**3GPP TSG-RAN WG1 Meeting #114 *R1-23xxxxx***

**Toulouse, France, August 21 – 25, 2023**

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| *CR-Form-v12.2* | | | | | | | | |
| **DRAFT CHANGE REQUEST** | | | | | | | | |
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|  | **38.214** | **CR** | **-** | **Rev** | **-** | **Current version:** | **17.6.0** |  |
|  | | | | | | | | |
| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **X** | Radio Access Network | **X** | Core Network |  |

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| ***Title:*** | Introduction of specification support for Expanded and Improved NR Positioning | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Source to WG:*** | Nokia | | | | | | | | | |
| ***Source to TSG:*** |  | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | NR\_pos\_enh2 | | | | |  | ***Date:*** | | | 2023-09-08 |
|  |  | | | |  | |  | | |  |
| ***Category:*** | **B** |  | | | | | ***Release:*** | | | Rel-18 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)* | |
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| ***Reason for change:*** | | Introduction of specification support for Expanded and Improved NR Positioning. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Summary of change:*** | | Introduction of specification support for Expanded and Improved NR Positioning. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Consequences if not approved:*** | | Specification does not support Expanded and Improved NR Positioning. | | | | | | | | |
|  | |  | | | | | | | | |
| ***Clauses affected:*** | | 2, 5.1.6.5, 6.2.1.4, 8, 8.1, 8.1.3.2, 8.2.4 (new), 8.2.4.1 (new), 8.2.4.1.1 (new), 8.2.4.1.2 (new), 8.2.4.2 (new), 8.2.4.X (new), 8.2.4.Y (new), 8.4.4 (new) | | | | | | | | |
|  | |  | | | | | | | | |
|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | | **X** |  | Other core specifications | | | | ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

<omitted text>

# 2 References

The following documents contain provisions which, through reference in this text, constitute provisions of the present document.

[1] 3GPP TR 21.905: "Vocabulary for 3GPP Specifications"

[2] 3GPP TS 38.201: " NR; Physical Layer – General Description"

[3] 3GPP TS 38.202: "NR; Services provided by the physical layer"

[4] 3GPP TS 38.211: "NR; Physical channels and modulation"

[5] 3GPP TS 38.212: "NR; Multiplexing and channel coding"

[6] 3GPP TS 38.213: "NR; Physical layer procedures for control"

[7] 3GPP TS 38.215: "NR; Physical layer measurements"

[8] 3GPP TS 38.101: "NR; User Equipment (UE) radio transmission and reception"

[9] 3GPP TS 38.104: "NR; Base Station (BS) radio transmission and reception"

[10] 3GPP TS 38.321: "NR; Medium Access Control (MAC) protocol specification"

[11] 3GPP TS 38.133: "NR; Requirements for support of radio resource management"

[12] 3GPP TS 38.331: "NR; Radio Resource Control (RRC); Protocol specification"

[13] 3GPP TS 38.306: "NR; User Equipment (UE) radio access capabilities"

[14] 3GPP TS 38.423: "NG-RAN; Xn Application Protocol (XnAP)"

[15] 3GPP TS 36.211: "Evolved Universal Terrestrial Radio Access (E-UTRA); Physical channels and modulation"

[16] 3GPP TS 37.213: "Physical layer procedures for shared spectrum channel access"

[17] 3GPP TS 37.355: "LTE Positioning Protocol (LPP)"

[18] 3GPP TS 38.822: "NR; User Equipment (UE) feature list"

<omitted text>

[20] 3GPP TS 38.305: "NG Radio Access Network (NG-RAN); Stage 2 functional specification of User Equipment (UE) positioning in NG-RAN"

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3.3 Abbreviations

For the purposes of the present document, the abbreviations given in TR 21.905 [1] and the following apply. An abbreviation defined in the present document takes precedence over the definition of the same abbreviation, if any, in TR 21.905 [1].

ARP Antenna reference point

BWP Bandwidth part

CBG Code block group

CLI Cross Link Interference

CP Cyclic prefix

CQI Channel quality indicator

CPU CSI processing unit

CRB Common resource block

CRC Cyclic redundancy check

CRI CSI-RS Resource Indicator

CSI Channel state information

CSI-RS Channel state information reference signal

CSI-RSRP CSI reference signal received power

CSI-RSRQ CSI reference signal received quality

CSI-SINR CSI signal-to-noise and interference ratio

CW Codeword

DCI Downlink control information

DL Downlink

DM-RS Demodulation reference signals

DRX Discontinuous Reception

EPRE Energy per resource element

IAB-MT Integrated Access and Backhaul – Mobile Terminal

L1-RSRP Layer 1 reference signal received power

LI Layer Indicator

MCS Modulation and coding scheme

PDCCH Physical downlink control channel

PDSCH Physical downlink shared channel

PSS Primary Synchronisation signal

PUCCH Physical uplink control channel

QCL Quasi co-location

PMI Precoding Matrix Indicator

PRB Physical resource block

PRG Precoding resource block group

PRS Positioning reference signal

PT-RS Phase-tracking reference signal

RB Resource block

RBG Resource block group

RI Rank Indicator

RIV Resource indicator value

RS Reference signal

SCI Sidelink control information

SL PRS Sidelink positioning reference signal

SLIV Start and length indicator value

SR Scheduling Request

SRS Sounding reference signal

SS Synchronisation signal

SSS Secondary Synchronisation signal

SS-RSRP SS reference signal received power

SS-RSRQ SS reference signal received quality

SS-SINR SS signal-to-noise and interference ratio

TB Transport Block

TCI Transmission Configuration Indicator

TDM Time division multiplexing

UE User equipment

UL Uplink

<omitted text>

#### 5.1.6.5 PRS reception procedure

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 DL PRS 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 values of 240kHz, 480 kHz, and 960 kHz.

*- 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-ResourceID* 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 DL PRS resource set with respect to SFN0 slot 0 of reference provided by *nr-DL-PRS-ReferenceInfo*.

*- 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 DL PRS 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 DL PRS 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 DL PRS 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 associated with the same *dl-PRS-ID*, or with *rs-Type* set to 'typeC', 'typeD', or 'typeC-plus-typeD' with a SS/PBCH Block from a serving or non-serving cell.

- *dl-PRS-ResourcePrioritySubset* defines a subset of DL-PRS resources for the DL PRS resource for the purpose of prioritization of measurement reporting as described in [17, TS 37.355].

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, DL PRS-RSRPP, 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-Uncertainty*. 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, or UE Rx-Tx time difference, respectively.

For the DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, and UE Rx-Tx time difference measurements the UE reports 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, the UE may request a measurement gap via higher layer parameter *NR-PRS-MeasurementInfoList* [12, TS 38.331] or as specified in clause 6.1.3.40 of [10, TS 38.321]. The UE may be preconfigured with one or more measurement gaps each associated with a *measPosPreConfigGapId*. When the UE requests activation or deactivation of a measurement gap as specified in clause 6.1.3.40 of [10, TS 38.321]it can request one of the preconfigured measurement gaps by referring to the *measPosPreConfigGapId*. The UE may have one of the preconfigured measurement gap(s) activated or deactivated as specified in clause 6.1.3.41 of [10, TS 38.321].

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*. If the UE is not configured to report with *multiMeasInSameReport-r17*, 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. If the UE is configured to report with *multiMeasInSameReport-r17*, the up to 4 measurements being performed on the same pair of *dl-PRS-ID* and all DL RSTD measurements in the same measurement instance of the same report use a single reference timing.

The UE may be configured to measure and report, subject to UE capability, up to 24 DL PRS-RSRP measurements on 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. When the UE reports DL PRS-RSRP measurements for a DL PRS resource, the reported multiple DL PRS-RSRP measurements associated with the same or different higher layer parameter *nr-DL-PRS-RxBeamIndex* may have the same or different timestamps.

The UE may be configured to measure and optionally report, subject to UE capability, up to 24 DL PRS-RSRPP for the first detected path on DL PRS resources associated with the same *dl-PRS-ID*. When the UE reports DL PRS-RSRPP measurements for a DL PRS resource, the reported multiple DL PRS-RSRPP measurements associated with the same or different higher layer parameter *nr-DL-PRS-RxBeamIndex* may have the same or different timestamps. When the UE reports DL PRS-RSRPP measurements from one DL PRS resource set, the UE may indicate which DL PRS-RSRPP 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-RSRPP measurements associated with it within the DL PRS resource set.

The UE may be configured to optionally report a differential DL PRS-RSRPP for a DL PRS resource with reference to *nr-DL-PRS-FirstPathRSRP-Result* and/or a differential DL PRS RSRP with reference to *nr-DL-PRS-RSRP-Result* via higher layer parameter *NR-DL-AoD-AdditionalMeasurementElement*.

For each DL PRS resource, the UE may be configured, subject to UE capability, with *dl-PRS-ResourcePrioritySubset* that is associated with this DL PRS resource, where the subset of DL PRS resources associated with the DL PRS resource can be in the same or different DL PRS resource set than the DL PRS resource. The UE may include UE measurements for the subset of DL PRS resources in *NR-DL-AoD-AdditionalMeasurementElement* if the UE measurements of the associated PRS resource are reported, where the UE measurement can be DL PRS-RSRP and/or DL PRS-RSRPP. The UE may report DL PRS-RSRP and/or DL PRS-RSRPP measurements only for the subset of DL PRS resources. Subject to UE capability, the UE may be configured with boresight direction via higher layer parameter *DL-PRS-BeamInfoElement* for each DL PRS resource.

The UE may be provided with beam/antenna information via higher layer parameter *NR-TRP-BeamAntennaInfo*.

The UE may request to be provided with either expected DL-AoD/ZoD and uncertainty range(s) of expected DL-AoD/ZoD, or expected DL-AoA/ZoA and uncertainty range(s) of the expected DL-AoA/ZoA. The UE may be provided with expected DL-AoD/ZoD and uncertainty range(s) of the expected DL-AoD/ZoD. The UE may be provided with expected DL-AoA/ZoA and uncertainty range(s) of the expected DL-AoA/ZoA. The uncertainty range(s) of the expected DL-AoD/DL-AoA may be configured within [0, 60]. The uncertainty range(s) of expected DL-ZoD/DL-ZoA may be configured within [0, 30].

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 DL PRS positioning frequency layers.

The UE may be configured to measure and report via higher layer parameter *additionalPaths* or *additionalPathsExt*, subject to UE capability, the timing and the quality metrics of up to 8 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*. For UE positioning measurement reporting in higher layer parameters *NR-DL-TDOA-SignalMeasurementInformation* or *NR-Multi-RTT-SignalMeasurementInformation*, the UE may be configured to measure and report, subject to UE capability, the DL PRS-RSRPP of the first path and the up to 8 additional paths that are associated with each RSTD or UE Rx – Tx time difference.

The UE may be requested, subject to UE capability, to measure and report one or more of the DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, or UE Rx-Tx time difference measurements with either or 4 samples, where = 1 or 2 is as defined in [11, TS 38.133], via higher layer parameter *reducedDL-PRS-ProcessingSamples* [17, TS 37.355] which applies for all DL PRS positioning frequency layers.

The UE may be requested, subject to UE capability, to report LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-IndicatorRequest*. The UE can report LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-Indicator* associated with each DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, and UE Rx-Tx time difference measurements. The UE can report LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-Indicator* associated with each *dl-PRS-ID* in a measurement report. For the LoS/NLoS indicator(s) associated with DL RSTD, the UE may report one indicator associated with the *dl-PRS-ID* indicated by higher layer parameter *dl-PRS-ReferenceInfo* and one indicator associated with the *dl-PRS-ID* of the DL RSTD measurement. A UE may be provided with LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-Indicator*, and it may be associated with each DL PRS resource of each configured *dl-PRS-ID* or may be associated with each configured *dl-PRS-ID*. The values of the higher layer parameter *LOS-NLOS-Indicator* may be soft values (0, 0.1, …, 0.9, 1) or hard values (0, 1) with the values corresponding to the likelihood of LoS, with a value of 1 corresponding to LoS and a value of 0 corresponding to NLoS.

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 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.

The UE is expected to measure the DL PRS outside the measurement gap, subject to UE capability, if the DL PRS is inside the active DL BWP and has the same numerology as the active DL BWP and is within the DL PRS processing window indicated by higher layer parameter *DL-PPW-PreConfig*. The UE is not expected to measure the DL PRS outside the measurement gap if the expected received timing difference between the DL PRS from the non-serving cell and that from the serving cell, determined by the higher layer parameters *nr-DL-PRS-ExpectedRSTD* and *nr-DL-PRS-ExpectedRSTD-Uncertainty,* is larger than maximum Rx timing difference provided by UE capability*.* For receiving the DL PRS outside the measurement gap and within the DL PRS processing window, the priority between DL PRS and SSB is defined in [11, TS 38.133] and the UE determines the DL PRS priority as indicated by higher layer parameter *priority* subject to UE capability or as implied by UE capability, except for SSB:

- with value *'st1'* where the DL PRS is higher priority than all the DL signals and channels, or

- with value *'st2'* where the DL PRS is lower priority than PDCCH and the PDSCH scheduled by DCI formats 1\_1 or 1\_2 with the priority indicator field in the corresponding DCI format set to 1, and is higher priority than other DL signals and channels, or

- with value *'st3'* where the DL PRS is lower priority than all the DL signals and channels.

Inside one *DL-PPW-PreConfig* the UE is only expected to measure a single DL PRS positioning frequency layer.

When the UE is expected to measure the DL PRS outside the measurement gap in a configured DL PRS processing window with *type1A* and if the DL PRS is determined to be higher priority than the DL signals and channels inside the DL PRS processing window, those DL signals and channels are not expected to be measured by the UE. When the UE is expected to measure the DL PRS outside the measurement gap in a configured DL PRS processing window with *type1B* and if the DL PRS is determined to be higher priority than the DL signals and channels inside the DL PRS processing window, those DL signals and channels in the same band as the DL PRS are not expected to be measured by the UE. When the UE is expected to measure the DL PRS outside the measurement gap in a configured DL PRS processing window with *type2* if the DL PRS is determined to be higher priority than the DL signals and channels inside the DL PRS processing window, those DL signals and channels from the impacted serving cells are not expected to be measured by the UE on the overlapped symbols with the DL PRS, where impacted serving cells refer to the serving cell on which the *DL-PPW-PreConfig* is configured for a frequency range 1 band, and all the serving cells in the same band as the DL PRS for a frequency range 2 band. When the UE is expected to measure the DL PRS outside the measurement gap in a configured DL PRS processing window with *type1B* or *type2,* and if the DL PRS is determined to be higher priority than the DL signals and channels inside the DL PRS processing window, the UE behavior is described in [11, TS 38.133] for inter-band case for frequency range 2 for the DL signals/channels from a different frequency range 2 band than the frequency range 2 band of the DL PRS.

When the UE has an activated DL PRS processing window with *type1A* or *type1B* and the UE determines the presence of other DL signals and channels, except SSB, of higher priority than the DL PRS in the DL PRS processing window no later than *N2* symbols, defined in clause 6.4 for the subcarrier spacing of the DL PRS, before the first symbol of the DL PRS processing window, the UE is expected to receive the other DL signals and channels and drop all PRS within the DL PRS processing window. When the UE has an activated DL PRS processing window with *type2* and the UE determines the presence of other DL signals and channels, except SSB, of higher priority than the DL PRS on a symbol configured with the DL PRS no later than *N2* symbols, defined in clause 6.4 for the subcarrier spacing of the DL PRS, before the DL PRS symbol, the UE is expected to receive the other DL signals and channels and drop the DL PRS symbol.

When the UE has an activated DL PRS processing window with *type1A* or *type1B* and the UE determines the presence of other DL signals and channels, except SSB, of higher priority than the DL PRS in the DL PRS processing window later than *N2* symbols, defined in clause 6.4 for the subcarrier spacing of the DL PRS, before the first symbol of the DL PRS processing window, the UE is not required to receive the other DL signals and channels and may receive the DL PRS and consider the DL PRS as higher priority in the DL PRS processing window. When the UE has an activated DL PRS processing window with *type2* and the UE determines the presence of other DL signals and channels, except SSB, of higher priority than the DL PRS on a symbol configured with the DL PRS later than *N2* symbols, defined in clause 6.4 for the subcarrier spacing of the DL PRS, before the DL PRS symbols, the UE is not required to receive the other DL signals and channels and may receive the DL PRS symbol and consider the DL PRS as higher priority in that symbol.

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 DL PRS positioning 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; [except when the UE is requested to perform aggregated measurement(s)]

- [A *dl-PRS-ID* or *nr-SelectedTRP-Index* associated with DL PRS bandwidth aggregation linkage has higher priority than a *dl-PRS-ID* or *nr-SelectedTRP-Index* not associated with DL PRS bandwidth aggregation linkage. If multiple *dl-PRS-ID(s)* or *nr-SelectedTRP-Index(s)* are associated with DL PRS bandwidth aggregation linkage, they are sorted according to priority]

- Up to 2 *DL-SelectedPRS-ResourceSetIndex* per *dl-PRS-ID* of the DL PRS positioning 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 DL PRS positioning frequency layer are sorted according to priority otherwise.[Except when the UE is requested to perform aggregated measurement(s)]

- [A DL PRS resource set associated with a *dl-PRS-ID* includes a DL PRS bandwidth aggregation linkage, in which case it has higher priority than a DL PRS resource set without a DL PRS bandwidth aggregation linkage. If multiple DL PRS resource sets associated with a *dl-PRS-ID* include PRS bandwidth aggregation linkage, then they are sorted according to priority.]

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, 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 DL PRS symbols and determines the DL 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 .

The UE may be configured to report one or more measurement instances, each with its own timestamp, on DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, and/or UE Rx-Tx time difference measurements, in a single measurement report.

Timing Error Group(s) (TEG(s)) at UE side are defined:

*-* UE Rx TEG is associated with one or more DL measurements, which have the Rx timing error difference within a certain margin.

*-* UE RxTx TEG is associated with one or more UE Rx-Tx time difference measurements, which have the 'Rx timing errors+Tx timing errors' difference within a certain margin.

The UE may be configured to report, subject to UE capability, via high layer parameter *nr-UE-RxTEG-Request*, the association information of DL RSTD measurement(s) with UE Rx TEG(s) via higher layer parameter *nr-UE-Rx-TEG-ID* when the UE reports the DL RSTD measurement(s). The UE may report up to 4 RSTD measurements associated with different DL PRS resources per UE Rx TEG per *dl-PRS-ID*.

The UE may report a UE Rx TEG ID via higher layer parameter *nr-UE-Rx-TEG-ID* for a RSTD reference time *dl-PRS-ReferenceInfo* and a UE Rx TEG ID for each DL RSTD measurement, where the DL RSTD can be DL RSTD measurement in *NR-DL-TDOA-MeasElement* and/or *NR-DL-TDOA-AdditionalMeasurementElement*.

If the UE reports a UE Rx TEG ID with a DL RSTD measurement, the UE may report a UE Rx TEG timing error margin value, via high layer parameter *nr-UE-RxTEG-TimingErrorMargin*, for all the UE Rx TEGs within one *NR-DL-TDOASignalMeasurementInformation.*

The UE may be configured to measure and report, via high layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTEGs* subject to UE capability, RSTD measurements on a DL PRS resource associated with a *dl-PRS-ID* using up to 8 different UE Rx TEGs with the same *dl-PRS-ReferenceInfo.* The higher layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTEGs* applies to all DL PRS positioning frequency layers.

The UE may be provided with association information of DL PRS resource(s) with TRP Tx TEGs via higher layer parameter *dl-prs-trp-Tx-TEG-ID* for a *dl-PRS-ID*.

The UE may be configured to report, via high layer parameter *nr-UE-RxTxTEG-Request*, subject to UE capability, the association information of UE Rx-Tx time difference measurement(s) with UE RxTx TEG(s) via higher layer parameter *nr-UE-RxTx-TEG-ID*. The UE may report up to 4 UE Rx-Tx time difference measurements associated with different DL PRS resources per UE RxTx TEG per *dl-PRS-ID*.

If the UE reports a UE RxTx TEG ID with a UE Rx-Tx time difference measurement, the UE may report a UE RxTx TEG timing error margin value, via high layer parameter *nr-UE-RxTxTEG-TimingErrorMargin*, for all the UE RxTx TEGs within one *NR-Multi-RTT-SignalMeasurementInformation.*

The UE may be configured to report, via high layer parameter *nr-UE-RxTxTEG-Request*, subject to UE capability, the association information of UE Rx-Tx time difference measurement(s) with the UE Rx TEG(s) and UE Tx TEG(s) via the higher layer parameters of *nr-UE-Rx-TEG-ID*, and *nr-UE-Tx-TEG-Index*. The UE may report up to 4 UE Rx-Tx time difference measurements associated with different DL PRS resources per UE Rx TEG per *dl-PRS-ID*.

If the UE reports a UE Rx TEG ID with a UE Rx-Tx time difference measurement, the UE may report a UE Rx TEG timing error margin value, via high layer parameter *nr-UE-RxTEG-TimingErrorMargin*, for all the UE Rx TEGs within one *NR-Multi-RTT-SignalMeasurementInformation*.

The UE may be configured to measure and report, via high layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTEGs* subject to UE capability, UE Rx-Tx time difference measurements on a PRS resource associated with a *dl-PRS-ID* using up to 8 different UE Rx TEGs. The high layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTEGs* applies to all DL PRS positioning frequency layers.

The UE may be configured to measure and report, via high layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTxTEGs* subject to UE capability, UE Rx-Tx time difference measurements with the same UE Tx TEG using up to 8 different UE RxTx TEGs*.* The high layer parameter *measureSameDL-PRS-ResourceWithDifferentRxTxTEGs* applies to all DL PRS positioning frequency layers.

The UE in RRC\_INACTIVE mode is expected to prioritize the reception of any other DL signals and DL channels than the reception of DL PRS.

The UE in RRC\_INACTIVE mode, subject to UE capability, is expected to process DL PRS outside or inside of the initial DL BWP. For DL PRS processing outside of the initial DL BWP, the UE may be configured with the same or different subcarrier spacing and CP for DL PRS resources than those of the initial DL BWP. For DL PRS processing inside of the initial DL BWP, the UE is configured with the same subcarrier spacing and CP for DL PRS resources as those of the initial DL BWP.

For a UE configured with preconfigured Measurement gap(s) for Positioning, when the UE receives an activation command, as described in clause 6.1.3.41 of [10, TS 38.321], for a preconfigured Measurement Gap for Positioning activation/deactivation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH.

For a UE configured with DL PRS Processing Window(s), when the UE receives an activation/deactivation command, as described in clause 6.1.3.42 of [10, TS 38.321], for a DL PRS processing window activation, and when the UE would transmit a PUCCH with HARQ-ACK information in slot n corresponding to the PDSCH carrying the command, the corresponding actions in [10, TS 38.321] and the UE assumptions shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH. The UE is not expected to be indicated with more than 4 activated DL PRS processing windows across all active DL BWPs and is not expected to be indicated with the activated DL PRS processing windows that overlap in time.

The reduced capability UE may be configured to measure and report, subject to UE capability, via [higher layer parameter] the DL RSTD, DL PRS-RSRP, DL PRS-RSRPP, or UE Rx-Tx time difference using receiver frequency hopping for a DL PRS resource, with bandwidth that may be greater than the maximum reduced capability UE bandwidth, within a configured measurement gap. The reduced capability UE performing receiver frequency hopping may be configured to report via [*higher layer parameter*] one measurement associated with one received frequency hop or one measurement based on multiple hops of the DL PRS. [In RRC\_CONNECTED mode], the reduced capability UE is expected to use a single instance of a configured measurement gap to receive all hops of the DL PRS using receiver frequency hopping.

For DL UE positioning measurement reporting in higher layer parameter *NR-DL-TDOA-SignalMeasurementInformation,* the UE may be configured to report the DL Reference Signal Carrier Phase Difference (RSCPD) [7, TS 38.215] measurement along with the DL RSTD. When the UE reports RSCPD measurements the reference *nr-DL-PRS-ReferenceInfo* is the same as the one reported, for the RSTD measurements. For DL UE positioning measurement reporting in higher layer parameter *NR-Multi-RTT-SignalMeasurementInformation* the UE may be configured to report the DL Reference Signal Carrier Phase (RSCP) measurement [7, TS 38,215] along with the UE Rx-Tx time difference measurement. When the UE reports DL RSCPD measurement(s) along with DL RSTD measurement(s) or DL RSCP measurement(s) along with UE Rx-Tx time difference measurement(s), the DL RSCPD and/or DL RSCP measurement(s) should be measured from a single DL PRS positioning frequency layer.

The UE, subject to UE capability, may be requested via [higher layer parameter] to performpositioning measurements on indicated DL PRS resource sets occurring within one or more time window(s) indicated by [*higher layer parameter*]. The UE is expected to obtain 1 DL RSCP or DL RSCPD measurement with as defined in [11, TS 38.133].

When the UE reports a timestamp associated with a DL RSCP measurement or a DL RSCPD measurement, subject to UE capability, it may include a symbol index in the timestamp.

If the UE reports LoS/NLoS indicator(s) via higher layer parameter *nr-los-nlos-Indicator* along with a measurement report containing DL RSCP or DL RSCPD the LoS/NLoS indicator(s) are assumed to also apply to the DL RSCP or DL RSCPD measurements.

The UE may be configured with [higher layer parameter] which contains DL carrier phase measurements performed by a positioning reference unit (PRU) [20, TS 38.305] along with the location information of the PRU.

When the UE is expected to perform joint measurements for bandwidth aggregation across DL PRS positioning frequency layers, the UE expects to be configured with linkage information, via higher layer parameter [*linkage*], between DL PRS resource sets across DL PRS positioning frequency layers. For the linked DL PRS resource sets, the UE is expected to be configured with the same values of QCL, *dl-PRS-Periodicity-and-ResourceSetSlotOffset, dl-PRS-NumSymbols*,*dl-PRS-ResourceTimeGap, dl-PRS-ResourceSymbolOffset,* *dl-prs-MutingBitRepetitionFactor,* *dl-PRS-CyclicPrefix*, comb size, power per subcarrier, *NR-MutingPattern*, and *NR-DL-PRS-SFN0-Offset,* and the UE is expected to be configured with DL PRS resources that maintain uniformly spaced DL PRS RE pattern within a symbol across aggregated DL PRS positioning frequency layers. The UE may assume that DL PRS resources across the linked DL PRS resource sets which satisfy the above conditions are linked for bandwidth aggregation, and the UE assumes phase continuity on the DL PRS resources; otherwise, the UE does not assume that PRS resources from the linked DL PRS resource sets are linked for bandwidth aggregation.

The UE may be configured to measure and report, subject to UE capability, [up to XX] joint DL RSTD measurement(s) per pair of *dl-PRS-ID,* from aggregated DL PRS resources across two or three DL PRS positioning frequency layers*.*

The UE may be configured to measure and report, subject to UE capability, [up to YY] joint UE Rx-Tx time difference measurement(s) from aggregated DL PRS resources across two or three DL PRS positioning frequency layers.

The UE may be requested via higher layer parameter [*positioning frequency layer aggregation indication*] to perform the joint DL RSTD measurement(s) or the joint UE Rx-Tx time difference measurement(s) across two or three DL PRS positioning frequency layers.

The UE may report via higher layer parameter [*positioning frequency layer aggregation information*] which indicates if bandwidth aggregation is performed and which two or three DL PRS positioning frequency layers are used for the joint DL RSTD measurement(s) and the joint UE Rx-Tx time difference measurement(s). In a measurement report, the UE may report PRS resource set IDs across the two or three DL PRS positioning frequency layers used to perform the joint DL RSTD measurement or the joint UE Rx-Tx time difference measurement.

<omitted text>

#### 6.2.1.4 UE sounding procedure for positioning purposes

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. If the UE is configured for transmission of *SRS-PosResource* in RRC\_INACTIVE mode, the configured *spatialRelationInfoPos* is also applicable.

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.

In RRC\_CONNECTED mode, 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.

Unless specified otherwise, 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.

Timing Error Group (TEG) at UE side is defined:

- UE Tx TEG is associated with the transmissions of one or more UL SRS resources for the positioning purpose, which have the Tx timing error difference within a certain margin.

The UE may be configured to report, via high layer parameter *nr-UE-RxTxTEG-Request* or *ue-TxTEG-RequestUL-TDOA-Config*, subject to UE capability, association information of the already transmitted SRS resource(s) configured by the higher layer parameter *SRS-PosResource* with UE Tx TEG(s) via higher layer parameter *nr-SRS-TxTEG-Set* or *ue-TxTEG-AssociationList*.

The UE may report, via high layer parameter *ue-TxTEG-TimingErrorMarginValue*, the UE Tx TEG timing error margin value of all the UE Tx TEGs within one *UEPositioningAssistanceInfo*.

If the UE reports a UE Tx TEG ID with a UE Rx-Tx time difference measurement, as defined in clause 5.1.6.5, the UE shall report the association information of the already transmitted SRS resources configured by the higher layer parameter *SRS-PosResource* with the UE Tx TEG ID.

If the UE is configured with SRS resources configured by the higher layer parameter *SRS-PosResource* in multiple CCs, the UE should report the *carrierFreq or servCellId* of the SRS resources when it reports the UE Tx TEG associations.

If the UE reports a UE RxTx TEG ID with a UE Rx-Tx time difference measurement, the UE may report a UE Tx TEG ID.

If the UE reports a UE Tx TEG ID with a UE Rx-Tx time difference measurement, the UE may report a UE Tx TEG timing error margin value, via high layer parameter *nr-UE-TxTEG-TimingErrorMargin*, for all the UE Tx TEGs within one *NR-Multi-RTT-SignalMeasurementInformation*.

Subject to UE capability, the UE may be configured with an SRS resource for positioning associated with the initial UL BWP, and the SRS resource is transmitted inside the initial UL BWP during RRC\_INACTIVE mode with the same CP and subcarrier spacing as configured for the initial UL BWP. Subject to UE capability, the UE may be configured with an SRS resource for positioning outside the initial BWP including frequency location and bandwidth, subcarrier spacing, and CP length for transmission of the SRS in RRC\_INACTIVE mode. If the transmission of SRS for positioning outside the initial BWP in RRC\_INACTIVE mode along with the switching time, indicated in higher layer parameter *switchingTimeSRS-TX-OtherTX*, in unpaired spectrum, subject to UE capability, collides in time domain with other DL signals or channels or UL signals or channels, the SRS for positioning transmission is dropped in the symbol(s) where the collision occurs. If the transmission of SRS for positioning outside the initial BWP in RRC\_INACTIVE mode along with the switching time, indicated in higher layer parameter *switchingTimeSRS-TX-OtherTX*, in paired spectrum or SUL band, subject to UE capability, collides in time domain with UL signals or channels on the same carrier, the SRS for positioning transmission is dropped in the symbol(s) where the collision occurs. The SRS resource for positioning outside the initial BWP in RRC\_INACTIVE mode is configured in the same band and CC as the initial UL BWP.

If the UE in RRC\_INACTIVE mode determines that the UE is not able to accurately measure the configured DL RS in *SRS-SpatialRelationInfoPos* for a SRS resource for positioning where the DL RS is semi-persistent or periodic, the UE stops transmission of the SRS resource for positioning.

The UE is not expected to simultaneously transmit SRS resources configured by the higher layer parameter *SRS-PosResource* on NUL and SUL band in RRC\_INACTIVE mode.

The reduced capability UE may be configured via [*higher layer parameter*], subject to UE capability, to perform transmit frequency hopping separate from the UL BWP configuration and outside of the UL BWP, where the UE may be configured with subcarrier spacing, CP and bandwidth that are different from the UL active BWP. The reduced capability UE transmit frequency hopping is configured within one SRS resource for positioning, that may be configured with a bandwidth larger than the maximum bandwidth of the reduced capability UE, in RRC\_CONNECTED or RRC\_INACTIVE mode. The reduced capability UE transmit frequency hopping, may be configured with overlapping or non-overlapping frequency hops in the frequency domain. When the reduced capability UE is configured to perform transmit frequency hopping it expects to be configured via [higher layer parameter] with the starting PRB of the first frequency hop.

The reduced capability UE may be configured, via [higher layer parameter], subject to UE capability, with an UL time window where the UE is not expected to transmit other signals/channels and is only expected to transmit the SRS for positioning using frequency hopping.

The UE is expected to be configured with linkage information [*linkage*] on SRS resource sets for positioning across two or three CCs which are linked for bandwidth aggregation. For the linked SRS resource sets, the UE is expected to be configured with the same values of *startPosition, nrofSymbols,* *periodicityAndOffset, slotOffset, alpha, p0,* subcarrier spacing, CP, and comb size, and the UE is expected to maintain phase continuity for the SRS transmission. The UE may assume that SRS resources across the linked SRS resource sets which satisfy the above conditions are linked for bandwidth aggregation, otherwise, the UE does not assume that SRS resources of the linked SRS resource sets are linked for bandwidth aggregation. For the linked SRS resource sets for bandwidth aggregation across CCs, if an SRS configured by the higher layer parameter *SRS-PosResource,* along with the [switching period] when applicable*,* collides with other signals or channels on a symbol and is the SRS in that symbol that is dropped, SRS transmission of the linked SRS resource sets across all CCs is dropped on that symbol.

A UE in RRC\_INACTIVE mode is expected to be configured with [frequency information] on additional component carrier(s) with respective SRS configuration(s) for bandwidth aggregation.

When an SRS resource configured in a CC without PUSCH or PUCCH is linked for bandwidth aggregation with an SRS resource configured in an active UL BWP of another [UL data transmission] CC, there is a [guard period] during which the UE is not expected to transmit or receive other signals or channels.

The UE may be configured with SRS, via [*SRS-PosRRC-InactiveConfig-ValidityArea*], subject to UE capability, valid in multiple cells within a validity area for RRC\_INACTIVE mode. For the configured SRS via [*SRS-PosRRC-InactiveConfig-ValidityArea*], if the UE in RRC\_INACTIVE mode determines that the UE is not able to accurately measure the configured DL RS in [*SRS-SpatialRelationInfoPos]* for a SRS resource for positioning where the DL RS is semi-persistent or periodic, the UE would not perform SRS transmission of the SRS resource for positioning. If the UE determines that the configured DL RS in [*SRS-SpatialRelationInfoPos]* for a SRS resource for positioning is being accurately measured, the UE is expected to perform the SRS transmission.

<omitted text>

8 Physical sidelink shared channel related procedures

A UE can be configured by higher layers with one or more sidelink resource pools. A sidelink resource pool can be for transmission of PSSCH, as described in Clause 8.1, and/or SL PRS, as described in Clause 8.2.4, or for reception of PSSCH, as described in Clause 8.3, and/or SL PRS, as described in Clause 8.4.4, and can be associated with either sidelink resource allocation mode 1 or sidelink resource allocation mode 2.

A sidelink resource pool which can be used for transmission of both SL PRS and PSSCH will be referred to as shared resource pool.

A sidelink resource pool which can be used for transmission of SL PRS and cannot be used for transmission of PSSCH will be referred to as dedicated SL PRS resource pool.

<omitted text>

A UE is not expected to use the last PRBs in the resource pool.

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## 8.1 UE procedure for transmitting the physical sidelink shared channel

Each PSSCH transmission is associated with an PSCCH transmission.

That PSCCH transmission carries the 1st stage of the SCI associated with the PSSCH transmission; the 2nd stage of the associated SCI is carried within the resource of the PSSCH.

If the UE transmits SCI format 1-A on PSCCH according to a PSCCH resource configuration in slot *n* and PSCCH resource *m*, then for the associated PSSCH transmission in the same slot

- one transport block is transmitted with up to two layers;

- The number of layers (ʋ) is determined according to the '*Number of DMRS port'* field in the SCI;

- The set of consecutive symbols within the slot for transmission of the PSSCH is determined according to clause 8.1.2.1;

- The set of contiguous resource blocks for transmission of the PSSCH is determined according to clause 8.1.2.2;

Transform precoding is not supported for PSSCH transmission.

Only wideband precoding is supported for PSSCH transmission.

The DM-RS antenna ports cid:image011.png@01D5F222.20AEBCB0 in Clause 8.4.1.1.2 of [4, TS38.211] are determined according to the ordering of DM-RS port(s) given by Tables 8.3.1.1-3 in Clause 8.3.1.1 of [5, TS 38.212].

The UE shall set the contents of the SCI format 2-A as follows:

- the UE shall set value of the *'HARQ process number'* field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*Cast type indicator*' field as indicated by higher layers.

- the UE shall set value of the '*CSI request*' field as indicated by higher layers.

The UE shall set the contents of the SCI formats 2-B as follows:

- the UE shall set value of the '*HARQ process number*' field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*Zone ID*' field as indicated by higher layers.

- the UE shall set the '*Communication range requirement*' field as indicated by higher layers.

The UE shall set the contents of the SCI format 2-C as follows:

- the UE shall set value of the *'HARQ process number'* field as indicated by higher layers.

- the UE shall set value of the '*NDI*' field as indicated by higher layers.

- the UE shall set value of the '*Redundancy version*' field as indicated by higher layers.

- the UE shall set value of the '*Source ID*' field as indicated by higher layers.

- the UE shall set value of the '*Destination ID*' field as indicated by higher layers.

- the UE shall set value of the '*HARQ feedback enabled/disabled indicator*' field as indicated by higher layers.

- the UE shall set value of the '*CSI request*' field as indicated by higher layers.

- the UE shall set value of '*Providing/Requesting indicator*' field as indicated by higher layers.

- if '*Providing/Requesting indicator*' indicates SCI format 2-C is used to convey an explicit request for inter-UE coordination information:

- the UE shall set value of the '*Priority*' field as indicated by higher layers.

- the UE shall set value of the '*Number of subchannels*' field as indicated by higher layers.

- the UE shall set value of the '*Resource reservation period*' field as indicated by higher layers.

- the UE shall set value of the '*Resource selection window location*' field as indicated by higher layers.

- the UE shall set value of the '*Resource set type*' field as indicated by higher layers if higher layer parameter *sl-DetermineResourceType* is configured to 'UE-B's request'; otherwise this field is omitted.

- if '*Providing/Requesting indicator*' indicates SCI format 2-C is used to convey inter-UE coordination information:

- the UE shall set value of the '*Resource set type*' field as indicated by higher layers.

- the UE shall set value of the '*Resource combination(s)*' field (clause 8.1.5A) as indicated by higher layers.

- the UE shall set value of the *'Lowest subchannel indices'* as indicated by higher layers

- the UE shall set value of the '*First resource location*' as indicated by higher layers

- the UE shall set value of the '*Reference slot location*' as indicated by higher layers

The UE shall set the contents of the SCI format 2-D as follows:

- the UE shall set value of the *'[SL PRS resource ID]'* field as indicated by higher layers.

- the UE shall set value of the *'[SL PRS request]'* field as indicated by higher layers.

- the UE shall set value of the *'[Embedded SCI format]'* field as indicated by higher layers.

- if *'Embedded SCI format'* indicates that SCI format 2-A is embedded within this SCI format 2-D then the UE shall include in the *'[Embedded SCI format payload]'* field the fields of SCI format 2-A, set as specified above, and add necessary padding such that the size of the SCI format 2-D is the same as if SCI format 2-B was embedded.

- if *'Embedded SCI format'* indicates that SCI format 2-B is embedded within this SCI format 2-D then the UE shall include in the *'[Embedded SCI format payload]'* field the fields of SCI format 2-B, set as specified above.

<omitted text>

#### 8.1.3.2 Transport block size determination

For the PSSCH assigned by SCI, if Table 5.1.3.1-2 is used and *,* or a table other than Table 5.1.3.1-2 is usedand *,* the UE shall first determine the TBS as specified below:

The UE shall first determine the number of REs (*NRE*) within the slot.

- A UE first determines the number of REs allocated for PSSCH within a PRB () by , where

- is the number of subcarriers in a physical resource block,

- = *sl-LengthSymbols* -2, where *sl-LengthSymbols* is the number of sidelink symbols within the slot provided by higher layers,

- = 3 if '*PSFCH overhead indication'* field of SCI format 1-A indicates "1", and = 0 otherwise, if higher layer parameter *sl-PSFCH-Period* is 2 or 4. If higher layer parameter *sl-PSFCH-Period* is 0, . If higher layer parameter *sl-PSFCH-Period* is 1, .

- is the number of OFDM symbols used for SL PRS in the slot,

- is the overhead given by higher layer parameter *sl-X-Overhead*,

- is given by Table 8.1.3.2-1 according to higher layer parameter *sl-PSSCH-DMRS-TimePatternList.*

<omitted text>

### 8.2.4 SL PRS transmission procedure

The following parameters for SL PRS transmission are associated with each SL PRS resource:

- [*SL PRS resource ID*] indicates an identity of a SL PRS resource. The SL PRS resource is identified by the SL PRS resource ID that is unique within a slot of a dedicated SL PRS resource pool. For a shared resource pool, a SL PRS resource is uniquely identified by a combination of the SL PRS resource ID and a SL PRS frequency domain allocation within a slot.

- [*SL PRS comb offset and comb size*] indicates a comb offset and a comb size of the SL PRS resource

- [*Starting symbol and the number of SL PRS symbols*] indicates the starting symbol index within a slot and the number of symbols of the SL PRS resource.

- [*SL PRS frequency domain allocation*] indicates the frequency location [and the number of resource blocks for SL PRS transmission in a shared resource pool.]

Each SL PRS transmission is associated with an PSCCH transmission in the same slot.

In the case of dedicated pool for SL positioning, that PSCCH carries the SCI format 1-B associated with the SL PRS transmission.

The UE may report the association information of the already transmitted SL PRS resources with UE Tx ARP ID.

8.2.4.1 Resource allocation

In sidelink resource allocation mode 1:

- For SL PRS transmission, a UE may be configured with dynamic grant, configured grant type 1, or configured grant type 2

8.2.4.1.1 Resource allocation in time domain

The UE shall transmit the SL PRS in the same slot as the associated PSCCH.

The UE shall transmit the SL PRS in consecutive symbols within the slot.

A UE does not transmit multiple SL PRS resources in the same slot.

For a shared resource pool, the UE transmits the SL PRS in PSSCH symbols according to clause 8.1.2.1, [with the following restrictions:

- the number of contiguous symbols for SL PRS transmission, ‘M’, shall correspond to one of the SL PRS resources in parameter.

- the UE shall not transmit SL PRS in symbols where associated PSCCH is transmitted.

- the UE shall not transmit SL PRS and PSSCH DMRS in the same symbol.

- the UE shall transmit SL PRS on contiguous symbols either in between or after symbols where PSSCH DMRS is transmitted.

- the UE shall transmit SL PRS only after the last symbol with second stage SCI.

- For a given value of ‘M’, SL PRS resource is mapped to the last consecutive ‘M’ SL symbols in the slot that meet all the other restrictions

- The UE shall not transmit PSSCH and SL PRS in the same symbol.]

A SL-PRS resource and PSFCH (including the preceding gap symbol) are not mapped on the same symbols

For a dedicated resource pool, the UE transmits SL PRS subject to the following restrictions:

- the UE shall not transmit SL PRS and associated PSCCH in the same symbol;

- the number of contiguous symbols and the starting symbol for SL PRS transmission shall correspond to one of the SL PRS resources in parameter [].

In sidelink resource allocation mode 1 for a shared resource pool, the time domain behaviour for sidelink dynamic grants and sidelink configured grants for SL PRS follows the behaviour in clause 8.1.2.1.

In sidelink resource allocation mode 1 for a dedicated resource pool, the time domain behaviour for sidelink dynamic grants and sidelink configured grants for SL PRS follows the behaviour in clause 8.1.2.1, with the following modifications:

* [“DCI format 3\_0” is replaced by “DCI format 3\_2”].
* “PSSCH” is replaced by “SL PRS”

8.2.4.1.2 Resource allocation in frequency domain

For a shared resource pool, the frequency domain resource assignment of a SL PRS resource is the same as PSSCH in the same slot.

For a dedicated resource pool, the frequency domain resource assignment of a SL PRS resource is same as frequency resources of a resource pool.

#### 8.2.4.2 UE procedure for determining the subset of resources to be reported to higher layers in SL PRS resource selection in a dedicated resource pool in sidelink resource allocation mode 2

In resource allocation mode 2 in a dedicated resource pool, the higher layer can request the UE to determine a subset of resources from which the higher layer will select resources for SL PRS[/PSCCH] transmission. To trigger this procedure, in slot *n,* the higher layer provides the following parameters for this SL PRS[/PSCCH] transmission:

- the resource pool from which the resources are to be reported;

- L1 priority, ;

- the remaining [delay budget];

- Set of SL-PRS resource ID(s);

- optionally, the resource reservation interval, , in units of msec.

- if the higher layer requests the UE to determine a subset of resources from which the higher layer will select resources for SL PRS[/PSCCH] transmission as part of re-evaluation or pre-emption procedure, the higher layer provides a set of resources which may be subject to re-evaluation and a set of resources which may be subject to pre-emption.

- it is up to UE implementation to determine the subset of resources as requested by higher layers before or after the slot - , where is the slot with the smallest slot index among and , and is equal to , whereis defined in slots in Table 8.1.4-2 whereis the SCS configuration of the SL BWP.

The following higher layer parameters affect this procedure:

*- [sl-SelectionWindowList*:internal parameter is set to the corresponding value from higher layer parameter *sl-SelectionWindowList* for the given value of .]

*- [sl-Thres-RSRP-List]*: this higher layer parameter provides an RSRP threshold for each combination , where is the value of the priority field in a received SCI format 1-B and is the priority of the transmission of the UE selecting resources; for a given invocation of this procedure, .

*- [reservationPeriodAllowed-Dedicated-SL-PRS-RP]*

*- [sl-SensingWindow]*: internal parameter is defined as the number of slots corresponding to *sl-SensingWindow* msec

*- [sl-TxPercentageLis]*: internal parameter for a given is defined as *sl-TxPercentageList ()* converted from percentage to ratio

- [*sl-PreemptionEnable]*: if *sl-PreemptionEnable* is provided, and if it is not equal to 'enabled', internal parameter is set to the higher layer provided parameter *sl-PreemptionEnable.*

The UE shall perform this procedure according to clause 8.1.4, with the following modifications:

* Partial sensing is not applicable in a dedicated SL PRS resource pool;
* A candidate single-slot resource for transmission is defined as the SL PRS resource with index within the Set of SL-PRS resource ID(s) provided by the higher layer and in slot
* “SCI format 1-A” is replaced by “SCI format 1-B”,
* In step 5 []
* In condition b of step 6, the RSRP measurement is the PSCCH-RSRP over the DM-RS resource elements of the PSSCH;
* In condition c of step 6 “determines according to clause 8.1.5 the set of resource blocks and slots” is replaced by “determines according to clause 8.2.4.X the set of slots and SL PRS resources”;

#### 8.2.4.2 UE procedure for determining slots and SL PRS resource(s) associated with an SCI format 1-B in a dedicated resource pool

The set of slots and SL PRS resources for SL PRS transmission is determined by the PSCCH containing the associated SCI format 1-B, and fields '[*SL-PRS resource ID (s))*', '[*Time resource assignment]*' of the associated SCI format 1-B as described below.

The set of slots is determined as in clause 8.1.5, with the following modifications:

* “SCI format 1-A” is replaced by “SCI format 1-B”,
* [ potential parameter name changes].

The first SL PRS resource is determined according to the sub-channel used for the PSCCH transmission containing the associated SCI format 1-B: The index of the sub-channel in the resource pool is identical to the index of the SL PRS resource provided by [higher layer parameter].

If [*sl-MaxNumPerReserve]* is 2 then the index of the second SL PRS resource is indicated by the field [Resource ID indication].

[ If [*sl-MaxNumPerReserve]* is3 then the index of the second / third SL PRS resource is indicated by the field [ Resource ID indication].]

If TRIV determined according to clause 8.1.5 indicates *N* < *sl-MaxNumPerReserve*, the SL PRS resource indices corresponding to *sl-MaxNumPerReserve* minus N last resources are not used.

The number of slots in one set of the time and frequency resources for transmission opportunities of SL PRS is given by where = 10\*SL\_RESOURCE\_RESELECTION\_COUNTER [10, TS 38.321] if configured else is set to 1.

If a SL PRS resource in slot is determined as the time and frequency resource for SL PRS transmission corresponding to the selected sidelink grant (described in [10, TS 38.321]), the same SL PRS resource in slots is also determined for SL PRS transmissions corresponding to the same sidelink grant where *j=*1, 2,*…,* , , if provided, is converted from units of msec to units of logical slots, resulting in according to clause 8.1.7, and is determined by Clause 8. Here, is the resource reservation interval indicated by higher layers.

#### 8.2.4.3 Sidelink congestion control in a dedicated resource pool in sidelink resource allocation mode 2

When transmitting SL-PRS in a dedicated pool the UE shall perform sidelink congestion control as specified in clause 8.1.6, with the following modification(s):

* “PSSCH” is replaced by “SL PRS”
* [ potential parameter name changes ]
* [ potential changes to processing times ]

<omitted text>

### 8.4.4 SL PRS reception procedure

The UE may be configured, via [*higher layer parameter(s)*], to measure and report one or more of the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements, for the first detected path and/or additional detected paths. The UE may report an ARP ID associated with the reported measurements. The UE may provide the ARP location information of the ARP ID via [*higher layer parameter(s)*].

The UE uses the same ARP for both the transmission and reception of sidelink positioning reference signals while performing an SL Rx-Tx time difference measurement.

The UE may include SL PRS resource ID(s) when it reports one or more of the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements.

For the SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements, the UE reports an associated SL PRS reception timestamp via higher layer parameter [*sl-prs-time-stamp*]. For SL Rx-Tx time difference, the UE may report an associated SL PRS transmission timestamp via higher layer parameter [*sl-prs-time-stamp*]. The timestamp includes the SFN, slot number, and optionally *nr-PhysCellID*, *nr-ARFCN*, *nr-CellGlobalID*, or the timestamp includes DFN and slot number.

The UE may report, LoS/NLoS indicator(s) via [*nr-los-nlos-Indicator*] associated with each SL RSTD, SL Rx-Tx time difference, SL RTOA, SL AoA, SL PRS-RSRP, and SL PRS-RSRPP measurements.

The UE may report synchronization information synchronization source type and/or relative time difference with the associated quality metric, via [*higher layer parameter(s)*]. For the SL RSTD measurement, the UE may report a reference UE information.

For SL RTOA measurement, SFN or DFN initialization time may be provided to the UE by a UE or the network.

The UE may be provided with the location information of other UEs via [higher layer parameter]. The UE may report the location information of the UE to the network.

The UE may be provided with expected SL AoA and uncertainty range of the expected SL AoA via [higher layer parameter].

The UE may report quality metric [*time quality*] corresponding to the SL RSTD, SL RTOA or SL Rx-Tx time difference measurements. The UE may report quality metric [*angle quality*] corresponding to the SL AoA measurement.[ If the *'[SL PRS request]'* field in the SCI associated with the received SL PRS is set to 1 then the UE shall report this request for SL PRS transmission to higher layers.]

<omitted text>