**3GPP TSG RAN WG1 Meeting #108-e R1-xxxxxxx**

**E-meeting, February 21 – March 3, 2022**

**Agenda Item: 8.3.4**

**Source: Moderator (Huawei)**

**Title: Feature lead summary on propagation delay compensation enhancements**

**Document for: Discussion and Decision**

# Introduction

The revised IIoT / URLLC work item description for Rel-17 [1] has enhancements for time synchronization as one of its main objectives:

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| 1. Enhancements for support of time synchronization:
2. RAN impacts of SA2 work on uplink time synchronization for TSN, if any. [RAN2]
3. Propagation delay compensation enhancements (including mobility issues, if any). [RAN2, RAN1, RAN3, RAN4]
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This document summarizes the key issues discussed under agenda item 8.3.4 based on the views in [2][3][4][5][6][7][8][9], and aims to discuss a set of issues in RAN1#108-e. The agreements in past meetings are captured in the Appendix.

# Remaining open issues for PDC

There are a few open issues raised in the contributions submitted in RAN1#108-e.

## Issue #2-1: Whether to confirm the WA spatial relation indication for SRS?

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| **Working Assumption**Alt.1: Add new “*spatialRelationInfo-PDC-r17*” field to *SRS-Resource* to indicate the spatial relation between a reference RS and the target SRS, with *spatialRelationInfo-PDC-r17* as below: spatialRelationInfo-PDC-r17 ::= SEQUENCE { referenceSignal CHOICE { ssb-Index SSB-Index, csi-RS-Index NZP-CSI-RS-ResourceId,dl-PRS-PDC nr-DL-PRS-ResourceID-r16 srs SEQUENCE { resourceId SRS-ResourceId, uplinkBWP BWP-Id } }}Note: RAN1 does not pursue further optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source. |

* ***Option 1****: Confirm this WA*
	+ *Ericsson*
	+ *Reasons*
		- *More flexibility for the SRS for PDC*
		- *MAC CEs can be easily extended to incorporate dl-PRS-PDC*
* ***Option 2****: do not confirm this WA*
	+ *Nokia/NSB, ZTE, OPPO, LGE*
	+ *reason*
		- *Just “nice to have” configuration and the gain is not clear*
		- *Much more standard effort needed, which is not aligned with the note in the working assumption*
			* *RAN2 impact due to modification needed for MAC CE.*
			* *RAN1 needs to discuss whether/how to apply the SRS for PDC to be used as reference for other signals*
			* *New FG needed to support PRS-SRS based spatial relation*
		- *Introducing restriction like no modification to the MAC CE and no application to other signals can meet the note, but it does not match the purpose of the flexibility targeted by the working assumption. In addition, it may have impact on the performance for MIMO if MAC CE update cannot be used due to not compatible with PRS as the spatial relation reference signal.*
		- *Restrict PDC SRS to be periodic SRS can meet the note, but it doesn't match the purpose of flexibility either, and may result in waste of UL resources since PDC behaviour likely happens in an aperiodic way.*
* ***Option 3****: Confirm this WA, but MAC CEs for SRS Spatial Relation Indication is not further optimised*
	+ *H3C, Intel (?)*
	+ *Reason*
		- *non-PDC usage of the SRS resource set which has spatial relation info set to PRS is not expected*
		- ***Feature lead****: According to the current RRC structure, in order not to have impact the potential number of SRS resource set(s) for MIMO, the SRS resource set configured for PDC will be configured with one non-PDC usage.*

**Feature lead:** Based on the views in the papers, it seems more companies prefer not to confirm the working assumption or even confirm it no any further optimization is done. As pointed by companies as captured under option 2, without any further optimization as captured in the note in the working assumption, then motivation to confirm the working assumption is questionable. Based on the situation, it is tentative to recommend not to confirm the working assumption.

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 2.1-1: Do not confirm the following working assumption made in RAN1#107b-e:**

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| **Working Assumption**Alt.1: Add new “*spatialRelationInfo-PDC-r17*” field to *SRS-Resource* to indicate the spatial relation between a reference RS and the target SRS, with *spatialRelationInfo-PDC-r17* as below: spatialRelationInfo-PDC-r17 ::= SEQUENCE { referenceSignal CHOICE { ssb-Index SSB-Index, csi-RS-Index NZP-CSI-RS-ResourceId,dl-PRS-PDC nr-DL-PRS-ResourceID-r16 srs SEQUENCE { resourceId SRS-ResourceId, uplinkBWP BWP-Id } }}Note: RAN1 does not pursue further optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source. |

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| *Company* | *View* |
| OPPO | Support Proposal 2.1-1. |
| New H3C | Support proposal 2.1-1 |
| Samsung | Support proposal 2.1-1 |
| vivo | Support Proposal 2.1-1. |

## Issue #2-2: whether/how to modify the existing MAC CE(s) for SRS spatial relation indication if the working assumption on spatial relation indication for SRS is confirmed?

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| *Ericsson (R1-2201004)*For semi-persistent SRS and aperiodic SRS, it is observed that an unused bit in the existing “Enhanced SP/AP SRS Spatial Relation Indication” MAC CE can be leveraged to provide indication of PRS. In the existing MAC CE, the unused bit is the first bit of the field “Resource IDi”, which is always set to 0 if Fi is set to 0, see the Appendix. Thus the first bit of the field “Resource IDi” can be set to 1 for the indication of PRS. This is illustrated in last row of below, while the other rows are according to the existing MAC CE definition. The last row of takes into account that the maximum number of PRS resources per resource set is 64 (same as that in 37.355), which takes 6 bits to indicate.Table . Bit values of Fi and Resource IDi, for indicating the resource used for spatial relationship derivation for SRS resource i

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| Fi | First bit of Resource IDi | Second bit of Resource IDi | Content carried by the remaining 6 bit of Resource IDi |
| 1 | NZP CSI-RS resource index |
| 0 | 0 | 1 | *SSB-Index* |
| 0 | 0 | 0 | *SRS-ResourceId* |
| **0** | **1** | **0** | ***nr-DL-PRS-ResourceID*** |

Accordingly, the text in section 6.1.3.26 of TS 38.321 can be updated as illustrated below. It is noted that the same can be done for the other MAC CE as well: “Serving Cell Set based SRS Spatial Relation Indication MAC CE” (see section 6.1.3.29 in TS 38.321).

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| TS 38.321 V16.7.06.1.3.26 Enhanced SP/AP SRS Spatial Relation Indication MAC CE…- Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource within SP/AP SRS Resource Set indicated with SP/AP SRS Resource Set ID field. F0 refers to the first SRS resource within the resource set, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index or PDC PRS resource index is used. The length of the field is 1 bit. This field is only present if MAC CE is used for activation of SP SRS resource set, i.e. the A/D field is set to 1, or for AP SRS resource set;…- Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource within the resource set, Resource ID1 to the second one and so on. If Fi is set to 0, the first bit of this field is ~~always~~ set to 0 to indicate either SSB index or SRS resource index, and is set to 1 to indicate PDC PRS resource index. If Fi is set to 0, the first bit of this field is set to 0, and the second bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, the first bit of this field is set to 0, and the second bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. If Fi is set to 0, and the first bit of this field is set to 1, the second bit of this field is always set to 0, and the remainder of this field contains *NR-DL-PRS-ResourceID* as specified in TS 38.331 [5]. The length of the field is 8 bits. This field is only present if MAC CE is used for activation of SP SRS resource set, i.e. the A/D field is set to 1, or for AP SRS resource set; |

Thus we have the following proposals:1. Modify the existing MAC CE(s) to support *nr-DL-PRS-ResourceID* as a resource ID for spatial relationship derivation for SRS.
2. Send an LS to RAN2 to recommend the modification of two existing MAC CEs: (a). Enhanced SP/AP SRS Spatial Relation Indication MAC CE; (b). Serving Cell Set based SRS Spatial Relation Indication MAC CE.
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**Feature lead:** Depending on the outcome of issue 2.1, we may need to discuss whether/how to modify the MAC CE. Note that according to the note of the working assumption, the default assumption should be that no further optimization of the MAC CE. According to TS 38.321, the SRS Spatial Relation Indication method can be shown in the following tables below, and specs are copied here for your reference.

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| **SP SRS Activation/Deactivation MAC CE** |
| **Fi (1 bit)** | **Resource IDi (7bits)** |
| **First bit of Resource IDi** | **remaining 6 bits of Resource IDi** |
| 1 | NZP CSI-RS resource index |
| 0 | 1 | *SSB-Index* |
| 0 | 0 | *SRS-ResourceId* |

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| **Enhanced SP/AP SRS Spatial Relation Indication MAC CE** |
| **Fi (1 bit)** | **Resource IDi (8bits)** |
| **First bit of Resource IDi** | **Second bit of Resource IDi** | **remaining 6 bits of Resource IDi** |
| 1 | NZP CSI-RS resource index |
| 0 | 0 | 1 | *SSB-Index* |
| 0 | 0 | 0 | *SRS-ResourceId* |

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| **Serving Cell Set based SRS Spatial Relation Indication MAC CE** |
| **Fi (1 bit)** | **Resource IDi (8bits)** |
| **First bit of Resource IDi** | **Second bit of Resource IDi** | **remaining 6 bits of Resource IDi** |
| 1 | NZP CSI-RS resource index |
| 0 | 0 | 1 | *SSB-Index* |
| 0 | 0 | 0 | *SRS-ResourceId* |

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| ***Copied from 38.321***6.1.3.17 SP SRS Activation/Deactivation MAC CE**……**- Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource within SP SRS Resource Set indicated with SP SRS Resource Set ID field. F0 refers to the first SRS resource within the resource set, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index is used. The length of the field is 1 bit. This field is only present if MAC CE is used for activation, i.e. the A/D field is set to 1;- Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource within the resource set, Resource ID1 to the second one and so on. If Fi is set to 0, and the first bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, and the first bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 7 bits. This field is only present if MAC CE is used for activation, i.e. the A/D field is set to 1;**……**6.1.3.26 Enhanced SP/AP SRS Spatial Relation Indication MAC CE**……**- Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource within SP/AP SRS Resource Set indicated with SP/AP SRS Resource Set ID field. F0 refers to the first SRS resource within the resource set, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index is used. The length of the field is 1 bit. This field is only present if MAC CE is used for activation of SP SRS resource set, i.e. the A/D field is set to 1, or for AP SRS resource set;- Resource Serving Cell IDi: This field indicates the identity of the Serving Cell on which the resource used for spatial relationship derivation for SRS resource i is located. The length of the field is 5 bits;- Resource BWP IDi: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], on which the resource used for spatial relationship derivation for SRS resource i is located. The length of the field is 2 bits;- Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource within the resource set, Resource ID1 to the second one and so on. If Fi is set to 0, the first bit of this field is always set to 0. If Fi is set to 0, and the second bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, and the second bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 8 bits. This field is only present if MAC CE is used for activation of SP SRS resource set, i.e. the A/D field is set to 1, or for AP SRS resource set;**……**6.1.3.29 Serving Cell Set based SRS Spatial Relation Indication MAC CE**……**- Fi: This field indicates the type of a resource used as a spatial relationship for SRS resource indicated with SRS Resource IDi field. F0 refers to the first SRS resource which is indicated SRS Resource ID1, F1 to the second one and so on. The field is set to 1 to indicate NZP CSI-RS resource index is used, and it is set to 0 to indicate either SSB index or SRS resource index is used. The length of the field is 1 bit;- Resource Serving Cell IDi: This field indicates the identity of the Serving Cell on which the resource used for spatial relationship derivation for SRS Resource IDi is located. The length of the field is 5 bits;- Resource BWP IDi: This field indicates a UL BWP as the codepoint of the DCI *bandwidth part indicator* field as specified in TS 38.212 [9], on which the resource used for spatial relationship derivation for SRS Resource IDi is located. The length of the field is 2 bits;- Resource IDi: This field contains an identifier of the resource used for spatial relationship derivation for SRS resource i. Resource ID0 refers to the first SRS resource which is indicated SRS Resource ID0, Resource ID1 to the second one and so on. If Fi is set to 0, the first bit of this field is always set to 0. If Fi is set to 0, and the second bit of this field is set to 1, the remainder of this field contains *SSB-Index* as specified in TS 38.331 [5]. If Fi is set to 0, and the second bit of this field is set to 0, the remainder of this field contains *SRS-ResourceId* as specified in TS 38.331 [5]. The length of the field is 8 bits.- R: Reserved bit, set to 0. |

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Question 2.2-1: If the working assumption is confirmed, is it also necessary to modify the SRS spatial relation MAC CE(s)? If yes, please share your view on how to modify the MAC CE, e.g. whether the proposal in Ericsson (R1-2201004) is appropriate or not.**

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| *Company* | *View* |
| OPPO | We do not prefer to impose any modification to MIMO framework.  |
| New H3C | We slight prefer not to touch MIMO framework. |
| Samsung | We share similar view with OPPO and New H3C. |

## Issue #2-3: measurement gap

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| *Nokia R1-2201019*We note that Release-16 PRS reception procedure specifies that Measurement Gaps is required for the UE to receive and process PRS. As we have already agreed in RAN1#107bis-e that measurement gaps is not needed for PRS for PDC purposes, we propose to add an exception to 38.214 to reflect this.**Proposal 3: Add an exception to TS 38.214 section 9 stating that measurement gaps is not needed for PRS configured for PDC purposes.** |

**Feature lead**: Yes as agreed in RAN1#107b-e, measurement gap is not needed for PRS for PDC. However, similar as the reception for CSI-RS for tracking, some specification change like rate matching among PRS for PDC and PDSCH would be needed, in which case we can just simply follow the way for CSI-RS for tracking. Note that if we just follow R17 positioning procedure to not permit receiving PRS for PDC and other signaling simultaneously, e.g. even on different frequency resource but on the same symbol, which may result in much waste of resource. For positioning, it just has to do that way because the signals are not from the same serving cells.

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| ZTE R1-2201163PRS is introduced for RTT-based PDC. In RAN1#107bis-e, the common understanding is that measurement gap is not mandatory for the UE to process PRS reception for PDC [1]. This is similar as the Rel-17 positioning, where the UE can process PRS outside the measurement gap. There were the discussions on the collision between the PRS for PDC and other downlink channels/signals in RAN1#107bis-e. First, sine all the signals are from the serving cell, the collision rarely occurs under the control of the network. In addition, even if the collision occurs, e.g., the collision between the PRS for PDC and SPS PDSCH, this can be handled by rate matching based on the proper configuration. For the collision between the PRS and slot format in TDD band, the UE behaviors have been specified in the specification. Therefore, there is no need to specify anything for the collision between PRS and other signals in this WID.***Proposal 1:*** *Further discussion on the collision between the PRS for PDC and other downlink channels/signals is not needed.* |

**Feature lead**: Agree that the collision can be handled by rate matching, just similar as what we did for CSI-RS for tracking. However, the current spec does not specify the rate matching among PRS for PDC and PDSCH, therefore the spec changes are still needed.

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| Intel R1-2201696In the last meeting it was discussed whether the measurement gap is required for RTT related measurements for PDC purpose. In high level, since DL PRS / TRS measurements in this case are performed in the serving cell on an active DL BWP, there is no need for measurement gaps which are usually required for inter-cell / inter-frequency measurements.

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| **Conclusion** Measurement gaps should not be mandatory for a UE to process PRS for PDC purposes. |

With this conclusion it still needs to be checked if there are any specification changes required. Furthermore, without measurement gaps, the UE is also expected to monitor other DL signals which may overlap with DL PRS / TRS.Currently, the following TS 38.214 spec part could be identified for handling measurement gaps and overlap with other DL signals:

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| 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.  |

As it can be seen, the measurement gap is required only for measurements in a different BWP and/or with a different numerology. Furthermore, for the serving cell DL PRS, the DL PRS is not mapped to SS/PBCH block symbols.There are also other channels which may potentially overlap with DL PRS: PDCCH (CORESET#0 or other), PDSCH, CSI-RS. In Rel.17, a gap-less positioning operation is also specified with handling of overlaps of DL PRS with other DL channels. Then, the question would be whether Rel.17 procedures for gap-less operation can be reused for PDC or not.In our understanding, it may not be a wise design choice to introduce additional handling for RTT-based PDC based on Rel.17 enhancements to positioning, since it is being finalized. We think other mechanisms are sufficient for RTT-based PDC purpose. Furthermore, TRS option can be used when full procedure for multiplexing with other channels is required.**Proposal 1*** *For RTT-based PDC using DL PRS, when measurement gap is not configured, RAN1 does not specify any additional handling*
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**Feature lead**: As discussed in RAN1#107b-e meeting, it makes sense that measurement gap is not needed for PRS PDC. Then regarding the potential specification changes, as pointed out by a few companies, we can just follow the behavior for receiving CSI-RS for tracking. If we follow this way, it seems the only additional specification change is on the rate matching part, which we can just simply follow the way for CSI-RS for tracking.

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| **Huawei R1-2202438**As shown in the conclusion below, in the RAN1#107bis-e meeting, it was agreed that a measurement gap is not mandatory to process PRS for a PDC UE.

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| **Conclusion** Measurement gaps should not be mandatory for a UE to process PRS for PDC purposes. |

If the measurement gap is not configured or the PDC PRS is outside the measurement gap, one remaining issue is the overlap between PDC PRS and other DL signals/channels [1]. In Rel-17 positioning, if the DL PRS priority is higher than other DL signals/channels, the UE is expected to only measure the DL PRS; otherwise, the UE is not expected to measure the DL PRS and expected to receive other DL signals/channels, subject to UE capabilities. This is because a Rel-17 positioning UE needs to receive PRS from neighbor cells for positioning purposes, and therefore the UE cannot simultaneously receive DL signals/channels from the current cell. But for PRS-based PDC it is different, the UE only needs to measure PRS from the current serving cell, there is no need to measure from neighbor cell(s). So, the DL signals/channels e.g. PDCCH/PDSCH can be received and the Rel-17 positioning procedure should not be reused for RTT-based PDC.The excerpt from TS 38.214 below shows the situation for positioning, i.e. that no other signals or channels are received on symbols overlapping with DL PRS.

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| **Copied from TS38.214 h00**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 [*PRSProcessingWindow*]. For receiving the DL PRS outside the measurement gap and within the DL PRS processing window, if the UE determines the DL PRS priority is higher than [other DL signals or channels except SSB] as indicated by higher layer parameter [*PRS-priority-indicator*] or as implied by UE capability, the UE is expected to measure the DL PRS; otherwise, the UE is not expected to measure the DL PRS and expected to receive [other DL signals and channels], subject to UE capabilities. When the UE is expected to measure the DL PRS outside the measurement gap if it is supporting [capability 1A] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the 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 if it is supporting [capability 1B] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the 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 if it is supporting [capability 2] and if the DL PRS is determined to be higher priority than the DL signals and channels inside the PRS processing window, those DL signals and channels are not expected to be measured by the UE on the overlapped symbols with the DL PRS. |

***Observation 1:* A *Rel-17 positioning UE cannot receive PRS and other DL signals/channels (e.g. PDCCH and PDSCH) simultaneously since the UE has to measure PRS from neighbor cell(s). But for PRS-based PDC, the UE only needs to measure PRS from the serving cell, there is no need for measurement from neighbor cell.***For TRS-based PDC, the UE can receive TRS and other DL signals/channels (e.g. PDCCH and PDSCH) simultaneously. The PDSCH is rate matched around TRS and the PDCCH and TRS are not overlapped. The corresponding spec is copied below.

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| **Copied from 38.211**7.3.1.5 Mapping to virtual resource blocksThe UE shall, for each of the antenna ports used for transmission of the physical channel, assume the block of complex-valued symbols conform to the downlink power allocation specified in [6, TS 38.214] and are mapped in sequence starting with to resource elements in the virtual resource blocks assigned for transmission which meet all of the following criteria: - they are in the virtual resource blocks assigned for transmission; - the corresponding physical resource blocks are declared as available for PDSCH according to clause 5.1.4 of [6, TS 38.214];- the corresponding resource elements in the corresponding physical resource blocks are- not used for transmission of the associated DM-RS or DM-RS intended for other co-scheduled UEs as described in clause 7.4.1.1.2;- not used for non-zero-power CSI-RS according to clause 7.4.1.5 if the corresponding physical resource blocks are for a PDSCH scheduled by a PDCCH with the CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI, G-RNTI, G-CS-RNTI, MCCH-RNTI, or a PDSCH with SPS, except if the non-zero-power CSI-RS is a CSI-RS configured by the higher-layer parameter *CSI-RS-Resource-Mobility* in the *MeasObjectNR* IE or except if the non-zero-power CSI-RS is an aperiodic non-zero-power CSI-RS resource;- not used for PT-RS according to clause 7.4.1.2;- not declared as 'not available for PDSCH according to clause 5.1.4 of [6, TS 38.214].The mapping to resource elements allocated for PDSCH according to [6, TS 38.214] and not reserved for other purposes shall be in increasing order of first the index over the assigned virtual resource blocks, where is the first subcarrier in the lowest-numbered virtual resource block assigned for transmission, and then the index . |

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| **Copied from 38.214**5.1.6 UE procedure for receiving reference signals5.1.6.1 CSI-RS reception procedureThe CSI-RS defined in Clause 7.4.1.5 of [4, TS 38.211], may be used for time/frequency tracking, CSI computation, L1-RSRP computation, L1-SINR computation, mobility, and tracking during fast SCell activation.For a CSI-RS resource associated with a *NZP-CSI-RS-ResourceSet* with the higher layer parameter *repetition* set to 'on', the UE shall not expect to be configured with CSI-RS over the symbols during which the UE is also configured to monitor the CORESET, while for other *NZP-CSI-RS-ResourceSet* configurations, if the UE is configured with a CSI-RS resource and a search space set associated with a CORESET in the same OFDM symbol(s), the UE may assume that the CSI-RS and a PDCCH DM-RS transmitted in all the search space sets associated with CORESET are quasi co-located with 'typeD', if 'typeD' is applicable. If the CORESET is activated with two TCI states, UE may assume that the first TCI state of the CORESET as the default QCL assumption for the CSI-RS. This also applies to the case when CSI-RS and the CORESET are in different intra-band component carriers, if 'typeD' is applicable. Furthermore, the UE shall not expect to be configured with the CSI-RS in PRBs that overlap those of the CORESET in the OFDM symbols occupied by the search space set(s). |

***Observation 2:* *For TRS-based PDC, the UE can receive TRS and PDCCH/PDSCH simultaneously. PDSCH is rate matched around TRS, and PRBs carrying TRS should not overlap with CORESET(s) in the OFDM symbols occupied by the search space set(s).***In our view, from the performance perspective of a PDC UE, it should be allowed that other channels or signals can be received while PDC PRS is measured. Therefore, for PRS-based PDC, the same procedure as for TRS-based PDC can be applied. The UE can then receive both PRS and PDCCH/PDSCH simultaneously in the current serving cell. The PDSCH is rate-matched around PDC PRS, and PRBs carrying PDC PRS should not overlap with CORESET(s) in the OFDM symbols occupied by the search space set(s).***Proposal 2: For PRS-based PDC, support to receive both PDC PRS and PDCCH/PDSCH simultaneously.**** + ***PDSCH is rate matched around PRS, and PRBs carrying PRS should not overlap with CORESET(s) in the OFDM symbols occupied by the search space set(s)***
	+ ***Note: This is the same procedure as for TRS-based PDC***
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**Feature lead**: It should be reasonable to follow the procedure for CSI-RS for tracking for receiving PRS for PDC from measurement gap perspective. For now it seems only spec changes on rate matching is needed, however it would be good to hear more views from other companies also.

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 2.3-1: The collision of DL PRS for PDC and other DL channel/signal(s) is handled following the same way as that for CSI-RS for tracking.**

* + **Clarify in TS 38.211 that PDSCH is rate matched around PRS for PDC**
	+ **Clarify in TS 38.214 that PRBs carrying PRS for PDC should not overlap with CORESET(s) in the OFDM symbols occupied by the search space set(s)**

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| *Company* | *View* |
| OPPO | Do not support. The current Rel-17 spec CR already makes things work. In our view, the PDC-PRS can share the same PDSCH limitations as for positioning-PRS; otherwise, RAN1 should firstly discuss whether the PDC-PRS and positioning-PRS can be physically the same DL signal for a UE, and if yes how a UE handles the potential conflicting behaviors relative to PDSCH respectively defined for PDC-PRS and positioning-PRS. This leads to unnecessary spec complexity given the UE could have been configured with CSI-RS for PDC if UE is desired to measure RTT at the time it receives PDCCH/PDSCH. Note that this may also complicate RAN1 UE feature discussion since the proposal seems to say certain PDSCH rate matching behavior would depend on whether PDC-PRS is supported.  |
| New H3C | In principal we are fine with this proposal. We can further discuss about how to handle TP. |
| Samsung | Not support. We wonder do we want to optimize the overlapping case that PDSCH and PRS for the same UE? We don’t see this is necessary. In current POS spec there is no rate matching for PRS. We think the motivation to introduce PRS based PDC is trying to reuse the PRS when its transmit and configured to that UE. In that case, gNB shall ensure UE can receive PRS without collision to other unicast channels.  |
| Vivo | Not support.PDC PRS and positioning PRS should have the same rate matching mechanism. Rate matching for PDC PRS only seems not necessary. In our opinion, gNB implementation can handle the collision between PRS and other channel/signal(s).  |

**Proposal 2.3-2: Endorse the following text proposal for TS 38.211:**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.211 v17.0.0-----------------------7.3.1.5 Mapping to virtual resource blocksThe UE shall, for each of the antenna ports used for transmission of the physical channel, assume the block of complex-valued symbols conform to the downlink power allocation specified in [6, TS 38.214] and are mapped in sequence starting with to resource elements in the virtual resource blocks assigned for transmission which meet all of the following criteria: - they are in the virtual resource blocks assigned for transmission; - the corresponding physical resource blocks are declared as available for PDSCH according to clause 5.1.4 of [6, TS 38.214];- the corresponding resource elements in the corresponding physical resource blocks are- not used for transmission of the associated DM-RS or DM-RS intended for other co-scheduled UEs as described in clause 7.4.1.1.2;- not used for non-zero-power CSI-RS according to clause 7.4.1.5 if the corresponding physical resource blocks are for a PDSCH scheduled by a PDCCH with the CRC scrambled by C-RNTI, MCS-C-RNTI, CS-RNTI, G-RNTI, G-CS-RNTI, MCCH-RNTI, or a PDSCH with SPS, except if the non-zero-power CSI-RS is a CSI-RS configured by the higher-layer parameter *CSI-RS-Resource-Mobility* in the *MeasObjectNR* IE or except if the non-zero-power CSI-RS is an aperiodic non-zero-power CSI-RS resource;- not used for PT-RS according to clause 7.4.1.2;- not used for PRS for RTT-based propagation delay compensation according to clause 9 of [6, TS 38.214]- not declared as 'not available for PDSCH according to clause 5.1.4 of [6, TS 38.214].The mapping to resource elements allocated for PDSCH according to [6, TS 38.214] and not reserved for other purposes shall be in increasing order of first the index over the assigned virtual resource blocks, where is the first subcarrier in the lowest-numbered virtual resource block assigned for transmission, and then the index .--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

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| *Company* | *View* |
| **Feature lead** | Note that the TP above just simply follow the way that is for CSI-RS for tracking.  |
| OPPO | Do not support. Please see our comments for Proposal 2.3-1.  |
| Samsung | We don’t support this.  |

**Proposal 2.3-3: Endorse the following text proposal for TS 38.214:**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.214 v17.0.0-----------------------9 UE procedures for transmitting and receiving for RTT-based propagation delay compensationFor operation with RTT-based propagation delay compensation, the UE may be configured with either:- one CSI-RS for tracking with higher layer parameter *pdc-Info* for Rx – Tx time difference estimation at UE side and one SRS resource set with *usage-r17*, or- one PRS configuration of higher layer parameter *NR-DL-PRS-PDC-ResourceSet-r17* [12, TS 38.331] for Rx – Tx time difference estimation at UE side and one SRS resource set with *usage-r17*.The related UE procedures for transmitting uplink reference signals and receiving downlink reference signals for RTT-based propagation delay compensation are defined as follows:- for reception of CSI-RS for tracking with higher layer parameter *pdc-Info*, the UE follows the procedures for reception of CSI-RS for tracking defined in Clause 5.1.6.1.1. - for reception of the one PRS configuration provided by RRC [12, TS 38.331] for RTT-based propagation delay compensation, the UE follows the procedure for PRS reception defined in Clause 5.1.6.5 using the configuration information provided by *NR-DL-PRS-PDC-ResourceSet-r17* instead of *NR-DL-PRS-ResourceSet* with the following modification:- the UE shall not expect to be configured with the PRS in PRBs that overlap those of the CORESET in the OFDM symbols occupied by the search space set(s)- for transmission of an SRS resource set configured with *usage-r17*, the UE follows the procedures for SRS transmission defined in Clause 6.2.1.--------------------------------- End of Text Proposal to TS 38.214 v17.0.0----------------------- |

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| *Company* | *View* |
| **Feature lead** | Note that the TP for PRS for PDC here is using the similar text that is used for CSI-RS for tracking as highlight in yellow below:==============5.1.6.1 CSI-RS reception procedureThe CSI-RS defined in Clause 7.4.1.5 of [4, TS 38.211], may be used for time/frequency tracking, CSI computation, L1-RSRP computation, L1-SINR computation, mobility, and tracking during fast SCell activation.For a CSI-RS resource associated with a *NZP-CSI-RS-ResourceSet* with the higher layer parameter *repetition* set to 'on', the UE shall not expect to be configured with CSI-RS over the symbols during which the UE is also configured to monitor the CORESET, while for other *NZP-CSI-RS-ResourceSet* configurations, if the UE is configured with a CSI-RS resource and a search space set associated with a CORESET in the same OFDM symbol(s), the UE may assume that the CSI-RS and a PDCCH DM-RS transmitted in all the search space sets associated with CORESET are quasi co-located with 'typeD', if 'typeD' is applicable. If the CORESET is activated with two TCI states, UE may assume that the first TCI state of the CORESET as the default QCL assumption for the CSI-RS. This also applies to the case when CSI-RS and the CORESET are in different intra-band component carriers, if 'typeD' is applicable. Furthermore, the UE shall not expect to be configured with the CSI-RS in PRBs that overlap those of the CORESET in the OFDM symbols occupied by the search space set(s).=========== |
| OPPO | We wonder why the proposed modification is needed, because such overlapping is also not there in case PRS configured with “NR-DL-PRS-ResourceSet”. In other words, if the overlapping between PRS and CORESET is not supported in Rel-16, there is no need to say it again in Rel-17 and categorize it as a “modification”.  |
|  |  |

## Issue #2-4: whether to include time stamp in the measurement report?

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| --- |
| *Ericsson (R1-2201004)*When reporting UE Rx-Tx time difference (if gNB side PDC) or gNB Rx-Tx time difference (if UE side PDC), it is useful to include the timing information when the measurement was performed. This measurement time may include both SFN and slot information, thus providing accurate time stamp). Alternatively, the time stamp may include SFN only, which provides coarser timing information, but the overhead is reduced.For example, the time stamp IE can be defined as follows, which is simplified from the existing NR-TimeStamp-r16 in TS 37.355.NR-TimeStamp-r17 ::= SEQUENCE { nr-SFN-r17 INTEGER (0..1023), nr-Slot-r17 CHOICE { scs15-r17 INTEGER (0..9), scs30-r17 INTEGER (0..19), scs60-r17 INTEGER (0..39), scs120-r17 INTEGER (0..79) }, ...}1. Include time stamp in the measurement report of UE Rx-Tx time difference (if gNB side PDC) and gNB Rx-Tx time difference (if UE side PDC).
 |

**Feature lead:** Although time stamp is included in the measurement report for positioning, it is not clear to me whether it is needed for PDC or not. In positioning, it is needed since usually need to know the time of the estimated position also. One potential benefit for including time stamp for PDC is to help check whether there is any inconsistent measurement, however not clear how useful it is. Maybe the proponents can clarify more why it is also needed for PDC.

### First round discussion

**Question 2.4-1: Do we need to include time stamp in the measurement report of UE Rx-Tx time difference (if gNB side PDC) and gNB Rx-Tx time difference (if UE side PDC)? Please also share your reasons.**

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| *Company* | *View* |
| OPPO | No. For time-stamp with UE Rx-Tx time difference: 1). The time-stamp in 37.355 is used for identification of DL measurements involving with multiple TRPs, such as in DL-TDOA, DL AoD and multi-RTT, so that the positioning algorithm in server can associate the measurements from different TRPs with the close-enough time stamps. But PDC does not fall into this logic. 2). It is RAN1 common understanding in earlier meeting when agreeing not to do any enhancement for inconsistent RTT measurements between gNB and UE that the RTT measurements are subject to measurement window (defined in RAN4 spec) and one RTT report may come from multiple RTT measurements at different times in that window. So far there is no RAN1 discussion on how to derive one single time stamp from multiple measurements. 3). It is RAN2 agreement that no information other than RTT is reported, refer to R1-2200892(R2-2201976): "*7. For RTT-based gNB side PDC, besides UE Rx-Tx time difference, no additional information needs to be reported to NW*."For time-stamp with gNB Rx-Tx time difference: It is not UE-implementation friendly, because it needs UE to "remember" the time instances of a number of RTT measurements in order to pick one to match the time-stamp of gNB-side RTT being received, while this number of memory is unknown to UE when UE is implemented. On the other hand, the benefit to have such time-stamp is not clear, given the PDC does not require UE to associate different RTTs from different TRPs based on time-stamp.  |
| New H3C | We slightly prefer to add time stamp for PDC to help check whether there is any inconsistent measurement between gNB and UE. |
| Samsung | We don’t see the need to support this time stamp in this maintains phase.  |
| vivo | No.We share the similar view with OPPO that time stamp is not needed in the measurement report.  |

**Question 2.4-2: If your answer to Question 2.4-1 above is yes, please also share whether you support the following time stamp IE:**

NR-TimeStamp-r17 ::= SEQUENCE {

 nr-SFN-r17 INTEGER (0..1023),

 nr-Slot-r17 CHOICE {

 scs15-r17 INTEGER (0..9),

 scs30-r17 INTEGER (0..19),

 scs60-r17 INTEGER (0..39),

 scs120-r17 INTEGER (0..79)

 },

 ...

}

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| *Company* | *View* |
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## Issue #2-5: whether PRS measurement is only applied to RRC\_CONNECTED mode?

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| *Ericsson (R1-2201004)*For positioning purpose, the UE in RRC\_INACTIVE mode, subject to UE capability, is expected to process DL PRS outside and inside of the initial DL BWP.On the other hand, the UE is not expected to perform propagation delay compensation when in RRC\_INACTIVE mode. Thus for PDC purpose, the UE is expected to receive PRS only in RRC\_CONNECTED mode.1. For PDC purpose, the UE is expected to receive PRS only in RRC\_CONNECTED mode.
 |

**Feature lead**: We already agreed that the Rx-Tx time difference is reported via RRC signaling. It is straightforward to only apply RRC connected UEs in my view.

|  |
| --- |
| AgreementFor RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signalling. |

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 2.5-1: For RTT-based PDC, the UE is expected to receive PRS only in RRC\_CONNECTED mode.**

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| *Company* | *View* |
| OPPO | Agree. But this seems to be a RAN2 issue, since it is RAN2 logic that the PDC-related configurations are likely to be released if UE leaves from RRC\_CONNECTED mode. The proposal does not have to result in RAN1 spec impact.  |
| New H3C | We are fine with this proposal. |
| Samsung | Yes.  |
| vivo | Fine with the proposal. |

## Issue #2-6: whether PRS measurement can be outside the active BWP?

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| --- |
| *Ericsson (R1-2201004)*Also, different from positioning purpose, the UE is not expected to measure DL PRS resource outside the active BWP for PDC purpose. This avoids the need of measurement gap for PRS reception. Confining the PRS in active BWP is achieved via the proper RRC configuration of *dl-PRS-StartPRB* and *dl-PRS-ResourceBandwidth*.1. For PDC purpose, the UE is not expected to measure DL PRS outside the active BWP.
 |

**Feature lead**: The proposal looks straightforward to me. Let’s hear more views from companies though.

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 2.6-1: For PDC purpose, the UE is not expected to measure DL PRS outside the active BWP.**

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| *Company* | *View* |
| OPPO | We wonder whether this should be part of UE implementation, unless the “not-expected thing” is the gNB configuration instead of UE behavior of measurement using a partially received signal, i.e., **For PDC purpose, the UE ~~is not expected to measure DL PRS outside the active BWP~~does not expect to be configured with DL PRS that exceeds the active BWP.**  |
| New H3C | We are fine with FL proposal with OPPO’s modification. |
|  |  |

## Other issues

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| --- |
| New H3C R1-2201024When CSI-RS (TRS) signal and PRS signal are configured for PDC measurement simultaneously, if collision of PRS signal with other DL signals, e.g., DCI, DG PDSCH, SPS PDSCH causes PRS signal isn’t available for PDC measurement, CSI-RS (TRS) signal can be used for PDC measurement.**Proposal 1: When CSI-RS (TRS) signal and PRS signal are configured for PDC measurement simultaneously, if PRS signal isn’t available for PDC measurement, CSI-RS (TRS) signal is used for PDC measurement.**Furthermore, when CSI-RS (TRS) signal and PRS signal are configured for PDC measurement simultaneously, dl-PRS-ID/csi-RS (The ID of a CSI-RS resource) should be included in the Rx-Tx measurement report provided from the UE to the gNB in order to pair the SRS and TRS/PRS for a gNB Rx-Tx time difference.**Proposal 2: The Rx-Tx measurement report provided from the UE includes dl-PRS-ID/csi-RS (The ID of a CSI-RS resource).** |

**Feature lead view**: The issue doesn’t exist, since TRS and PRS will not be configured for PDC measurement simultaneously according to the agreement below.

**Agreement**

If RTT-based propagation delay compensation is supported,

* CSI-RS for tracking (TRS) can be used for Rx – Tx time difference estimation at UE side, if PRS is not configured for the UE.
* PRS can be used for Rx – Tx time difference estimation at UE side, if PRS is configured for the UE.

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| *Company* | *View* |
| OPPO | Agree with FL assessment.  |
| New H3C | We want to clarify this scenario that if both DL signal are configured, due to SFI, PRS isn’t available and in this case, CSI-RS can’t be used? |
| Samsung | Agree with FL |

# Miscellaneous issues on RRC parameters

Several issues on RRC parameters are raised in the contributions submitted to RAN1#108-e.

## Issue #3-1: clarification for subcarrier spacing and cyclic prefix

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| ***Ericsson (R1-2201004)***For PDC purpose, the PRS is sent from the serving cell. The PRS should use the same subcarrier spacing and cyclic prefix as the downlink of the serving cell. Thus it should be clarified that *dl-PRS-SubcarrierSpacing* and *dl-PRS-CyclicPrefix* are not needed for PDC. This is similar to the treatment of *dl-PRS-PointA*.**Proposal 2 Do not include *dl-PRS-SubcarrierSpacing* and *dl-PRS-CyclicPrefix* for PDC PRS. PDC PRS share the same subcarrier spacing and cyclic prefix as the downlink of the serving cell.** |

**Feature lead:** Aligned with my original thinking, that is why I didn’t include these parameters as the potential RRC parameters for PRS for PDC. The default assumption should be that any parameters not included in the latest excel to RAN2 is not needed for PRS for PDC. However, since the issue is raised in the paper here, no harm to further confirm.

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| **Nokia (R1-2201019)**

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| --- | --- | --- |
| *dl-PRS-SubcarrierSpacing*  | Informs on the SCS used for the PRS resource set. Similar as to Point A, the SCS configuration can be derived from the serving cells active DL BWP.  | Do not include. Need to be clarified in 38.214. |
| *dl-PRS-CyclicPrefix*  | Informs on the CP used for the PRS resource set. Similar as to Point A, the CP configuration can be derived from the serving cells active DL BWP.  | Do not include. Need to be clarified in 38.214. |

**Observation: No new RRC parameters (relative to R1-2200699**) **are needed for PRS for PDC purposes. Only *dl-PRS-QCL-Info* needs further discussion.**Based on the above analysis of the identified mandatory parameters in the Release-16 PRS reception procedure from 38.214, we propose the following changes before the existing procedure can be reused for PRS for PDC purposes:**Proposal 1: The following parameters currently needed for the PRS reception procedure in 38.214 should not be specified for PRS for PDC purposes as they can be derived from the serving cell active BWP, which means that *NR-DL-PRS-PositioningFrequencyLayer* is not needed for PRS for PDC:*** ***dl-PRS-SubcarrierSpacing***
* ***dl-PRS-CyclicPrefix***
* **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
 |

**Feature lead:** Aligned with my original thinking, that is why I didn’t include these parameters as the potential RRC parameters for PRS for PDC. The default assumption should be that any parameters not included in the latest excel to RAN2 (i.e. R1-2200699) is not needed for PRS for PDC. However, since the issue is raised in the paper here, no harm to further confirm. In addition, it is true that some clarification is needed in TS 38.214.

### First round discussion

The following question is set for the first round email discussions.

**Proposal 3.1-1: Do not include *dl-PRS-SubcarrierSpacing* and *dl-PRS-CyclicPrefix* for the PRS configuration for RTT-based PDC.**

* **PDC PRS share the same subcarrier spacing and cyclic prefix as the downlink active BWP of the serving cell. Detailed spec change(s) are up to editor(s).**

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| --- | --- |
| *Company* | *View* |
| **Feature lead** | Since similar changes for a few other parameters would be needed for TS 38.214 also, it seems good to leave it to the editor to check and update overall. Of course, if there is any good suggestion, your inputs are always welcome here also.  |
| OPPO | Agree Proposal 3.1-1.  |
| New H3C | We are fine with this proposal  |
| Samsung | Fine |
| vivo | Agree with Proposal 3.1-1. |

## Issue #3-2: whether to include dl-PRS-ID or not?

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| *Nokia (R1-2201019)*

|  |  |  |
| --- | --- | --- |
| *dl-PRS-ID* | Used to uniquely identify a PRS Resource together with PRS-ResourceID or PRS-ResourceSetID. But as we only have a single PRS-ResourceSet for PDC purposes and each PRS-Resouce has an ID in the set, *dl-PRS-ID* is not needed. | Do not include. Needs to be clarified in 38.214. |

**Proposal 2: The following parameters are mandatory for the PRS reception procedure in 38.214, but not needed for PRS for PDC purposes and should not be included:*** ***dl-PRS-ID***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
* ***nr-DL-PRS-ResourceSetID***
* ***NR-DL-PRS-SFN0-Offset***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
* ***nr-DL-PRS-ReferenceInfo***
* ***dl-PRS-CombSizeN***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
 |

**Feature lead:** Aligned with my original thinking, that is why I didn’t include these parameters as the potential RRC parameters for PRS for PDC. The default assumption should be that any parameters not included in the latest excel to RAN2 (i.e. R1-2200699) is not needed for PRS for PDC. However, since the issue is raised in the paper here, no harm to further confirm. In addition, it is true that some clarification is needed in TS 38.214 as highlight below.

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| --- |
| **Copied from 38.214**5.1.6.5 PRS reception procedure**……**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. **……** |

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 3.2-1: Do not include *dl-PRS-ID* for the PRS configuration for RTT-based PDC.**

* **Detailed clarification(s) for the exception handling in TS 38.214 are up to the editor.**

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| *Company* | *View* |
| **Feature lead** | Since similar changes for a few other parameters would be needed for TS 38.214 also, it seems good to leave it to the editor to check and update overall. Of course, if there is any good suggestion, your inputs are always welcome here also.  |
| OPPO | Agree. Because there can be up to only one PRS configuration for PDC, there is no strong need to define the ID.  |
| New H3C | We are fine with this proposal  |
| Vivo  | Agree with Proposal 3.2-1. |

## Whether to include NR-DL-PRS-SFN0-Offset or not?

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| *Nokia (R1-2201019)*

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| --- | --- | --- |
| *NR-DL-PRS-SFN0-Offset* | This parameter sets the SFN0 offset of the gNB transmitting PRS relative to the serving gNB. As we only have a single gNB, this parameter is not needed. | Do not include. Needs to be clarified in 38.214 |

 |

**Feature lead**: Aligned with my original thinking, that is why I didn’t include these parameters as the potential RRC parameters for PRS for PDC. The default assumption should be that any parameters not included in the latest excel to RAN2 (i.e. R1-2200699) is not needed for PRS for PDC. However, since the issue is raised in the paper here, no harm to further confirm. As to whether any clarification needed in TS 38.214, my original understanding is no need for further clarification in the spec since gNB cannot configure this IE for PDC UEs since the corresponding parameter doesn’t exist for PRS PDC configuration. Then for PDC UE, this definition does not apply if my understanding is correct. Let’s hear views from other companies.

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| **Copied from 38.214**5.1.6.5 PRS reception procedure**……***- 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*. **……**9 UE procedures for transmitting and receiving for RTT-based propagation delay compensationFor operation with RTT-based propagation delay compensation, the UE may be configured with either:- one CSI-RS for tracking with higher layer parameter *pdc-Info* for Rx – Tx time difference estimation at UE side and one SRS resource set with *usage-r17*, or- one PRS configuration of higher layer parameter *NR-DL-PRS-PDC-ResourceSet-r17* [12, TS 38.331] for Rx – Tx time difference estimation at UE side and one SRS resource set with *usage-r17*.The related UE procedures for transmitting uplink reference signals and receiving downlink reference signals for RTT-based propagation delay compensation are defined as follows:- for reception of CSI-RS for tracking with higher layer parameter *pdc-Info*, the UE follows the procedures for reception of CSI-RS for tracking defined in Clause 5.1.6.1.1. - for reception of the one PRS configuration provided by RRC [12, TS 38.331] for RTT-based propagation delay compensation, the UE follows the procedure for PRS reception defined in Clause 5.1.6.5 using the configuration information provided by *NR-DL-PRS-PDC-ResourceSet-r17* instead of *NR-DL-PRS-ResourceSet.*- for transmission of an SRS resource set configured with *usage-r17*, the UE follows the procedures for SRS transmission defined in Clause 6.2.1. |

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 3.3-1: Do not include *NR-DL-PRS-SFN0-Offset* for the PRS configuration for RTT-based PDC.**

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| *Company* | *View* |
| OPPO | Agree. |
| New H3C | We are fine with this proposal  |
| vivo | We are fine with the proposal. |

**Question 3.3-1: Do we need any clarification in TS 38.214 if proposal 3.3-1 above is agreed?**

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| --- | --- |
| *Company* | *View* |
| OPPO | Either way is fine. A simple wording for clarification could be: *- 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*. This does not apply to PRS configured by *NR-DL-PRS-PDC-ResourceSet-r17.*   |
| New H3C | It is better to clarify proposal 3.3-1 in TS38.214  |
| vivo | We are open to add the clarification in TS 38.214 or only make a conclusion. |

##  Issue #3.4: the determination of point A for PDC PRS

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| --- |
| LGE R1-2202343For PRS configuration, it was agreed to preclude *dl-PRS-PointA-r16* for simplicity. Since PDC is perform within a single cell, it is reasonable to associate PRS resource with the cell structure for PDC purpose. However, it has not been identified how to determine downlink PRS resource based on single cell structure. In Rel-16, PRS resource is configured by point A, PRS bandwidth and starting PRB are based on the point A. Since PRS for PDC has no point A, it can be considered that UE assumes the point A as the lowest subcarrier index of active downlink cell for PRS configuration for PDC purpose. In this case, starting PRB should be configured based on the assumed point A. Otherwise, it can also be considered to re-use the original point A of active downlink cell in order to fully re-use PRS resource configuration structure.Proposal 2: It is necessary to define how to configure PRS resource for RTT-based PDC without *“dl-PRS-PointA-r16”* |

**Feature lead**: When we made the conclusion not to include *dl-PRS-PointA-r16* in RAN1#107b-e meeting, the assumption is that the point A of the serving cell will be used, which is now captured in the 214 draft CR R1-2200825.

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| OPPO (R1-2201297)***The determination of pointA for PDC PRS***In the current 38.211, the PRS RE allocation in frequency domain is described as following:

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| The reference point for is the location of the point A of the positioning frequency layer, in which the downlink PRS resource is configured where point A is given by the higher-layer parameter *dl-PRS-PointA*. |

 Further, RAN1 #107bis agreed that:

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| **Agreement**Include *dl-PRS-ResourceBandwidth-r16* and *dl-PRS-StartPRB-r16* in *NR-DL-PRS-Resource-r16* for the PRS configuration for RTT-based PDC.**Agreement***dl-PRS-PointA-r16* is not included for the PRS configuration for RTT-based PDC.* RAN1 specification change is expected
 |

However, the above two RAN1 #107bis agreements are a bit conflicting to each other, because according to 37.355 the parameter “*dl-PRS-StartPRB-r16*” is defined based on point-A of PRS, as following:

|  |
| --- |
| ***dl-PRS-StartPRB***This field specifies the start PRB index defined as offset with respect to reference DL-PRS Point A for the Positioning Frequency Layer. All DL-PRS Resources Sets belonging to the same Positioning Frequency Layer have the same value of dl-PRS-StartPRB. |

Therefore, RAN1 should re-define “*dl-PRS-StartPRB-r16*” for PDC PRS in order to indicate the frequency domain location for the starting RE of PDC PRS in a way independent from point-A of positioning PRS. ***Proposal 2: “dl-PRS-StartPRB-r16” for PDC PRS is re-defined as offset in unit of PRB between the starting PRB index of PRS used for PDC and the subcarrier of k=0. This means:**** ***The PRS RE allocation formula in 38.211 is modified as by adding a term , where is indicated by “dl-PRS-StartPRB-r16” for PDC PRS and equal to 0 for positioning PRS.***
* ***The following spec text in current 38.211 is restricted to be applicable to positioning PRS only.***

***“The reference point for is the location of the point A of the positioning frequency layer, in which the downlink PRS resource is configured where point A is given by the higher-layer parameter dl-PRS-PointA.”*** |

**Feature lead**: In the TS 38.214 draft CR R1-2200825 as copied below, it was already captured that the point A is the same as the serving cell, which matches the intention of the agreement below we made in RAN1#107b-e also. Note that in RAN1#107b-e it was already pointed out that if *dl-PRS-PointA-r16* is not included for PRS configuration for PDC, then specification changes needed, which was claimed as the drawback of the agreed option. Similar as what done in the TS 38.214 draft CR, some specification changes needed in TS 38.211 also. The original thinking is to leave it to TS 38.211 editor, but a tentative TP is given in the following section for further discussion.

**Agreement**

*dl-PRS-PointA-r16* is not included for the PRS configuration for RTT-based PDC.

RAN1 specification change is expected



### First round discussion

The following question is set for the first round email discussions.

**Proposal 3.4-1: Endorse text proposal below for TS 38.211.**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.211 v17.0.0-----------------------7.4.1.7.3 Mapping to physical resources in a downlink PRS resourceFor each downlink PRS resource configured, the UE shall assume the sequence is scaled with a factor and mapped to resources elements according to <Unchanged parts are omitted>The reference point for is the location of the point A of the positioning frequency layer if the downlink PRS is not configured for RTT based propagation delay compensation, in which the downlink PRS resource is configured where point A is given by the higher-layer parameter *dl-PRS-PointA*. Otherwise, the reference point for is the location of the point A of the serving cell defined in Clause 4.4.4.2.< Unchanged parts are omitted >--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

|  |  |
| --- | --- |
| *Company* | *View* |
| OPPO | Ok with the principle. In current RAN1 spec, the other DL signal such as CSI-RS has its k=0 subcarrier defined relative to subcarrier 0 in common RB 0. For example, for CSI-RS, the current logic is: * 38.211 7.4.1.5.3: *The reference point for is subcarrier 0 in common resource block 0*.
* 38.211 4.4.4.3: *The center of subcarrier 0 of common resource block 0 for subcarrier spacing configuration coincides with 'point A'*.

So despite of the equivalence, it is suggested to change to the description logic as used for CSI-RS, as following: “The reference point for is the location of the point A of the positioning frequency layer if the downlink PRS is not configured for RTT based propagation delay compensation, in which the downlink PRS resource is configured where point A is given by the higher-layer parameter *dl-PRS-PointA*. Otherwise, the reference point for is ~~the location of the point A of the serving cell defined in Clause 4.4.4.2~~subcarrier 0 in common resource block 0.”Even with above proposal, the parameter “*dl-PRS-StartPRB-r16*” in the current RRC parameter list still needs to be clarified, otherwise it would still follow legacy description to link to “reference DL-PRS Point A”; however, **strictly speaking there is no “DL-PRS PointA” for PDC PRS**. Below is what 38.331 says for starting RB of CSI-RS: “***startingRB***PRB where this CSI resource starts in relation to common resource block #0 (CRB#0) on the common resource block grid. ....”It is suggested to follow the same way as CSI-RS to define starting RB of PDC-PRS in RRC parameter list sent to RAN2.  |
| New H3C | We slightly prefer the original TP from FL proposal |
|  |  |

## Issue #3.5: whether to restrict the same start PRB and bandwidths for any two PDC PRS resources?

|  |
| --- |
| *OPPO R1-2201297*Another issue of frequency domain allocation for PDC PRS is that both *dl-PRS-ResourceBandwidth-r16* and *dl-PRS-StartPRB-r16* are defined per resource for PDC PRS, which is a different way from positioning PRS. For the latter one, all the positioning PRS resources and PRS resource sets in a PRS frequency layer share the same bandwidth and the same starting PRB. Therefore, in order to allow UE reusing the same hardware to perform receptions of PDC PRS and positioning SRS, it is proposed that***Proposal 3: UE does not expect to be configured with different dl-PRS-StartPRB-r16 or different dl-PRS-ResourceBandwidth-r16 for any two PDC PRS resources.*** Note that without the restriction in Proposal 3, * The UE implementation may be different between the reception of PDC PRS and the reception of positioning PRS, which may make it debatable whether the UE feature of PRS-based RTT PDC (FG 25-19a) should take positioning PRS feature as a prerequisite.
* 38.822 says for positioning PRS that “UE is not expected to support DL PRS bandwidth that exceeds the reported DL PRS bandwidth value”. But for PDC PRS, RAN1 needs to clarify whether such “not expected to support” should be applicable to PDC PRS per PRS configuration or per PRS resource, i.e., whether a PRS BW larger than reported capability should invalidate the whole PRS configuration or the corresponding PRS resource only.
 |

**Feature lead:** Since the restriction is adopted by positioning PRS, then it would be fine to apply to PRS for PDC also. However, let’s hear views from other companies first.

### First round discussion

The following question is set for the first round email discussions.

**Question 3.5-1: do you agree with “UE does not expect to be configured with different dl-PRS-StartPRB-r16 or different dl-PRS-ResourceBandwidth-r16 for any two PDC PRS resources”? Please provide your reasons also.**

|  |  |
| --- | --- |
| *Company* | *View* |
| OPPO | Yes, agree.  |
| New H3C | We are fine with this proposal  |
| vivo | Agree. |

## Issue #3-6: Whether to clarify that the comb size for PDC PRS is obtained from *dl-PRS-CombSizeN-AndReOffset* ?

|  |  |
| --- | --- |
| *Ericsson (R1-2201004)*For propagation delay compensation purpose, there is no need to configure NR-DL-PRS-PositioningFrequencyLayer. On the other hand, parameter dl-PRS-CombSizeN was carried by NR-DL-PRS-PositioningFrequencyLayer in 37.355. Thus it needs to be clarified in 38.211 that dl-PRS-CombSizeN is obtained from dl-PRS-CombSizeN-AndReOffset when the PRS for PDC was transmitted.Another editorial change is provided in the TP to clarify that PDC PRS is described in a different section of 38.214.1. Adopt the text proposal to TS 38.211 to provide the comb size configuration for PRS.

|  |
| --- |
| ============= Start of TP to TS 38.211 V17.0.0 ======================7.4.1.7.3 Mapping to physical resources in a downlink PRS resourceFor each downlink PRS resource configured, the UE shall assume the sequence is scaled with a factor and mapped to resources elements according to <Unchanged parts are omitted>- the comb size is given by the higher-layer parameter *dl-PRS-CombSizeN* such that the combination is one of {2, 2},{4, 2}, {6, 2}, {12, 2}, {4, 4}, {12, 4}, {6, 6}, {12, 6} and {12, 12} when the downlink PRS is not configured for RTTbased propagation delay compensation; Otherwise, the combination is given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* and have the same set of candidate combinations.<Unchanged parts are omitted>For a downlink PRS resource in a downlink PRS resource set configured, the UE shall assume the downlink PRS resource being transmitted as described in clause 5.1.6.5 of [6, TS 38.214] when the downlink PRS is not configured for RTT based propagation delay compensation, and as described in clause 9 of [6, TS 38.214] otherwise.=============== End of TP to TS 38.211 V17.0.0 ======================== |

As a reference, the comb size related parameters from TS 37.355 are copied below:NR-DL-PRS-Resource-r16 ::= SEQUENCE { nr-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16, dl-PRS-SequenceID-r16 INTEGER (0.. 4095), dl-PRS-CombSizeN-AndReOffset-r16 CHOICE { n2-r16 INTEGER (0..1), n4-r16 INTEGER (0..3), n6-r16 INTEGER (0..5), n12-r16 INTEGER (0..11), ... }, dl-PRS-ResourceSlotOffset-r16 INTEGER (0..nrMaxResourceOffsetValue-1-r16), dl-PRS-ResourceSymbolOffset-r16 INTEGER (0..12), dl-PRS-QCL-Info-r16 DL-PRS-QCL-Info-r16 OPTIONAL, --Need ON ...}NR-DL-PRS-PositioningFrequencyLayer-r16 ::= SEQUENCE { dl-PRS-SubcarrierSpacing-r16 ENUMERATED {kHz15, kHz30, kHz60, kHz120, ...}, dl-PRS-ResourceBandwidth-r16 INTEGER (1..63), dl-PRS-StartPRB-r16 INTEGER (0..2176), dl-PRS-PointA-r16 ARFCN-ValueNR-r15, dl-PRS-CombSizeN-r16 ENUMERATED {n2, n4, n6, n12, ...}, dl-PRS-CyclicPrefix-r16 ENUMERATED {normal, extended, ...}, ...} |

**Feature lead**: My original intention is also to rely on *dl-PRS-CombSizeN-AndReOffset* to determine the comb size with introducing new RRC parameter. The Text proposal in R1-2201004 looks reasonable to me.

|  |  |  |  |
| --- | --- | --- | --- |
| **Nokia (R1-2201019)**

|  |  |  |
| --- | --- | --- |
| *dl-PRS-CombSizeN* | Specified the resource element spacing. This can be considered redundant when *dl-PRS-CombSizeN-AndReOffset* is already present in the RAN1 RRC parameter sheet of R1-2200699 with parent IE *NR-DL-PRS-Resource*. | Do not include. Needs to be clarified in 38.214 that *dl-PRS-CombSizeN-AndReOffset* is used instead. |

Based on the above analysis of the identified mandatory parameters in the Release-16 PRS reception procedure from 38.214, we propose the following changes before the existing procedure can be reused for PRS for PDC purposes:**Proposal 2: The following parameters are mandatory for the PRS reception procedure in 38.214, but not needed for PRS for PDC purposes and should not be included:*** ***dl-PRS-ID***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
* ***nr-DL-PRS-ResourceSetID***
* ***NR-DL-PRS-SFN0-Offset***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
* ***nr-DL-PRS-ReferenceInfo***
* ***dl-PRS-CombSizeN***
	+ **Related exception handling needs to be clarified in TS 38.214 (specs impact)**
 |

**Feature lead**: My original intention is also to rely on *dl-PRS-CombSizeN-AndReOffset* to determine the comb size with introducing new RRC parameter. The analysis and proposal in Nokia paper looks reasonable to me.

### First round discussion

The following questions and/or proposals are set for the first round email discussions.

**Proposal 3.6-1: Endorse text proposal below for TS 38.211.**

|  |
| --- |
| ---------------------------------Start of Text Proposal to TS 38.211 v17.0.0-----------------------7.4.1.7.3 Mapping to physical resources in a downlink PRS resourceFor each downlink PRS resource configured, the UE shall assume the sequence  is scaled with a factor and mapped to resources elements according to <Unchanged parts are omitted>- the comb size is given by the higher-layer parameter *dl-PRS-CombSizeN* such that the combination is one of {2, 2},{4, 2}, {6, 2}, {12, 2}, {4, 4}, {12, 4}, {6, 6}, {12, 6} and {12, 12} when the downlink PRS is not configured for RTTbased propagation delay compensation; Otherwise, the combination is given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* and have the same set of candidate combinations.<Unchanged parts are omitted>7.4.1.7.4 Mapping to slots in a downlink PRS resource setFor a downlink PRS resource in a downlink PRS resource set, the UE shall assume the downlink PRS resource being transmitted when the slot and frame numbers fulfil<Unchanged parts are omitted>For a downlink PRS resource in a downlink PRS resource set configured, the UE shall assume the downlink PRS resource being transmitted as described in clause 5.1.6.5 of [6, TS 38.214] when the downlink PRS is not configured for RTT based propagation delay compensation, and as described in clause 9 of [6, TS 38.214] otherwise.< Unchanged parts are omitted >--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

|  |  |
| --- | --- |
| *Company* | *View* |
| OPPO | Agree.  |
| New H3C | We are fine with this TP |
| vivo | We are fine with the text proposal. |

**Proposal 3.6-2: Clarify in TS 38.214 that *dl-PRS-CombSizeN-AndReOffset* is used instead of *dl-PRS-CombSizeN* for the PRS reception for PDC.**

* **Detailed change(s) are up to TS 38.214 editor.**

|  |  |
| --- | --- |
| *Company* | *View* |
| **Feature lead** | Since similar changes for a few other parameters would be needed for TS 38.214 also, it seems good to leave it to the editor to check and update overall. Of course, if there is any good suggestion, your inputs are always welcome here also.  |
| OPPO | Agree. |
| New H3C | We are fine with this proposal  |
| vivo | Agree. |

# References

1. RP-201310, Revised WID: Enhanced Industrial Internet of Things (IoT) and ultra-reliable and low latency communication (URLLC) support for NR, Nokia, Nokia Shanghai Bell
2. R1-2201004 Propagation Delay Compensation Enhancements for Time Synchronization Ericsson
3. R1-2201019 On remaining issues of propagation delay compensation Nokia, Nokia Shanghai Bell
4. R1-2201024 Discussion on propagation delay compensation enhancements New H3C Technologies Co., Ltd.
5. R1-2201163 Discussion on propagation delay compensation enhancements ZTE
6. R1-2201297 Remaining issues for PDC OPPO
7. R1-2201696 Open issues for RTT-based propagation delay compensation Intel Corporation
8. R1-2202343 Discussion on propagation delay compensation enhancements LG Electronics
9. R1-2202438 Enhancements for support of time synchronization Huawei, HiSilicon

# Appendix Agreements in the past meetings

**RAN1#102-e**

Agreements:

* Take the following use cases as the representative use cases for further study on propagation delay compensation enhancements in Rel-17.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **User-specific clock synchronicity accuracy level**  | **Number of devices in one Communication group for clock synchronisation** | **5GS synchronicity budget requirement** **(note)** | **Service area**  | **Scenario** |
| 2 | Up to 300 UEs | ≤900 ns           | ≤ 1000 m x 100 m | * Control-to-control communication for industrial controller
 |
| 4 | Up to 100 UEs | <1  µs | < 20 km2 | * Smart Grid: synchronicity between PMUs
 |

Agreements:

* ±8\*64\*Tc/2μ as the TA indicating error is assumed in the evaluation.

Agreements:

For 5GS synchronicity budget requirement,

* One Uu interface is assumed for smart grid.
* Two Uu interfaces are assumed for control-to-control.

Agreements:

For BS transmit timing error, further study the following three options:

* **Option 1**:65 ns
* **Option 2**:±130ns for the indoor scenario and ±200ns for the smart grid scenario
* **Option 3**:82.5 ns

Agreements:

The value defined in Table 7.1.2-1 for initial transmit timing error (Te) in TS 38.133 should be considered for evaluation of the time synchronization.

Agreements:

Asymmetry between downlink and uplink channel for control-to-control scenario is not considered.

Agreements:

100 ns is assumed for BS detecting error.

Agreements:

Timing advance adjustment accuracy defined in Table 7.3.2.2-1 in TS 38.133 is assumed for evaluation of the time synchronization.

Agreements:

Both 15 kHz and 30 kHz are assumed for both control-to-control and smart grid for evaluation of the time synchronization.

Agreements:

Send an LS to RAN2 with the content including

* Inform RAN2 the two representative use cases concluded in RAN1 for further study;
* Ask RAN2 for input about Uu interface error budget for each of the two use cases;

Agreements:

The following options for propagation delay compensation are further studied in RAN1

* **Option 1**: TA-based propagation delay
	+ **Option 1a**: Propagation delay estimation based on legacy Timing advance (potentially with enhanced TA indication granularity).
	+ **Option 1b**: Propagation delay estimation based on timing advanced enhanced for time synchronization (as 1a but with updated RAN4 requirements to TA adjustment error and Te)
	+ **Option 1c:** Propagation delay estimation based on a new dedicated signaling with finer delay compensation granularity (Separated signaling from TA so that TA procedure is not affected)
* **Option 2**: RTT based delay compensation:
	+ Propagation delay estimation based on an RAN managed Rx-Tx procedure intended for time synchronization (FFS to expand or separate procedure/signaling to positioning).

Draft LS R1-2007445 is approved, with final LS in R1-2007446.

**RAN1#103-e**

Agreements:

* Take 65 ns as the assumption of transmit timing error for evaluation of the overall time synchronization error for control-to-control.
* Asymmetry between downlink and uplink channel for smart grid scenario is not considered.
* ~~TA adjustment accuracy is not considered for the evaluation of time synchronization error.~~
* *errorBS,DL,TX* is included in the equation for calculating the overall time synchronization error.

Agreements:

TA adjustment accuracy is not considered for the evaluation of time synchronization error.

Agreements:

For evaluation of the overall time synchronization error for smart grid, companies can take one of the following two options as the assumption for BS transmit timing error:

* Option 1: 200 ns
* Option 2: 65 ns

**RAN1#104-e**

Agreements:Take ±100 ns as the assumption for downlink frame timing detection error (errorUE,DL,RX) at the UE for evaluation of the overall time synchronization error for TA based propagation delay compensation, if downlink frame timing detection error needs to be considered separately.

* Send a LS to RAN4 to ask for clarification on whether downlink frame timing detection error is included in Te or not
	+ In the LS, to include more details about option 1 (included) & option 2 (not included); also including the necessary background
* FFS whether to apply the same value to RTT-based propagation delay compensation, and the corresponding condition (if any) if the same value will be applied

**Decision:** As per email posted on feb 5th, the draft LS is endorsed. Final LS is approved in [R1-2102245](file:///C%3A%5CUsers%5Cc00387628%5CAppData%5CLocal%5CTemp%5CDocs%5CR1-2102245.zip).

**RAN1#104b-e**

Agreements:If downlink frame timing detection error needs to be considered separately from propagation delay estimation error, take ±100 ns as the assumption for downlink frame timing detection error (errorUE,DL,RX) at the UE for evaluation of the overall time synchronization error for RTT based propagation delay compensation

Agreements: Take the following equation for evaluation of the DL propagation delay estimation error for TA based propagation delay compensation:



* Either option 1 or option 2 below will be applied based on the RAN4 reply to RAN1 LS [R1-2102245](file:///C%3A%5CUsers%5Cc00387628%5CAppData%5CLocal%5CTemp%5CDocs%5CR1-2102245.zip).



* FFS whether *errorBS,DL,TX* in the above equation should be included or not.

Agreements:

* Observation 1: Propagation delay compensation based on existing Rel-15/Rel-16 TA procedure and associated granularity, with no enhancements in RAN1, is sufficient for meeting the Uu interface synchronicity error budget in LS R2-2010837 for the smart grid scenario.
* Observation 2: RAN1 needs to further study and specify the feasible enhancement (if any with RAN1 spec impact) for propagation delay compensation for control-to-control scenario, in order to meet the synchronicity budget of Uu interface in LS R2-2010837.

Working assumption:



Agreement:

Take the following as the evaluation assumptions for both RTT-based PDC and TA-based PDC.

* The UE may acquire an up-to-date PD estimation after waking up from DRX. This implies that gNB may signal an update timing advance value or complete a Rx-Tx measurement procedure.
* *errorUE,DL,RX* is based on other signals (e.g. CSI-RS) instead of SSB.
* *errorBS, UL,RX* iss based on other uplink signals instead of contention based PRACH, e.g. SRS.
* Further study and specify new procedure/signaling (if necessary) to ensure that the PD estimation can be acquired after DRX for the adopted PDC method.

Agreement:

Existing DL reference signal(s) are used for Rx – Tx time difference estimation at UE side for RTT-based propagation delay compensation, if RTT-based propagation delay compensation is supported.

* FFS whether PRS can be used for UE Rx – Tx time difference estimation or not
* FFS which DL reference signal(s) to be used if/when PRS is not used

**Conclusion:**

* Leave it to RAN2 to decide whether to support UE based compensation and/or gNB based compensation for any propagation delay compensation method RAN1 may adopt for Rel-17, if applicable.

**RAN1#106-e**

**Agreement**

SRS can be used for Rx – Tx time difference estimation at gNB side for RTT-based propagation delay compensation, if RTT-based propagation delay compensation is supported.

**Agreement**

Send LS to RAN4 to ask for feedback on the following questions:

* **Question 1**: Is it feasible to support a smaller value than the current Te for the use of propagation delay compensation, assuming the existing conditions in TS 38.133 for Te requirement? If not, is it feasible under new conditions (e.g. using TRS instead of SSB)? If the answer is yes, please also provide feedback on how much it can be reduced at most.
* **Question 2**: Is it feasible to introduce enhanced TA command indication granularity? If the answer is yes, please also provide feedback on how much it can be reduced at most (e.g. reduced to (1/16)\* (16\*64\*Tc/2μ)) similar as the granularity for Rel-16 IAB based on the Timing Delta MAC CE and related condition.
* Note 1: The alternatives in the working assumption achieved in RAN1#104bis-e together with the examples in Table 4.2-2 will be included in the LS to give some background for RAN4
* Note 2: The agreement “both SCS 15 kHz and 30 kHz are assumed for both control-to-control and smart grid for evaluation of the time synchronization” achieved in RAN1#102-e will be included in the LS for RAN4 information also.
* Note 3: Inform RAN4 that the enhancements on Te and TA command indication granularity for propagation delay compensation may or may not have impact on normal TA related procedure, depending on which candidate option for TA-based PDC is adopted. Note that this is just for RAN4 information.
* Note 4: Whether RAN1 will introduce specification enhancements is still undetermined.

**Agreement**

If RTT-based propagation delay compensation is supported,

* CSI-RS for tracking (TRS) can be used for Rx – Tx time difference estimation at UE side, if PRS is not configured for the UE.
* PRS can be used for Rx – Tx time difference estimation at UE side, if PRS is configured for the UE.

**Agreement**

Send LS to RAN4 to ask for defining the following for RTT-based propagation delay compensation, if RTT-based propagation delay compensation is supported.

* UE Rx-Tx time difference measurement accuracy *errorUE,RxTxDiff* based on CSI-RS for tracking
* gNB Rx-Tx time difference absolute accuracy *errorUE,RxTxDiff* based on SRS

**R1-2108513** Feature lead summary on propagation delay compensation enhancements Moderator (Huawei)

**Agreement**

Support the following configurations for RTT-based propagation delay compensation, if RTT-based propagation delay compensation is supported.

* At least one CSI-RS for tracking (TRS) configuration for Rx – Tx time difference estimation at UE side if PRS is not configured
* At least one SRS configuration for Rx – Tx time difference estimation at gNB side

**Agreement**

If RTT-based propagation delay compensation is supported and performed at the UE side, the Rx-Tx measurement report provided from the gNB to the UE should include at least:

* gNB Rx-Tx time difference at a given granularity
* FFS whether to include SRS-Resource-ID

**Agreement**

Take the following two alternatives as the equation for evaluation of the overall time synchronization error for RTT-based propagation delay compensation. RAN1 to select one of the alternatives in RAN1#106bis-e.

* **Alt. 1:**



* + is to reflect the error due to indication granularity of Rx-Tx time difference
	+ and reflects the measurement inaccuracy of gNB Rx-Tx time difference, and the measurement inaccuracy of UE Rx-Tx time difference, respectively.
	+ Note: The equation may be updated after clarification on the gNB TX-RX timing difference and UE TX-RX timing difference
* **Alt. 2:**



* + is to reflect the error due to indication granularity of Rx-Tx time difference
	+ Note: Alt.2 assumes that gNB can coordinate the time of TA procedure and the time of PD compensation, so that the DL frame timing error and BS transmit timing error for propagation delay estimation is correlated to (e.g. the same as) that for the transmission of RRC signaling carrying the reference time clock

Note: FFS whether / how to handle inconsistent RTT measurement in gNB and UE due a change of uplink TX timing

**R1-2108618 Draft LS on TA-based propagation delay compensation Moderator (Huawei)**

**Decision:** The draft LS is endorsed with the following note

* Note: It’s pending further discussion in RAN1 whether the WA is to be confirmed including which alternative is to be selected

Final LS is approved in R1-2108635.

**RAN1#106bis-e**

Agreement

For evaluation of the overall time synchronization error for RTT-based propagation delay compensation,

* Alt.1 for RTT-based PDC

Agreement

For evaluation of the overall time synchronization error for TA-based propagation delay compensation,

* Alt.1 for TA-based PDC

Agreement

For evaluation of the overall time synchronization error for RTT-based propagation delay compensation with Alt.1, it is assumed that

* The UE Rx-Tx time difference measurement accuracy based on PRS defined in Table 10.1.25.2-2 in TS 38.133 v17.3.0 is taken as the reference for the UE Rx-Tx time difference measurement accuracy
* The gNB Rx-Tx time difference accuracy based on SRS for positioning defined in Table 13.2.2.2-1 in TS 38.133 v17.3.0 is taken as the reference for the gNB Rx-Tx time difference accuracy based on SRS for PDC

Agreement

For RTT-based PDC, only a single pair of CSI-RS for tracking (TRS)/PRS and SRS configuration, i.e. one CSI-RS for tracking (TRS)/PRS configuration for Rx – Tx time difference estimation at UE side and one SRS configuration for Rx – Tx time difference estimation at gNB side, is configured for PDC in Rel-17, if RTT-based PDC is supported.

Agreement

If RTT-based propagation delay compensation is supported and performed at the gNB side, the Rx-Tx measurement report provided from the UE to the gNB should include at least:

* UE Rx-Tx time difference at a given granularity

Conclusion

When evaluating enhanced TA-based PDC, there is no need to replace Te by TA adjustment error.

Agreement

Send an LS to RAN2 and CC RAN4 with the content including:

* The latest available status on PDC methods in RAN1, e.g. key agreements achieved for TA-based PDC and RTT-based PDC.

[**R1-2110594**](file:///C%3A%5CUsers%5CL00367611%5CAppData%5CLocal%5CTemp%5CDocs%5CR1-2110594.zip) **Draft LS on propagation delay compensation Huawei**

**Decision:** The draft LS is endorsed. Final version is approved in [R1-2110647](file:///C%3A%5CUsers%5CL00367611%5CAppData%5CLocal%5CTemp%5CDocs%5CR1-2110647.zip).

Agreement

For evaluation and comparison of enhanced TA-based PDC and RTT-based PDC, the timing detection error = 0.5/(RS BW) = 0.5/(N\_PRB\*12\*SCS) can be used to achieve and , if needed in the evaluation equation separately, where N\_PRB is the number of PRBs of the RS bandwidth used in the detection by UE and gNB, respectively.

* Note: Detection error achieved by evaluations is not precluded if available.

Agreement

If enhanced TA-based PDC with reduced Te based on TRS is supported in Rel-17, one CSI-RS for tracking (TRS) configuration is configured for enhanced TA-based PDC.

* FFS whether/how to configure UL signal for enhanced TA-based PDC

Agreement

If enhanced TA-based PDC with enhanced TA command indication granularity is supported in Rel-17,

* The enhanced TA command indication granularity introduced for enhanced PDC is applied for PDC purpose, which doesn’t have impact on normal TA procedure, i.e. normal TA procedure will still follow the existing TA command indication granularity.

Agreement

If RTT-based propagation delay compensation is supported, the Rx-Tx time difference is reported with granularity *2k\*Tc*, where *k* is an integer satisfying 0<=*k*<=5.

* FFS the value of *k*
* FFS the reporting range of Rx-Tx time difference measurement for PDC

**RAN1#107-e**

Agreement

If RTT-based PDC is supported, a single granularity 32Tc (i.e. k=5) is supported for Rx-Tx measurement report.

Agreement

For Rel-17

* Support RTT-based PDC method
* Support PDC method based on legacy TA-based mechanism
	+ No RAN1/RAN4 specification impact expected

Agreement

For RTT-based PDC, existing definitions of UE Rx – Tx time difference (i.e. section 5.1.30 in TS 38.215) and gNB Rx – Tx time difference (i.e. section 5.2.3 in TS 38.215) are reused, with updates at least to reflect the single pair of TRS/PRS and SRS configured for RTT-based PDC.

Agreement

Send an LS to RAN2 and RAN4 with the content including:

* The agreements made in RAN1#107-e for propagation delay compensation.
* Ask RAN4 to define the following for RTT-based propagation delay compensation:
	+ UE Rx-Tx time difference measurement accuracy based on CSI-RS for tracking
	+ UE Rx-Tx time difference measurement accuracy based on PRS (including reuse existing spec if appropriate)
	+ gNB Rx-Tx time difference absolute accuracy based on SRS (including reuse existing spec if appropriate)
* Inform RAN4 that enhanced TA-based PDC with reduced Te and enhanced TA command granularity is precluded in RAN1.

Conclusion

For RTT-based PDC, it is assumed that the transmission of DL TRS/PRS, UL SRS and reference time information are associated with a same TRP.

Note: No RAN1 specification impact is expected for this conclusion

Agreement

For RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signalling.

Conclusion

The reporting range of Rx-Tx time difference measurement for RTT-based PDC is up to RAN4.

[**R1-2112729**](file:///C%3A%5CUsers%5CL00367611%5CAppData%5CRoaming%5CMicrosoft%5CDocs%5CR1-2112729.zip) **Draft LS on propagation delay compensation Huawei**

**Decision:** As per email decision posted on Nov 20th, the draft LS is endorsed. Final LS to RAN2/RAN4 is approved in [R1-2112834](file:///C%3A%5CUsers%5CL00367611%5CAppData%5CRoaming%5CMicrosoft%5CDocs%5CR1-2112834.zip).

**RAN1#107bis-e**

Conclusion

SRS for positioning is not supported for RTT-based PDC, regardless of whether TRS or PRS is used for RTT-based PDC.

Conclusion

Measurement gaps should not be mandatory for a UE to process PRS for PDC purposes.

Agreement:

Add *dl-PRS-ResourceRepetitionFactor-r16* and *dl-PRS-ResourceTimeGap-r16* in the RRC parameters list for RTT-based PDC

Agreement:

Include *dl-PRS-ResourceBandwidth-r16* and *dl-PRS-StartPRB-r16* in *NR-DL-PRS-Resource-r16* for the PRS configuration for RTT-based PDC.

Agreement

Add new “*usage-pdc-r17*” field to *SRS-ResourceSet* to indicate that this ResourceSet is used for PDC purpose, meanwhile also indicate that this ResourceSet is used for other purpose by *usage*.

Agreement

* Alt.2: No need to add new “*pathlossReferenceRS-PDC-r17*” field to *SRS-ResourceSet* to indicate a reference signal (e.g. a CSI-RS config or a SS block or a DL-PRS config) to be used for SRS path loss estimation.
	+ Note: With Alt.2, the existing RRC parameter *PathlossReferenceRS-Config* is used to indicate a reference signal (e.g. a CSI-RS config or a SS block) to be used for SRS path loss estimation.

Working Assumption

* Alt.1: Add new “*spatialRelationInfo-PDC-r17*” field to *SRS-Resource* to indicate the spatial relation between a reference RS and the target SRS, with *spatialRelationInfo-PDC-r17* as below:

spatialRelationInfo-PDC-r17 ::= SEQUENCE {

 referenceSignal CHOICE {

 ssb-Index SSB-Index,

 csi-RS-Index NZP-CSI-RS-ResourceId,

dl-PRS-PDC nr-DL-PRS-ResourceID-r16

 srs SEQUENCE {

 resourceId SRS-ResourceId,

 uplinkBWP BWP-Id

 }

 }

}

Note: RAN1 does not pursue further optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source.

Conclusion

For PDC method based on legacy TA-based mechanism, the TA value for PDC is the timing advance value associated with the PTAG of MCG.

Agreement

*"dl-PRS-PointA-r16"* is not included for the PRS configuration for RTT-based PDC.

* Note: RAN1 specification change is expected

Agreement

*“dl-PRS-ResourcePower-r16”* from 37.355 is not included in the RRC parameters list for PRS configuration for RTT-based PDC.

Conclusion

There is no consensus to introduce new RRC parameter “*DL-PRS-PDC-QCL-Info*” to specify the QCL indication with other DL reference signals, for DL PRS configuration for PDC.