Initial Round #1

Companies are invited to provide their views on text proposal(s) in section 2.2.

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Huawei/HiSilicon | We have concern on the change. We think that the intention of the text was to describe that reporting of DL PRS resource set ID and resource ID is configurable, which is not applicable for DL-AoD. The related parameters should have been *nr-DL-PRS-RstdMeasurementInfoRequest* and *nr-UE-RxTxTimeDiffMeasurementInfoRequest* in DL-TDOA and Multi-RTT RequestLocationInformation messages, respectively. The text was there in TS 38.214 g20, but was replaced by *NR-DL-TDOA-SignalMeasurementInformation* and *NR-Multi-RTT-SignalMeasurementInformation* in TS 38.214 g30, due to inaccurate description.This change gives the wrong impression that reporting of DL PRS resource set ID and DL PRS resource ID can be configurable by LMF for DL-AoD positioning, which is not aligned with LPP. |
| Nokia/NSB | We do not support the change. The UE should always report the DL PRS resource set ID and DL PRS resource ID for DL-AoD positioning. Otherwise the measurement report it completely useless at the LMF. The current spec reflects the intended behavior in our view.  |
| Qualcomm | Do not support the change as explained above |
| vivo | Support.Again, this proposal is meant to align RAN1 with RAN2’s specification. As can be seen from quoted TS 37.355, when report for DL-AoD, DL PRS resource ID and DL PRS set ID are optional, the same as for RSTD and RTT report.NR-DL-AoD-MeasElement-r16 ::= SEQUENCE { dl-PRS-ID-r16 INTEGER (0..255), nr-PhysCellID-r16 NR-PhysCellID-r16 OPTIONAL, nr-CellGlobalID-r16 NCGI-r15 OPTIONAL, nr-ARFCN-r16 ARFCN-ValueNR-r15 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-DL-PRS-RSRP-Result-r16 INTEGER (0..126), nr-DL-PRS-RxBeamIndex-r16 INTEGER (1..8) OPTIONAL, -- Cond SameRx nr-DL-AoD-AdditionalMeasurements-r16 NR-DL-AoD-AdditionalMeasurements-r16 OPTIONAL, …} |
| Apple | Do not support as HW explained.  |
| Huawei/HiSilicon2 | To vivo, optionality of nr-DL-PRS-ResourceID and nr-DL-PRS-ResourceSetID does not mean that including them can be configurable. The optional field in ASN.1 seems to be a RAN2 issue due to copy-paste, which should have been mandatory. |
| ZTE | In my understanding, it’s possible that only one DL PRS resource set and one DL PRS resource in the set are configured as defined by UE feature 13-2 and 13-2a for DL-AoD. So, there is no need to report DL PRS resource ID and DL PRS resource set ID.But from location request perspective, network can configure whether DL PRS resource ID and DL PRS resource set ID should be reported for DL-TDOA and Multi-RTT, but not for DL-AoD.Therefore, no spec change is needed. |
| OPPO | No change is needed as Huawei/ZTE explained above |
| LG | From our understanding, the UE should report the DL PRS resource set ID and DL PRS resource ID with the RSRP measurement for DL-AoD positioning. In case that a single PRS resource is configured, we are not sure if the DL-AoD positioning is possible. In our understanding, at least reporting of the PRS resource ID needs to be mandatory since the number of PRS resource sets can be 1.  |
| CATT | We share the same view with Huawei and ZTE that this change is not needed. |

Based on discussion, majority of companies do not support proposed change. Considering provided arguments it is proposed to conclude that no change is needed for DL-AOD reporting. Note that there is no intention to make official conclusion in chair notes but confirmation from companies is welcome.

### Round #2

**Proposal 4 (Round #2):**

* **Conclude that there is no need to change specification with respect to DL PRS Resource/Resource Set ID reports for DL-AOD positioning**

Companies are invited to provide comments:

|  |  |
| --- | --- |
| **Company Name** | **Comments** |
| Nokia/NSB | Support the FL view.  |
| Ericsson | Support the FL view.  |
| vivo | OK |
|  |  |

Conclusions

In this contribution, the summary of the RAN WG1 e-mail discussion: “[104-e-NR-Pos-01] Email discussion/approval on DL PRS” is provided. As an outcome the following was agreed by RAN WG1: TBD

References

1. R1-2100127 Text Proposals on NR Positioning OPPO
2. R1-2100282 Maintenance of NR positioning support ZTE
3. R1-2100342 Discussion and TP on remaining issues in NR positioning CATT
4. R1-2100419 Maintenance on Rel-16 NR positioning vivo
5. R1-2100552 Draft CR on the usage of the term cell Nokia, Nokia Shanghai Bell
6. R1-2100707 Editorial CR on Rel-16 NR positioning LG Electronics
7. R1-2101731 Corrections to positioning SRS and higher layer parameters Huawei, HiSilicon
8. R1-2101758 Maintenance of NR positioning support Ericsson
9. R1-2100005 LS on Rel-16 NR Positioning Correction RAN3, Huawei
10. R1-2101835 Feature Leads Summary for NR Positioning Maintenance – AI 7.2.8, Moderator (Intel Corporation), CATT, Ericsson, Qualcomm