**3GPP TSG RAN WG1 #106e R1-210zzzz**

**e-Meeting, August 16th – 27th, 2021**

**Source: Moderator (Intel Corporation)**

**Title: Summary of the preparation phase 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#106e meeting.

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]-[9].

## Aspect #1: Replacement of Cell Terminology

In [1], it is proposed to change the terminology “cell” in the descriptions of the higher layer parameters *NR-DL-PRS-SFN0-Offset* and *dl-PRS-QCL-Info* as shown below:

* In *NR-DL-PRS-SFN0-Offset*, the “transmitting cell” is changed to “DL PRS resource set”, and the “reference cell” is chagned to “reference indicated by *nr-DL-PRS-ReferenceInfo*”.
* In *dl-PRS-QCL-Info*, “a non-serving cell” is changed to “not from any serving cell”.

The corresponding TP is provided below:

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| **TS 38.214**  5.1.6.5 PRS reception procedure  ========================= Unchanged parts =========================  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:  ========================= Unchanged parts =========================  *- NR-DL-PRS-SFN0-Offset* defines the time offset of the SFN0 slot 0 for the DL PRS resource set with respect to SFN0 slot 0 of reference provided by *nr-DL-PRS-ReferenceInfo*.  ========================= Unchanged parts =========================  A DL PRS resource is defined by:  ========================= Unchanged parts =========================  *- dl-PRS-QCL-Info* defines any quasi co-location information of the DL PRS resource with other reference signals. The DL PRS may be configured with QCL 'typeD' with a DL PRS either from a serving cell or not from any serving cell, or with *rs-Type* set to 'typeC', 'typeD', or 'typeC-plus-typeD' with a SS/PBCH Block from a serving or non-serving cell.  ========================= Unchanged parts ========================= |

In [7], the similar change was proposed, for the description of ‘cell’ in section 5.1.6.5 in TS38.214, it is suggested to use the unified description just like ‘TRP’ in the specification, e.g., ‘*dl-PRS-ID*’ as provided in TP below:

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| **TS 38.214 (clause 5.1.6.5)**  < Unchanged parts are omitted >  *NR-DL-PRS-SFN0-Offset* defines the time offset of the SFN0 slot 0 for ~~the transmitting cell~~ each *dl-PRS-ID* with respect to SFN0 slot 0 of the reference indicated by *dl-PRS-ID* in higher layer parameter *nr-DL-PRS-ReferenceInfo*~~reference cell~~.  < Unchanged parts are omitted > |

**FL response:**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #2: DL PRS Antenna Ports + Editorial SRS Corrections

In [3], it is noticed that in TS 38.211, the antenna ports description lacks that for DL PRS, particularly for the cases when (slot-level) repetition is configured, whereas the DM-RS have the dedicated restriction for the same port “in the same slot”. Therefore, 1) the description for PRS antenna ports is added and 2) some editorial corrections to the SRS are provided as shown below:

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| 4.4.1 Antenna ports  ========================= Unchanged parts =========================  For DM-RS associated with a PBCH, the channel over which a PBCH symbol on one antenna port is conveyed can be inferred from the channel over which a DM-RS symbol on the same antenna port is conveyed only if the two symbols are within a SS/PBCH block transmitted within the same slot, and with the same block index according to clause 7.4.3.1.  For PRS, the channel over which a PRS symbol on one antenna port is conveyed can be inferred from the channel over which a PRS symbol on the same antenna port is conveyed only if the two symbols are within a DL PRS resource within the same slot.  Two antenna ports are said to be quasi co-located if the large-scale properties of the channel over which a symbol on one antenna port is conveyed can be inferred from the channel over which a symbol on the other antenna port is conveyed. The large-scale properties include one or more of delay spread, Doppler spread, Doppler shift, average gain, average delay, and spatial Rx parameters.  ========================= Unchanged parts =========================  6.4.1.4.2 Sequence generation  ========================= Unchanged parts =========================  The sequence group and the sequence number  in clause 5.2.2 depends on the higher-layer parameter *groupOrSequenceHopping* in the *SRS-Resource* IE or the *SRS-PosResource* IE*.* The SRS sequence identity  is given by the higher layer parameter *sequenceId* in the *SRS-Resource* IE, in which case , or the *SRS-PosResource* IE, in which case . The quantity is the OFDM symbol number within the SRS resource.  ========================= Unchanged parts =========================  6.4.1.4.4 Sounding reference signal slot configuration  For an SRS resource configured as periodic or semi-persistent by the higher-layer parameter *resourceType*, a periodicity  (in slots) and slot offset  are configured according to the higher-layer parameter *periodicityAndOffset-p* or *periodicityAndOffset-sp* in the *SRS-Resource* IE, or in the *SRS-PosResource* IE. Candidate slots in which the configured SRS resource may be used for SRS transmission are the slots satisfying    SRS is transmitted as described in clause 11.1 of [5, TS 38.213].  ========================= Unchanged parts ========================= |

**FL response:**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #3: Expected RSTD and RSTD Uncertainty

In [4], it is stated that according to the field descriptions in TS 37.355, *nr-DL-PRS-ExpectedRSTD* indicates the RSTD value that the target device is expected to measure between one TRP and the assistance data reference TRP. Therefore, the proposed correction aims to clarify that *nr-DL-PRS-ExpectedRSTD* and *nr-ExpectedRSTD-Uncertainty* are defined per pair of TRPs rather than per pair of DL PRS resource sets.

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| ---- Unchanged texts omitted ----  5.1.6.5 PRS reception procedure  <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 in a positioning frequency layer, is calculated by  *-* Type 1 duration calculation with UE symbol level buffering capability  *-* Type 2 duration calculation with UE slot level buffering capability  *- S* is the set of slots based on the numerology of the DL PRS of a serving cell within the *P* msec window in the positioning frequency layer that contains potential DL PRS resources considering the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of the associated *dl-PRS-ID* of the DL PRS and the reference provided by *nr-DL-PRS-ReferenceInfo*.  *-* For Type 1, is the smallest interval in msec within slot corresponding to an integer number of OFDM symbols based on the numerology of the DL PRS of a serving cell that covers the union of the potential PRS symbols and determines the PRS symbol occupancy within slot , where the interval considers the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of the associated *dl-PRS-ID* of the DL PRS and the reference provided by *nr-DL-PRS-ReferenceInfo*.  *-* For Type 2, is the numerology of the DL PRS, and is the cardinality of the set .  ---- Unchanged texts omitted ---- |

**FL response:**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #4: DL PRS Reference Resources

In [5], it is noticed that, when network indicates a reference, it may optionally select a DL PRS Resource ID, a subset of DL PRS Resource IDs or a DL PRS Resource set. None of the three items is mandatory. However, the description in section 5.1.6.5 of TS 38.214 seems that the DL PRS Resource set ID should always be indicated. In addition, UE is allowed to use a single different DL PRS Resource to determine the reference. This option is missed in the spec, as only ‘different DL PRS resources’ is mentioned in section 5.1.6.5 of TS 38.214.

The following TP is proposed to address the raised aspect.

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| 5.1.6.5 PRS reception procedure  ===================== Unchanged parts =====================  The UE may be indicated by the network that 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 *nr-DL-PRS-ReferenceInfo*. The reference 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* and *nr-DL-PRS-ExpectedRSTD-Uncerainty*. The UE expects the reference to be indicated whenever it is expected to receive the DL PRS. This reference provided by *nr-DL-PRS-ReferenceInfo* may include a *dl-PRS-ID*, and optionally a DL PRS resource set ID, a single DL PRS resource ID or a list of DL PRS resource IDs [17, TS 37.355]. The UE may use different DL PRS resource(s) 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 *dl-PRS-ID*, the DL PRS resource ID(s) or the DL PRS resource set ID used to determine the reference.  ===================== Unchanged parts ===================== |

**FL response:**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #5: UE Rx-Tx time difference measurements from different DL PRS resources

In [8], it is noticed that the UE may be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference 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. The UE capability provides additional details which are not present in the 38.214 specs.

The following TP was provided to clarify that the UE may be configured to measure and report, subject to UE capability, up to 4 UE Rx-Tx time difference measurements from different DL PRS resources configured with the same dl-PRS-ID, in the same positioning frequency layer:

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| ---- Unchanged texts omitted ----  5.1.6.5 PRS reception procedure  <Unchanged parts are 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 from different DL PRS resources configured with the same dl-PRS-ID, in 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 texts omitted ---- |

**FL response**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #6: Alignment with RAN4 on DL PRS Processing

In [7], it is noticed that based on current TS 38.133, 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*.

It is proposed to adopt one of the following options and related text proposals into TS38.214 regarding PRS processing capability.

***Option 1:*** ***change the descriptions related to ‘P msec window’ to align with RAN4 specification***.

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| < 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 in a positioning frequency layer~~ described in Clause 9.9.2.5 [11, TS 38.133], is calculated by…  < Unchanged parts are omitted > |

***Option 2:*** ***delete the descriptions related to ‘P msec window’.***

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| < 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 in a positioning frequency layer~~, is calculated by…  < Unchanged parts are omitted > |

In [9], the following changes were proposed to align with RAN4 specification on DL PRS processing:

* Evaluation window of P should no longer be corresponding to the maximum PRS periodicity, and the simplest way is to cite the RAN4 terminology .
* Duration calculation equation, the counted PRS slot/symbol should be mapping to those PRS that are neither muted nor outside the MG. From RAN1 perspective, those PRS could be referred to as “PRS to process”, as UE is not expected to process those PRS outside the MG or muted.
* Change the wording “For the purpose of DL PRS processing capability” since it may sometimes be interpreted inaccurately. The suggested wording can be “For the purpose of DL PRS processing”.

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| =========================== Unchanged parts ===========================  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, the duration *K* msec of DL PRS symbols within *P* msec window corresponding to as defined in clause 9.9 of [11, TS 38.133] in positioning frequency layer , is calculated by  *-* Type 1 duration calculation with UE symbol level buffering capability  *-* Type 2 duration calculation with UE slot level buffering capability  *- S* is the set of slots based on the numerology of the DL PRS of a serving cell within the *P* msec window in the positioning frequency layer that contains potential DL PRS resources to process considering the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets.  *-* For Type 1, is the smallest interval in msec within slot corresponding to an integer number of OFDM symbols based on the numerology of the DL PRS of a serving cell that covers the union of the potential PRS symbols to process and determines the PRS symbol occupancy within slot , where the interval considers the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS resource sets (target and reference).  *-* For Type 2, is the numerology of the DL PRS, and is the cardinality of the set .  =========================== Unchanged parts =========================== |

**FL response**

* It is proposed to discuss and decide whether/how to clarify this aspect

## Aspect #7: Section re-arrangement in TS 38.214

In [2], [6] it is noticed that “current arrangement of DL PRS reception procedure and positioning SRS transmission procedure in the clauses for PDSCH/PUSCH related procedures in TS 38.214 is not proper” due to the following reasons:

* DL PRS reception procedure is NOT related to PDSCH Rx procedure at all.
* SRS for positioning Tx procedure is NOT related to PUSCH Tx procedure at all.
* SRS for MIMO used for positioning is transparent to the UE.

It is proposed to address the discussed aspect by the following TP implementing proposed changes below:

* A new clause for positioning related procedures separated from PDSCH/PUSCH is created. The content from clauses 5.1.6.5 and 6.2.1.4 is transferred to the new clause, with two new sub-clauses.
* Create sub-sub-clauses for DL PRS related procedures, including assistance data, DL PRS measurement reporting, DL PRS processing capability
* Move three paragraphs in 6.2.1 that are only related to positioning SRS procedures in the new subclause for SRS for positioning related procedures

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| ============================== Unchanged parts ==============================  5.1.6 UE procedure for receiving reference signals  ============================== Unchanged parts ==============================  5.1.6.5 Void  ============================== Unchanged parts ==============================  6.2.1 UE sounding procedure  ============================== Unchanged parts ==============================  ============================== Unchanged parts ==============================  6.2.1.4 Void  ============================== Unchanged parts ==============================  X Positioning related procedures  X.1 DL PRS related procedures  X.1.1 Assistance data  The UE can be configured with one or more DL PRS resource set configuration(s) as indicated by the higher layer parameters *NR-DL-PRS-ResourceSet* and *NR-DL-PRS-Resource* as defined by Clause 6.4.3 [17, TS 37.355]. Each DL PRS resource set consists of K≥1 DL PRS resource(s) where each has an associated spatial transmission filter. The UE can be configured with one or more DL PRS positioning frequency layer configuration(s) as indicated by the higher layer parameter *NR-DL-PRS-PositioningFrequencyLayer.* A DL PRS positioning frequency layer is defined as a collection of DL PRS resource sets which have common parameters configured by *NR-DL-PRS-PositioningFrequencyLayer*.  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:  *- 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.  *- dl-PRS-CyclicPrefix* defines the cyclic prefix 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-CyclicPrefix.* The supported values of *dl-PRS-CyclicPrefix* are given in Table 4.2-1 of [4, TS38.211].  *- dl-PRS-PointA* defines the absolute frequency of the reference resource block. Its lowest subcarrier is also known as Point A. All DL PRS resources belonging to the same DL PRS resource set have common Point A and all DL PRS resources sets belonging to the same DL PRS positioning frequency layer have a common Point A.  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. The UE expects that one of these *dl-PRS-ID* along with a *nr-DL-PRS-ResourceSetID* and a *nr-DL-PRS-ResourceID-r16* can be used to uniquely identify a DL PRS resource.  The UE may be configured by the network with *nr-PhysCellID*, *nr-CellGlobalID*, and *nr-ARFCN* [17, TS 37.355] associated with a *dl-PRS-ID*.  - If *nr-PhysCellID* or *nr-CellGlobalID* is provided, and if *nr-PhysCellID*, *nr-CellGlobalID* and *nr-ARFCN* associated with the *dl-PRS-ID*, if provided, are the same as the corresponding information of a serving cell, the UE may assume that the DL PRS is transmitted from the serving cell;  - Otherwise, the UE may assume that the DL PRS is not transmitted from a serving cell.  If the UE assumes that the DL PRS is transmitted from a serving cell, and if the serving cell is the same as the serving cell defined by the SS/PBCH block, the UE may assume that the DL PRS and the SS/PBCH block are transmitted from the same serving cell.  If the UE assumes that the DL PRS is not transmitted from a serving cell, and if *nr-PhysCellID* is provided, and is the same as physical cell ID of the SS/PBCH block from a non-serving cell of the same band as the DL PRS, the UE may assume that the DL PRS and the SS/PBCH block are transmitted from the same non-serving cell.  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 DL PRS resource periodicity , the higher layer parameter *dl-prs-MutingBitRepetitionFactor* and the size of the bitmap of *dl-PRS-MutingOption1* exceeds , where for *dl-PRS-SubcarrierSpacing*=15, 30, 60 and 120 kHz respectively.  *- dl-PRS-ResourceRepetitionFactor* defines how many times each DL-PRS resource is repeated for a single instance of the DL-PRS resource set and takes values . All the DL PRS resources within one resource set have the same resource repetition factor.  *- dl-PRS-ResourceTimeGap* defines the offset in number of slots between two repeated instances of a DL PRS resource with the same *nr-DL-PRS-ResourceSetId* within a single instance of the DL PRS resource set. The UE only expects to be configured with *dl-PRS-ResourceTimeGap* if *dl-PRS-ResourceRepetitionFactor* is configured with value greater than 1. The time duration spanned by one instance of a *nr-DL-PRS-ResourceSet* is not expected to exceed the configured value of DL PRS periodicity. All the DL PRS resources within one resource set have the same value of *dl-PRS-ResourceTimeGap.*  *- dl-PRS-MutingOption1* and *dl-PRS-MutingOption2* define the time locations where the DL PRS resource is expected to not be transmitted for a DL PRS resource set. If *dl-PRS-MutingOption1* is configured, each bit in the bitmap of *dl-PRS-MutingOption1* corresponds to a configurable number provided by higher layer parameter *dl-prs-MutingBitRepetitionFactor* of consecutive instances of a DL PRS resource set where all the DL PRS resources within the set are muted for the instance that is indicated to be muted. The length of the bitmap can be {2, 4, 6, 8, 16, 32} bits. If *dl-PRS-MutingOption2* is configured each bit in the bitmap of *dl-PRS-MutingOption2* corresponds to a single repetition index for each of the DL PRS resources within each instance of a *nr-DL-PRS-ResourceSet* and the length of the bitmap is equal to the values of *dl-PRS-ResourceRepetitionFactor*. Both *dl-PRS-MutingOption1* and *dl-PRS-MutingOption2* may be configured at the same time in which case the logical AND operation is applied to the bit maps as described in Clause 7.4.1.7.4 of [4, TS 38.211].  *- NR-DL-PRS-SFN0-Offset* defines the time offset of the SFN0 slot 0 for the transmitting cell with respect to SFN0 slot 0 of reference cell.  *- dl-PRS-ResourceList* determines the DL PRS resources that are contained within one DL PRS resource set.  *- dl-PRS-CombSizeN* defines the comb size of a DL PRS resource where the allowable values are given in Clause 7.4.1.7.3 of [TS38.211]. All DL PRS resource sets belonging to the same positioning frequency layer have the same value of *dl-PRS-CombSizeN*.  *- dl-PRS-ResourceBandwidth* defines the number of resource blocks configured for DL PRS transmission. The parameter has a granularity of 4 PRBs with a minimum of 24 PRBs and a maximum of 272 PRBs. All DL PRS resources sets within a positioning frequency layer have the same value of *dl-PRS-ResourceBandwidth*.  *- dl-PRS-StartPRB* defines the starting PRB index of the DL PRS resource with respect to reference Point A, where reference Point A is given by the higher-layer parameter *dl-PRS-PointA*. The starting PRB index has a granularity of one PRB with a minimum value of 0 and a maximum value of 2176 PRBs. All DL PRS resource sets belonging to the same positioning frequency layer have the same value of *dl-PRS-StartPRB*.  *- dl-PRS-NumSymbols* defines the number of symbols of the DL PRS resource within a slot where the allowable values are given in Clause 7.4.1.7.3 of [4, TS38.211].  A DL PRS resource is defined by:  *- nr-DL-PRS-ResourceID* determines the DL PRS resource configuration identity. All DL PRS resource IDs are locally defined within a DL PRS resource set.  *- dl-PRS-SequenceID* is used to initialize cinit value used in pseudo random generator as described in Clause 7.4.1.7.2 of [4, TS 38.211] for generation of DL PRS sequence for a given DL PRS resource.  *- dl-PRS-CombSizeN-AndReOffset* defines the starting RE offset of the first symbol within a DL PRS resource in frequency. The relative RE offsets of the remaining symbols within a DL PRS resource are defined based on the initial offset and the rule described in Clause 7.4.1.7.3 of [4, TS 38.211].  *- dl-PRS-ResourceSlotOffset* determines the starting slot of the DL PRS resource with respect to corresponding DL PRS resource set slot offset.  *- dl-PRS-ResourceSymbolOffset* determines the starting symbol of a slot configured with the DL PRS resource.  *- dl-PRS-QCL-Info* defines any quasi co-location information of the DL PRS resource with other reference signals. The DL PRS may be configured with QCL 'typeD' with a DL PRS from a serving cell or a non-serving cell, or with *rs-Type* set to 'typeC', 'typeD', or 'typeC-plus-typeD' with a SS/PBCH Block from a serving or non-serving cell.  X.1.2 DL PRS measurement reporting  The UE assumes constant EPRE is used for all REs of a given DL PRS resource.  The UE may be indicated by the network that 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 *nr-DL-PRS-ReferenceInfo*. The reference 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* and *nr-DL-PRS-ExpectedRSTD-Uncerainty*. The UE expects the reference to be indicated whenever it is expected to receive the DL PRS. This reference provided by *nr-DL-PRS-ReferenceInfo* may include a *dl-PRS-ID*, a DL PRS resource set ID, and optionally a single DL PRS resource ID or a list of DL PRS resource IDs [17, TS 37.355]. 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 *dl-PRS-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 *NR-TimingQuality* corresponding to the DL RSTD and UE Rx-Tx time difference measurements which include the following fields:  *- timingQualityValue* which provides the best estimate of the uncertainty of the measurement  *- timingQualityResolution* which specifies the resolution levels used in the *timingQualityValue* field.  The UE expects to be configured with higher layer parameter *nr-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 *nr-DL-PRS-ExpectedRSTD-Uncertainty*, which defines a search window around the *nr-DL-PRS-ExpectedRSTD*.  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.  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*.  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].  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 *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 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.  The UE may be configured to measure and report, subject to UE capability, the timing and the quality metrics of up to 2 additional detected paths that are associated with each RSTD or UE Rx – Tx time difference. The timing of each additional path is reported relative to the path timing used for determining *nr-RSTD* or *nr-UE-RxTxTimeDiff*.  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 associated with the same *dl-PRS-ID*. If *DL-PRS-QCL-Info* is configured to the UE with *qcl-Type* set to 'type-D' with a source DL PRS resource then the *nr-DL-PRS-ResourceSetId* and the *nr-DL-PRS-ResourceId* of the source DL PRS resource are expected to be indicated to the UE.  UE is not expected to process DL PRS without configuration of measurement gap.  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:  - Up to 64 *NR-SelectedDL-PRS-IndexPerTRP* of the frequency layer are sorted according to priority if *nr-SelectedDL-PRS-IndexListPerFreq* is provided, or up to 64 *NR-DL-PRS-AssistanceDataPerTRP* of the frequency layer are sorted according to priority otherwise;  - Up to 2 *DL-SelectedPRS-ResourceSetIndex* per *dl-PRS-ID* of the frequency layer are sorted according to priority if *dl-SelectedPRS-ResourceSetIndexList* is provided, or up to 2 *NR-DL-PRS-ResourceSet* per *dl-PRS-ID* of the frequency layer are sorted according to priority otherwise.  X.1.3 DL PRS processing capability  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 in a positioning frequency layer, is calculated by  *-* Type 1 duration calculation with UE symbol level buffering capability  *-* Type 2 duration calculation with UE slot level buffering capability  *- S* is the set of slots based on the numerology of the DL PRS of a serving cell within the *P* msec window in the positioning frequency layer that contains potential DL PRS resources considering the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS Resource Sets.  *-* For Type 1, is the smallest interval in msec within slot corresponding to an integer number of OFDM symbols based on the numerology of the DL PRS of a serving cell that covers the union of the potential PRS symbols and determines the PRS symbol occupancy within slot , where the interval considers the actual *nr-DL-PRS-ExpectedRSTD*, *nr-DL-PRS-ExpectedRSTD-Uncertainty* provided for each pair of DL PRS resource sets (target and reference).  *-* For Type 2, is the numerology of the DL PRS, and is the cardinality of the set .  X.2 SRS for positioning related procedures  When the SRS is configured by the higher layer parameter *SRS-PosResource* and if the higher layer parameter *spatialRelationInfoPos* is configured*,* it contains the ID of the configuration fields of a reference RS according to Clause 6.3.2 of [TS 38.331]. The reference RS can be an SRS configured by the higher layer parameter *SRS-Resource* or *SRS-PosResource*, CSI-RS, SS/PBCH block, or a DL PRS configured on a serving cell or a SS/PBCH block or a DL PRS configured on a non-serving cell.  The UE is not expected to transmit multiple SRS resources with different spatial relations in the same OFDM symbol.  If the UE is not configured with the higher layer parameter *spatialRelationInfoPos* the UE may use a fixed spatial domain transmission filter for transmissions of the SRS configured by the higher layer parameter *SRS-PosResource* across multiple SRS resources or it may use a different spatial domain transmission filter across multiple SRS resources.  The UE is only expected to transmit an SRS configured by the higher layer parameter *SRS-PosResource* within the active UL BWP of the UE.  When the configuration of SRS is done by the higher layer parameter *SRS-PosResource*, the UE can only be provided with a single RS source in *spatialRelationInfoPos* per SRS resource for positioning.  For operation on the same carrier, if an SRS configured by the higher parameter *SRS-PosResource* collides with a scheduled PUSCH, the SRS is dropped in the symbols where the collision occurs.  For operations in the same carrier, the UE is not expected to be configured on overlapping symbols with more than one SRS resources configured by the higher layer parameter *SRS-PosResource* with *resourceType* of the SRS resources as 'periodic'.  For operations in the same carrier, the UE is not expected to be activated or triggered to transmit SRS on overlapping symbols with more than one SRS resources configured by the higher layer parameter *SRS-PosResource* with *resourceType* of the SRS resources as 'semi-persistent' or 'aperiodic'.  For intra-band and inter-band CA operations, a UE can simultaneously transmit more than one SRS resource configured by *SRS-PosResource* on different CCs, subject to UE's capability.  The UE does not expect to be configured with *SRS-PosResource* on a carrier of a serving cell with slot formats comprised of DL and UL symbols, not configured for PUSCH/PUCCH transmission.  ============================== Unchanged parts ============================== |

**FL response**

* It is proposed to discuss and decide how to proceed on section re-arrangement

# Proposal for E-Mail Discussion

## Round - 1

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: Replacement of Cell Terminology

Aspect #2: DL PRS Antenna Ports + Editorial SRS Corrections

Aspect #3: Expected RSTD and RSTD Uncertainty

Aspect #4: DL PRS reference resources

Aspect #5: UE Rx-Tx time difference measurements from different DL PRS resources

Aspect #6: Alignment with RAN4 on DL PRS Processing

Aspect #7: Section re-arrangement in TS 38.214

Companies are invited to provide comments in table below

|  |  |
| --- | --- |
| Company Name | Comments |
| CATT | Support the FL proposal on the email discussion of these issues. |
| Huawei, HiSilicon | Support. |
| ZTE | Support FL’s arrangement. |
| Nokia/NSB | We don’t support discussing Aspect #4 or aspect #7 for the following reasons:   * On Aspect #4: The resource set ID is always needed in order to uniquely define the DL PRS resources, so the change is technically incorrect and not needed in our view. * On Aspect #7: There is no technical concern addressed by the proposed change and this is not an essential correction. Therefore, it is not appropriate to discuss at this time. |
| OPPO | On Aspect #2: We do not agree with the proposed change with “within the same slot” because the repetition of PRS resource is used to repeat the same Tx beam so that the UE can either combine multiple repetitions or apply Rx beam sweeping on same PRS resources.  On Aspect #7: share similar understanding as Nokia/NSB, there seems to be no technical reason to change the Spec by so much. The current specification does not have confusion. So, we prefer not to discuss it. |
| Qualcomm | We don’t support Aspect #3, #4, #5 and Aspect #7.   * For Aspect #3: The specifications need to be read jointly and not just by looking at each one individually. If already in 37.355 is clear that the expectedRSTD is for a TRP, then it means it is for all the resources/sets of that TRP; there is no other option to interpret the spec, nor a confusion. No clarification or confusion is solved by discussing this topic. * For Aspect #5: Same reasoning as in #3. One can read in 37.355 that the 4 additional measurements are only associated with a new resource ID/set-ID, and are associated with the same PRS-ID included in the NR-Multi-RTT-MeasElement-r16. The spec is clear.   NR-Multi-RTT-MeasElement-r16 ::= SEQUENCE {  dl-PRS-ID-r16 INTEGER (0..255),  …  nr-Multi-RTT-AdditionalMeasurements-r16  NR-Multi-RTT-AdditionalMeasurements-r16 OPTIONAL,  ...  }  NR-Multi-RTT-AdditionalMeasurements-r16 ::= SEQUENCE (SIZE (1..3)) OF  NR-Multi-RTT-AdditionalMeasurementElement-r16  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-UE-RxTxTimeDiffAdditional-r16 CHOICE {  k0-r16 INTEGER (0..8191),  k1-r16 INTEGER (0..4095),  k2-r16 INTEGER (0..2047),  k3-r16 INTEGER (0..1023),  k4-r16 INTEGER (0..511),  k5-r16 INTEGER (0..255),  ...  },  }  For the remaining 2 aspects, similar reasoning with Nokia. |
| Ericsson | OK to discuss all aspects beside 2 and 7. In our view, aspect 2 is not correct (same channel can be experienced over multiple repetition instances/slots of the PRS). Aspect 7 is a structural change of the spec, which should be up to the editor. |
| Apple | We share same view as Nokia/NSB on aspects 4 & 7, and with Quaalcomm on aspects 3 & 5. |
| Huawei, HiSilicon2 | Regarding aspect#2, based on the comment from OPPO and Ericsson, for repetition in different slots, the major concern is about phase discontinuity across slots at both transmitter side and receiver side, which prevents the receiver from using coherent combining (e.g. using the Rx sequence longer than a slot to do the cross-correlation, if correlation method is used). Similar issue was discussed in Rel-16 when investigating whether SRS slot-level repetition should be adopted. It should not harm beam training using repetition even if the antenna port (the strictest sense of channel coherency) may be assumed the same, e.g. BM CSI-RS with repetition ON.  Regarding aspect#7, we would like to remind the group that we are one RAN meeting cycle away from the Rel-17 Cat.B CR. Clearly NR positioning is going to have higher degree of abundance in terms of features. Even if this is left up to the editor, we think that it should be useful to also remind the editor that the following issues exist in the current arrangement:   * DL PRS reception procedure is NOT related to PDSCH Rx procedure at all. * SRS for positioning Tx procedure is NOT related to PUSCH Tx procedure at all.   A better specification is not only the responsibility of the specification editor, but also of all the delegates. |
| CATT | To Nokia/NSB, Qualcomm and Apple, for Aspect#4, in RAN1#96bis meeting, the reference determination for RSTD measurements has been agreed 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   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   According to the agreements, when network indicates a reference, it may optionally select a DL PRS Resource ID, a subset of DL PRS Resource IDs or a DL PRS Resource set. None of the three items is mandatory. However, the description in section 5.1.6.5 of TS 38.214 seems that the DL PRS Resource set ID should always be indicated.  Moreover, as shown in the following descriptions in TS37.355 (section 6.4.3), the DL PRS resource set ID is also optional.   |  | | --- | | –*DL-PRS-ID-Info* The IE *DL-PRS-ID-Info* provides the IDs of the reference TRPs' DL-PRS Resources.  -- ASN1START  DL-PRS-ID-Info-r16 ::= SEQUENCE {  dl-PRS-ID-r16 INTEGER (0..255),  nr-DL-PRS-ResourceID-List-r16 SEQUENCE (SIZE (1..nrMaxResourceIDs-r16)) OF  NR-DL-PRS-ResourceID-r16 OPTIONAL,  nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL  }  -- ASN1STOP |     In addition, UE is allowed to use a single different DL PRS Resource to determine the reference. This option is missed in the spec, as only ‘different DL PRS resources’ is mentioned in section 5.1.6.5 of TS 38.214.  Based on the above reasons, we believe that current descriptions in specs are not correct and the Aspect#4 is an essential correction and should be discussed in this meeting. |
| ZTE | To Qualcomm and Apple on Aspect#3,  We agree with you that ExpectedRSTD is for all the resources/sets of that TRP. However, it’s obvious that current descriptions in TS 38.214 wrongly interpret the definition in TS 37.355. Why not just fix it to avoid confusion when reading the spec?  It’s fair to discuss this issue since most companies show their preferences. |
| vivo | We don’t see the need to discuss aspect#5 and #7.  The exact same issue of aspect#5 has been brought up and discussed in RAN1#105-e with no consensus to adopt the proposed TP. We don’t support to repeat the discussion in this meeting.  On aspect#7, we share the understanding that the proposed changes are mainly up to editor as we don’t see any serious technical issue of current specification. |

## Round - 2

Based on expressed views and discussion in Round-1, the following is observed:

* Aspect #1: Replacement of Cell Terminology
  + It seems there is a consensus to discuss it further over e-mail based on TPs in [1] and [7]
* Aspect #2: DL PRS Antenna Ports + Editorial SRS Corrections
  + Two companies do not support further discussion. Suggestion is to discuss how to deal with phase discontinuity across slots at transmitter side (receiver side seems not necessary to discuss).
* Aspect #3: Expected RSTD and RSTD Uncertainty
  + Two companies do not support further discussion. Considering that DL PRS Resource Set is associated with TRP and that TS 37.355 provides clear description the raised aspect does not seem to be a critical correction.
* Aspect #4: DL PRS reference resources
  + Three companies do not support further discussion. The reason is that resource set ID is always needed to uniquely define the DL PRS resource(s).
* Aspect #5: UE Rx-Tx time difference measurements from different DL PRS resources
  + Three companies do not support further discussion. The TP was already discussed at RAN1#105e without consensus reached as captured in R1-2106020.
* Aspect #6: Alignment with RAN4 on DL PRS Processing
  + It seems there is a consensus to discuss it further over e-mail based on TPs provided in [7] and [9].
* Aspect #7: Section re-arrangement in TS 38.214
  + Six companies do not support discussion. Companies do not see technical issue and view it as a structural change which can be left up to editor.

**Proposal**

Considering the provided input, it is recommended to

* + Approve discussions for the following two aspects:
    - Aspect #1: Replacement of Cell Terminology
    - Aspect #6: Alignment with RAN4 on DL PRS Processing
  + Further analyze whether/how to deal with potential phase discontinuity of DL PRS transmission for Aspect 2 till the next meeting
  + Regarding aspect #7, it seems there is no consensus to approve discussion right away, but some companies may consider leaving it up to the editor. Therefore, it is recommended to follow the chair guidance on how to proceed further

Companies are invited to provide further comments for above proposal in table below

|  |  |
| --- | --- |
| Company Name | Comments |
| Huawei, HiSilicon | From our side, we think at least Aspect#2 should be discussed. No discussion at this meeting would result in no progress on the understanding of this issue at all, which means the same situation will exist in the next meeting.  Whether and how to change the spec should be a separate issue, and should be decided upon the outcome of the discussion. |
| CATT | We have different opinions on Aspect #4.  We still believe that Aspect#4 should be discussed in this meeting. In our point of view, the reason from three companies as follows is not reasonable and lack of evidence.   |  | | --- | | * *Aspect #4: DL PRS reference resources*   + *Three companies do not support further discussion. The reason is that resource set ID is always needed to uniquely define the DL PRS resource(s).* |   We had explained the reason why the DL-PRS resource ID is not mandatory and should be optional according to RAN1 previous agreements or TS 37.355. We would like to clarify them below:  In RAN1#96bis meeting, the reference determination for RSTD measurements has been agreed 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   According to the agreements, when network indicates a reference, it may optionally select a DL PRS Resource ID, a subset of DL PRS Resource IDs or a DL PRS Resource set. None of the three items is mandatory. However, the description in section 5.1.6.5 of TS 38.214 seems that the DL PRS Resource set ID should always be indicated.  Moreover, as shown in the following descriptions in TS37.355 (section 6.4.3), the DL PRS resource set ID is also optional.   |  | | --- | | –*DL-PRS-ID-Info* The IE *DL-PRS-ID-Info* provides the IDs of the reference TRPs' DL-PRS Resources.  -- ASN1START  DL-PRS-ID-Info-r16 ::= SEQUENCE {  dl-PRS-ID-r16 INTEGER (0..255),  nr-DL-PRS-ResourceID-List-r16 SEQUENCE (SIZE (1..nrMaxResourceIDs-r16)) OF  NR-DL-PRS-ResourceID-r16 OPTIONAL,  nr-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16 OPTIONAL  }  -- ASN1STOP |     Based on above analysis, we believe that current descriptions in specs are not correct and the Aspect#4 is an essential correction and should be discussed in this meeting. |
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## Round - 3

Based on additional discussion over the RAN1 e-mail reflector, the following proposal was finally made to conclude the e-mail thread “[106-e-Prep-7.2.8] Preparation phase - Email discussion on Rel.16 NR Positioning”

**Proposal**

* + Approve discussions for the following aspects:
    - Aspect #1: Replacement of Cell Terminology
    - Aspect #2: DL PRS Antenna Ports + Editorial SRS Corrections
    - Aspect #3: Expected RSTD and RSTD Uncertainty per TRP pair
    - Aspect #4: Optional content in nr-DL-PRS-ReferenceInfo
      * Potential revision in the following sentence “This reference provided by nr-DL-PRS-ReferenceInfo may include a dl-PRS-ID, and optionally a DL PRS resource set ID, a single DL PRS resource ID or a list of DL PRS resource IDs [17, TS 37.355].” to align it with signaling in TS 37.355.
    - Aspect #6: Alignment with RAN4 on DL PRS Processing
  + Regarding aspect #7, it seems there is no consensus to approve discussion right away, but some companies may consider leaving it up to the editor. Therefore, it is recommended to follow the chair guidance on how to proceed further

# Conclusions

As an outcome of preparation phase, it was agreed to organize the following two e-mail discussions:

# References

1. R1-2106448 Draft CR on terminology correction to cell for positioning Huawei, HiSilicon
2. R1-2106503 Discussion on clauses for positioning procedures in TS 38.214 Huawei, HiSilicon
3. R1-2106504 Draft CR on PRS antenna ports Huawei, HiSilicon
4. R1-2106540 Interpretation of expected RSTD and expected RSTD uncertainty ZTE
5. R1-2106994 Draft CR on PRS reception procedure in NR positioning CATTI
6. R1-2107682 Correction on clauses for positioning procedures in TS 38.214 Huawei, HiSilicon
7. R1-2107991 Maintenance on Rel-16 NR positioning vivo
8. R1-2108163 Maintenance on Rel-16 NR positioning Ericsson
9. R1-2108189 Aligning PRS duration calculation with RAN4 Huawei, HiSilicon