**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. |
| Intel | We prefer to discuss minimal changes / clarifications to make this WA operating, instead of dropping the WA. |
| ZTE | Support Proposal 2.1-1. |
| Nokia/NSB | Support Proposal 2.1-1  |
| HW/HiSi | Given the significant spec impact of the WA, we would prefer not confirming it. |
| LG | Support proposal 2.1-1 |
| Ericsson | Do not supportThe gNB TxRxTimeDiff in the PDC operation with PRS should be comparable to that of positioning. For SRS of positioning, DL PRS is available for spatial relation, see below. Thus this is not ‘nice to have’. It’s important to have this to achieve comparable gNB TxRxTimeDiff accuracy as those for positioning in 38.133. 38.331:SRS-SpatialRelationInfoPos-r16 ::= CHOICE {…dl-PRS-r16 DL-PRS-Info-r16 DL-PRS-Info-r16}The concern “*whether/how to apply the SRS for PDC to be used as reference for other signals*” does not make sense. We understood the reason that “*usage-pdc-r17*” was added is, it is acceptable to take away one SRS resource set from MIMO if necessary. Recall that we had pointed out in last meeting that “*usage-pdc-r17*” had the disadvantage that MIMO will have one less dedicated SRS resource set. We were told that this was acceptable compromise, compared to the alternative of introducing a separate SRS configuration for PDC. Thus this SRS resource set should be prioritized for PDC usage, and MIMO usage is opportunistic. We cannot accept any doubt about this understanding at this meeting. Otherwise, a separate SRS configuration for PDC should be accepted.Feature lead: In the end the RRC parameters is agreed in the way to ensure no impact on the potential number of SRS resource sets that can be used for MIMO, that is why now a SRS resource set configured for PDC will for sure be used for one of other MIMO purposes also. With regard to MAC CE concern, we recognize that this issue was raised at last meeting GTW, and this was the reason that WA was made, instead of Agreement. In our understanding, working out MAC CE is consistent with the Note in the WA, and MAC CE was understood to be the issue to further check. * For periodic SRS, no MAC CE is involved.
* For SP- and aperiodic SRS, R1-2200677 showed how the existing MAC CE can be easily modified to support PRS indication. Note that this does not give any “optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source”.

Since there is no show-stopper issue with the WA, the WA should be confirmed. |

**Summary of the status for proposal 2.1-1 based on inputs for the first round**

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| Support | *OPPO, New H3C, Samsung, vivo, ZTE, Nokia, NSB, Huawei, HiSilicon, LG* |
| Not support | *Intel, Ericsson*  |

**FL recommendation**: Most companies prefer not to confirm the working assumption, while Ericsson prefer to confirm the working assumption. Intel prefers to confirm the working assumption without any further optimization, i.e. no modification to MAC CE. The main concern from companies who prefer not to confirm the working assumption is that without the modification to MAC CE, then the gain brought by confirming the working assumption is very limited, meanwhile we still need some additional specification impact at least on RRC parameter. It is recommended to follow the majority view.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**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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| Support | *OPPO, New H3C, Samsung, vivo, ZTE, Nokia, NSB, Huawei, HiSilicon, LG, Intel (can accept)* |
| Objecting companies  | Ericsson |

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| *Company* | *View* |
| Feature lead | @Intel @Ericsson Please check my replies and see if you will still object the proposal.  |
| Intel | We are not objecting the majority view and can accept removing the WA. At the same time we don’t see the issue of keeping the possibility to configured PRS for spatial relation w/o further optimizations.Feature lead: Thank you for being flexible! |
| Ericsson | As explained, there is no show-stopper issue with the WA, the WA should be confirmed.At a minimum, for periodic SRS, no MAC CE is involved. The WA already functional without any further change. Thus, at least for periodic SRS, the WA should be confirmed. Can somebody show what is not working if this SRS resource is configured as periodic?Also: we disagree that an SRS designated for PDC should not be configured firstly for PDC. The MIMO usage is secondary, opportunistic for this SRS. If this is not the understanding, we don’t think Rel-17 PDC can satisfy the performance requirement. RAN4 cannot reuse the positioning gNB RxTxTimeDiff spec for PDC. |

**Summary of the status for proposal 2.1-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this proposal. It seems stable, thus it will be recommended to chairman for email approval.

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| **Ericsson** | **Sorry for late comment. Ericsson object to this proposal.** |

## 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 Table 1 below, while the other rows are according to the existing MAC CE definition. The last row of Table 1 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 1. 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. |
| Intel | We prefer minimal changes thus not to support MAC CE enhancement. |
| ZTE | We share the same view with other companies that MIMO framework should not be impacted. |
| Nokia/NSB | Agree with the others, do not support such enhancements.  |
| HW/HiSi | A modification of the SRS spatial relation MAC CE could be seen as an optimization of the SRS configuration, in that situation it may violate the WA |
| LG | We share similar view to other company, it is preferred not to touch MIMO works.  |
| Ericsson | Although we’ve shown that MAC CE can be easily modified to support SP- and periodic SRS, we can accept not modifying the MAC CE, i.e., limit PRS to pair with periodic SRS only.Note that we don’t think modifying MAC CE to support SP- and periodic SRS with PRS violates the Note in WA. The modification merely enables indication of PRS; it does not do “further optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source”.Also, the proposed changes do not change MIMO configurations. |

**Summary of the status for Question 2.2-1 based on inputs for the first round**

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| **Support** modification to SRS spatial relation MAC CE | *Ericsson* (can accept no modification) |
| **Do not support** modification to SRS spatial relation MAC CE  | *OPPO, New H3C, Samsung, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, LG* |

**FL recommendation**: All companies prefer not to make any change to the existing MAC CE(s) to support DL PRS as a reference signal for spatial relationship derivation for SRS. In addition, per the guidance from Chairman, there should be no change to RAN2/3 unless essential.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Proposed conclusion 2.2-1**: **Do not support any modification to the existing MAC CE(s) for spatial relationship derivation for SRS in Rel-17 IIoT/eURLLC WI, regardless of whether the working assumption on spatial relationship for SRS is confirmed or not.**

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| Support | *OPPO, New H3C, Samsung, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, LG, Ericsson (can accept)* |
| Objecting companies  |  |

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| *Company* | *View* |
| Feature lead | It seems all companies agree it in principle. Companies can comment on the wording.  |
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**Summary of the status for proposed conclusion 2.2-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this conclusion. It is stable, thus it will be recommended to chairman for email approval.

## 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.

**Revised Proposal 2.3-1: The collision of DL PRS for PDC only 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 the PRS that is used only for PDC**
	+ **Clarify in TS 38.214 that PRBs carrying PRS for PDC only 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. Feature lead: 1. If UE the DL PRS for PDC is just the one that is used for positioning, then for sure we will still follow the procedure for positioning on collision handling. However, for the DL PRS that is only configured for PDC purpose, as explained before following R17 positioning procedure would result in much unnecessary waste of resource, because even receiving other DL signals in different PRBs from the ones used for PRS is not allowed. If the main concern is for the case that the PRS is used for both PDC and positioning, then we can revise the proposal to limit it to PDC only case. 2. The spec changes are very simple, since it is the same way as that for CSI-RS for tracking. You can see from the two TPs below, you could tell it is simple. 3. I think it is ok not to make any additional change for UE feature, just similar as CSI-RS for tracking, rate matching is just one of the basic thing for receiving PRS for PDC only. Whether to do rate matching or do the R17 positioning procedure is not the key aspect to justify a new FG.When I looked at the existing collision handling for TRS and collision handling for PRS for positioning, I did agree with a few companies that the collision handling for PRS for PDC is more like that for CSI-RS for tracking, and since the collision handling for TRS is simple, I think we can just reuse it, since it indeed can provide additional benefit. Of course, let’s see the overall situation depending on the views from companies.  |
| 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. Feature lead: Please see my replies above to OPPO. In addition, the intention is not to optimize, but just when comparing the existing collision handling for TRS and existing collision handling for PRS for positioning, the existing behavior for TRS is chosen. However, let’s see the views from companies first.  |
| 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). Feature lead: No rate matching for PRS for positioning. Here just reusing the rate matching for TRS mechanism. In addition, the intention is to avoid unnecessary resource waste as replied above to OPPO comments.  |
| Intel | We think current PRS handling works, no rate-matching is needed. If it is necessary to support simultaneous transmission of PDSCH and RS, then CSI-RS framework can be used for PDC.Feature lead: Yes the proposal is aligned with CSI-RS framework. |
| ZTE | We don’t support this proposal.Since PRS for PDC is transmitted by the serving cell, the collision can be handled by the network. On the other hand, If rate matching is needed, the current framework supports RB level and RE level rate matching for PDSCH via the configuration, which works well. We don’t see the need of this proposal.Feature lead: There is no rate matching for PRS in the existing mechanism yet. The intention is to reuse the rate matching mechanism for CSI-RS for tracking.  |
| Nokia/NSB | Operation should be aligned with the related Rel-17 positioning assumptions, in case the UE does not require a measurement gap.  |
| HW/HiSi | Support the proposal.Agree with the reasons raised by the FL, it is straight forward to support this and otherwise there would be a big waste of resources, considering all symbols that contain PRS are blocked for other channels over the whole band. |
| LG | We are open to this issue. We think the proposal would be good to have for usefulness of SRS-PRS based PDC, but it seems not essential. |
| Ericsson | Do not supportSimilar to several other companies, the same processing should be applied to both PRS for positioning and PRS for PDC. For positioning, PRS can already be monitored outside the measurement gap. |

**Summary of the status for proposal 2.3-1 based on inputs for the first round**

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| Support  | *New H3C, Huawei, HiSilicon*  |
| Do not support  | *OPPO, Samsung, vivo, Intel, ZTE, Ericsson*  |

**FL recommendation**: Most companies don’t support the proposal. However, the question is if we don’t support the proposal, then what behavior for UE to follow. It is not so easy to follow the PRS procedure, detailed as shown in the questions in section 2.3.2.

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

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| ---------------------------------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 the PRS that is only 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. Feature lead: Please see my replies above for proposal 2.3-1. The proposal is updated accordingly also.  |
| Samsung | We don’t support this.  |
| ZTE | We don’t support this TP as discussed above. |
| Nokia/NSB | Let’s first discuss what we want to say, and discuss the detailed TP later on.  |
| HW/HiSi | Support. It is simple and helps resource efficiency.  |
| LG | We are open to this issue.  |
| Ericsson | Do not support. PRS should be treated the same for positioning or for PDC. |

**FL recommendation**: Let’s make decision on proposal 2.3-1 first.

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

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| ---------------------------------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 that is used only for propagation delay compensation 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”. Feature lead: Just following the existing mechanism for TRS. Note that there is no this kind of definition for R16 PRS.  |
| Nokia/NSB | Let’s first discuss what we want to say, and discuss the detailed TP later on.  |
| HW/HiSi | Support.  |
| LG | We are open to this issue.  |
| Ericsson | Do not support. PRS should be treated the same for positioning or for PDC. |

**FL recommendation**: Let’s make decision on proposal 2.3-1 first.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Revised Proposal 2.3-1: The collision of DL PRS for PDC only 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 the PRS that is used only for PDC**
	+ **Clarify in TS 38.214 that PRBs carrying PRS for PDC only should not overlap with CORESET(s) in the OFDM symbols occupied by the search space set(s)**

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| *Company* | *View* |
| Feature lead | Based on the inputs from the first round, most companies don’t support the proposal. However, I would encourage companies to reconsider it again, since at least according to my analysis, it seems the simplest solution while it can provide benefits, compared to follow Rel-17 positioning procedure. The reasons from my side are given as below:If we follow the Rel-17 positioning procedure for the collision handling, we still at least have the following two things to discuss in order to make the final decision:**1. Which type from positioning below to pick for PRS for PDC? Or support all types up to UE capability? Note that the details of the types are still up to discussion in Rel-17 positioning.** * Type 1A refers to the determination of prioritization between DL PRS and other DL signals/channels in all OFDM symbols within the PRS processing window. The DL signals/channels from all DL CCs (per UE) are affected across LTE and NR
* Type 1B refers to the determination of prioritization between DL PRS and other DL signals/channels in all OFDM symbols within the PRS processing window. The DL signals/channels from a certain band are affected
* Type 2 refers to the determination of prioritization between DL PRS and other DL signals/channels only in DL PRS symbols within the PRS processing window

**2. Which option below from positioning to pick for PRS for PDC regarding the priority between PRS and other DL channel/signal? Or support all options up to UE capability? Note that the details of the options are still up to discussion in Rel-17 positioning.** * 1. Option 1: UE may indicates support of two priority states.
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		2. State 2: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	2. Option 2: UE may indicate support of three priority states
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		2. State 2: PRS is lower priority than PDCCH and URLLC PDSCH and higher priority than other PDSCH/CSI-RS
			1. Note: The URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority.
		3. State 3: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	3. Option 3: UE may indicate support of single priority state
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS

**3. How to modify the UE capability for PDC which may depend on the types and/or options to choose for the above first two questions, e.g. we may need to add FG 27-3-2 and FG 27-3-2a for positioning as the prerequisite of FG 25-9a for PDC based on PRS.** **4. What additional updates needed for RRC parameters for PRS configuration? For example, we need to add RRC parameter to configure the priority of PRS if we follow PRS for Rel-17 positioning.**However, based on the analysis in section 2.3.1, it looks to me that following the behaviour for CRS-RS tracking is much simpler and save us much effort. Companies are encouraged to check more and provide your views.  |
| Nokia/NSB | **Fine with the intention of the proposal:** Looking at the discussions below, it seems that FL has a good point here. And trying to rely on the Positioning framework too much (which is still not complete for Rel-17), this may in addition jeopardize the timely completion of PDC in Rel-17. So we couldBut still on the proposal above, **how is the UE to differentiate ‘DL PRS for PDC only’ and ‘other’ DL PRS for PDC’** * Is the ‘only’ meaning a DL PRS resource configured by RRC for RTT or
* Is the UE to determine first, if the DL PRS resource for PDC is not used also for POS? i.e. UE needs to check across all the configured PRS resources for PDC and POS – and only these which are exclusively for RTT (i.e. part of PRS for PDC configured by RRC, but not part of PRS for POS configured by LPP)?

So some clarification what the ‘only’ refers to would be good to have when takin this agreement. Feature lead: For receiving the PRS, UE anyway has to check the time and frequency resource for each DL PRS resource. Then in the end, it would be clear for UE that some of the DL PRS resource(s) are configured for both PDC and positioning purpose. Then for a DL PRS resource that will be used for both purpose, UE will know the positioning procedure should be followed, since the spec defines that rate matching is for PRS for PDC only. Of course, whether UE will check across the sets first or not, that would be up to the implementation I think. From spec perspective, everything is clear, that is for PDC only, then rate matching. For positioning, which implied the case of for both positioning and PDC, then follow the positioning procedure.  |
| OPPO | We are still not convinced to support the proposal. Several further comments as following.1. Assume two neighbouring gNBs A and B respectively serve UE x running PDC and UE y running PRS-based positioning. Now gNB A configures UE x with a DL PRS for PDC-only purpose. Then under proposal of PDSCH rate matching, this DL PRS cannot be informed to LMF for being share-used as a positioning tool, because otherwise gNB-A never knows whether LMF configures this DL-PRS to UE y in cell served by gNB-B and, if LMF does, the PRS measurement by UE-y in the same slot for a PRS from a third neighbouring gNB (say gNB-C) would very likely to be interfered and to fail without any entity knowing the reason. In other words, the network needs to not only keep this DL-PRS as strictly PDC-only use in the serving cell but also likely make sure it is not used as positioning PRS system-wide. So this proposal does not actually save resource but consume resources for a single functional usage, which could have been avoided by using TRS.

Feature lead: In my understanding, even with the proposal here the sharing can still be done. In your example, PRS for PDC and PRS for positioning sharing the same time and frequency resource, then if gNB will schedule PDSCH for UE x running PDC, gNB can do rate matching for the PDSCH, in this case since the resource is already occupied by PDSCH for UE x, there is no PDSCH scheduled there for UE y, there is no collision for UE y. In a word, it is clear at the gNB side that the collision is for PDC or for positioning. At the UE side, UE doesn’t need to know what it is for other UEs, just look at what it is for itself. [OPPO] In this case, the issue is not the collision but the interference from PDSCH of gNB-A (for UE-x) to PRS (received by UE-y from gNB-C). Feature lead: I don’t understand the interference part actually. If the PRS is shared for PDC and positioning, then all gNBs will see the same time and frequency resource for this PRS? If yes, then even under other gNBs, UEs will not take the signal transmitted on other REs for the measurement. 1. The proposal only addresses the collision between PDC-PRS and PDSCH that are configured and scheduled to the same UE. It does not address the same collision for UE-x between PDSCH scheduled to UE-x and the PDC-PRS not configured to UE-x. As a specific example, what if that PDSCH is a broadcast PDSCH?

Feature lead: If this is an issue, it exists for TRS also, right? As described before, the behavior here is to follow the mechanism for receiving TRS. [OPPO] My understanding is that TRS resource can work with rate matching by configuring ZP CSI-RS whose pattern matches that of TRS, i.e., UE-x can see ZP CSI-RS for rate matching although it does not see PDC-TRS. Feature lead: There are other signals for rate matching also, e.g. PT-RS. In my understanding, this would not be an issue, since it is gNB do the scheduling, if it is broadcast PDSCH it would be able to avoid this kind of collision. The intention here is to allow rate matching then at least unicast can be transmitted there, then the resource can be used. 1. Rel-17 positioning agenda discussed prioritization between PRS and other DL signal. However the rate matching or other multiplexing solution has not been discussed over there. As UE vendor, we do not prefer to make two tracks of PRS mechanisms to become more and more different.

Feature lead: Anyway the measurement and receiving for PRS for PDC and PRS for positioning is already different, right? In addition, the proposal here is just to reuse the rate matching behavior for TRS, receiving TRS is mandatory, therefore I think there is no additional complexity. [OPPO] But prioritization vs. rate matching pushes the difference to another level. 1. The concerned resource utilization issue should not be big, given the resource utilization picture is the same as in Rel-16 positioning situation and the NW could use TRS in Rel-17 for PDC if PDC-PRS is not satisfactory on resource side.

Feature lead: As explained before, the real worry is that if we follow positioning procedure, there are a lot of remaining issues to be discussed especially that R17 positioning itself is still discussing their solutions, which may have impact on the completion of the URLLC WI here. The benefit of avoiding resource waste is kind of additional benefit, not the main focus. [OPPO] Using TRS would not lead to issues mentioned with PRS. Even with PRS, staying under Rel-16 situation also avoids the potential issues caused by Rel1-7 positioning solution. So our point is: do not try Rel-17 PRS prioritization for PDC, and do not try PDSCH rate matching around PRS either.Feature lead: According to current agreements, only either TRS or PRS can be configured for PDC, which means you cannot dynamically use TRS when the collision is expected to happen. Or the only choice is not to configure PRS for PDC always.  |
| Samsung | We admit the issue is better to be clarified. However, if the design goes to this direction, i.e., similar as CSI-RS other than PRS, we wonder during UE feature discussion, whether this PRS based RTT needs to follow the capability of PRS for Positioning. Feature lead: The current assumption among companies is not to follow positioning in the UE feature discussion. In our understanding, the intention/motivation to agree on PRS based solution is to use this RTT information from Position for “free”, however, current PRS design looks more like TRS other than PRS, e.g., rate matching. We don’t see the need to do so. This will cause UE implementation impact on regular PDSCH decoding procedure. We cannot accept this direction. Feature lead: I understand your concern. The problem is that if we go follow the positioning, as analyzed above actually we have much more additional things to discuss or much more specification impact. So not free any more. ☺For collision handling, we can compromise to some direction like: UE doesn’t expect collision between PRS for PDC and PDSCH or CSS for PDCCH, or follow the capability as PosFeature lead: If we go this way, actually it is equal to have measurement gap for PRS for PDC, but we agreed with the conclusion that measurement gap is not mandatory for PRS for PDC  |
| ZTE | We still don’t think this proposal is needed. If rate matching around PRS is needed indeed, the network can configure the ZP CSI-RS with the same pattern with PRS. Then the UE should perform rate matching round ZP CSI-RS as well as PRS. We don’t see any issue.Feature lead: Please see my reply to OPPO.  |
| LG | As we commented before, we are open to this issue. We have some comments. PRS and TRS for PDC were agreed to support in order to re-use existing mechanism for each side. Therefore, it could not be an issue that one is better than the other. For PRS, we prefer to have same/similar UE behaviors for PRS for PDC as UE behaviors for PRS for positioning. The proposal basically says “handle PRS as TRS in terms of reception procedure”, it is difficult to accept at once. As FL mentioned, we think that how to handle dependency of PRS for PDC on positioning would need to be discussed than how to rate-match for PDSCH. Those capability issue cannot be entirely gone even if the proposal is agreedFor dependency, our view is to make PRS for PDC work as PRS for positioning as much as possible, e.g., make positioning FG pre-requisite and let positioning WI decide to how it works. Of course, we can distinguish PRS for PDC from positioning UE behavior, so that PRS for PDC become easier to be utilized. However, we are not sure that it is good idea to check whether to include positioning progress into PRS for PDC every times.Feature lead: It is kind of common understanding in the previous discussion that we should decouple PRS for PDC with PRS for positioning.  |
| vivo | We also have concern on this proposal. In our understanding, the PDSCH rate matching by a PDC-PRS for a UE in a serving cell may lead to different interference condition on PRS measurement of UEs from different cell if multiple PRSs including the PRS are configured for positioning. Feature lead: Please see my reply to OPPO. |
| Intel | We suggest that R17 gap-less positioning operation is not reused, thus no need for priority and RRC parameters discussion. What we target is to use R16 assumption that PRS do not overlap with other channels.As we commented earlier, for optimized multiplexing of RS and PDSCH/PDCCH, it is better to use TRS option rather than PRS.If we go this way, actually it is equal to have measurement gap for PRS for PDC, but we agreed with the conclusion that measurement gap is not mandatory for PRS for PDC |

**Question 2.3-1: If the collision of DL PRS for PDC and other DL channel/signal(s) is handled following the mechanism defined for Rel-17 PRS positioning, which type below from positioning do you prefer for PRS for PDC? Or do you prefer to support all types up to UE capability?**

* Type 1A refers to the determination of prioritization between DL PRS and other DL signals/channels in all OFDM symbols within the PRS processing window. The DL signals/channels from all DL CCs (per UE) are affected across LTE and NR
* Type 1B refers to the determination of prioritization between DL PRS and other DL signals/channels in all OFDM symbols within the PRS processing window. The DL signals/channels from a certain band are affected
* Type 2 refers to the determination of prioritization between DL PRS and other DL signals/channels only in DL PRS symbols within the PRS processing window

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| *Company* | *View* |
| Nokia/NSB | If we go down that route (which is not preferred as noted in our reply to 2.3-1), we just simply pick a single determination mode and not introduce additional capabilities. If this is not fully clear yet in positioning, we may need to first wait on the outcome from the positioning discussions. Still a note here, it seems at at least the first bullet would not be applicable, as the PRS for PDC is only received on a single DL CC / single DL serving cell based on our understanding.  |
| OPPO | We do not think the group has to pick one type from 1A/1B/2. All these three types are designed for Rel-17 positioning, where the PRS not only comes from serving cell but also remote cells, which the UE does not care to distinguish. So it is even premature to list 1A/1B/2 as candidates for PDC. As mentioned in 1st round, we think Rel-17 PDC could assume Rel-16 limitations on resource allocation between PRS and other DL signals, or put it in a wording as following: *For a UE configured to measure a PRS for RTT-based PDC, the UE does not expect to be configured/scheduled to receive DL signals in symbols overlapping with the PRS.* Feature lead: If we go this way, actually it is equal to have measurement gap for PRS for PDC, but we agreed with the conclusion that measurement gap is not mandatory for PRS for PDC. [OPPO] It may look like that way. But there is no measurement gap configuration anyway, and the PRS measurement delay due to measurement gap is gone because now it is other DL signal that gives their ways to PRS by gNB implementation.  |
| Samsung | Agree with Nokia that we shall avoid to introduce new capability for PRS based PDC. Or, we can simply say that, UE doesnot expect such collision. We think PDC is not very frequent event and it should be acceptable.  |
| vivo | It is unnecessary to adopt solutions for Rel-17 PRS positioning because PRS transmission for PDC only comes from serving cell. These solutions would make the discussion more complicated. We suggest gNB implementation to solve this issue. |
| Intel | We don’t think that reusing R17 gap-less positioning procedures is justified. |

**Question 2.3-2: If the collision of DL PRS for PDC and other DL channel/signal(s) is handled following the mechanism defined for Rel-17 PRS positioning, which option from positioning below do you prefer for PRS for PDC regarding the priority between PRS and other DL channel/signal? Or do you prefer to support all options up to UE capability?**

* 1. Option 1: UE may indicates support of two priority states.
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		2. State 2: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	2. Option 2: UE may indicate support of three priority states
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS
		2. State 2: PRS is lower priority than PDCCH and URLLC PDSCH and higher priority than other PDSCH/CSI-RS
			1. Note: The URLLC channel corresponds a dynamically scheduled PDSCH whose PUCCH resource for carrying ACK/NAK is marked as high-priority.
		3. State 3: PRS is lower priority than all PDCCH/PDSCH/CSI-RS
	3. Option 3: UE may indicate support of single priority state
		1. State 1: PRS is higher priority than all PDCCH/PDSCH/CSI-RS

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| Company | View |
| Nokia/NSB | If we go that route (which is not preferred by us, based on FL discussions), we should go for Option 3. For this case actually there is no need for UE to indicate anything (as we have a fixed prioritization here already), which could be either State 1, State 2 or State 3 fixed in the specifications.  |
| OPPO | Same comment from us as for Question 2.3-1.  |
| Samsung  | Same comment from us as for Question 2.3-1. |
| vivo | The discussion on these options is still open in positioning AI. We should avoid waiting the progress from other AI considering the limited time.  |
| Intel | We don’t think that reusing R17 gap-less positioning procedures is justified. |

**Question 2.3-3: If the collision of DL PRS for PDC and other DL channel/signal(s) is handled following the mechanism defined for Rel-17 PRS positioning, how to modify the UE capability for PDC, e.g. do we need to add FG 27-3-2 and FG 27-3-2a for positioning as the prerequisite of FG 25-9a for PDC based on PRS?**

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| Company | View |
| Nokia/NSB | We don’t prefer to couple the related capabilities between PDC and POS.  |
| OPPO | All these questions assume the gNB has to put PDC-PRS and other DL channel/signals together in a way of collision. We do not think RAN1 should discuss this new issue at this late stage, given the collision is not unavoidable and any of following tools may work: 1. use TRS; or
2. put PDC-PRS in a isolated scheduling time unit (from a single UE perspective) like Rel-16 positioning PRS;
3. mark sufficient symbols holding PDC-PRS as reserved (supported since Rel-15), and leave other symbols in the scheduling time unit usable for other DL signals.

Feature lead: If we go this way, actually it is equal to have measurement gap for PRS for PDC, but we agreed with the conclusion that measurement gap is not mandatory for PRS for PDC. |
| Intel | We don’t think that reusing R17 gap-less positioning procedures is justified. |

**Question 2.3-4: If the collision of DL PRS for PDC and other DL channel/signal(s) is handled following the mechanism defined for Rel-17 PRS positioning, what additional updates needed for RRC parameters for PRS configuration, e.g. do we need to add RRC parameter to configure the priority of PRS and/or to configure PPW?**

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| Company | View |
| Nokia/NSB | As commented above, we do not see a need for such configuration for the priority of PRS, but should fix this in the specification to keep it simple.  |
| OPPO | Again, before jumping into the complication to solve the collision, could FL explain why the collision has to be existing to require a solution? Feature lead: As explained before, since we have agreed with the conclusion that measurement gap is not mandatory for PRS for PDC, then we need to discuss how to handle the collision behavior. If collision is not allowed to happen as you commented before, then actually it is equal to the behavior that measurement gap is always assumed.[OPPO] Please see my comment under Q2.3-1.  |
|  |  |

**Question 2.3-5: Do you have any other candidate solution for handing the collision of DL PRS for PDC and other DL channel/signal(s), e.g. leave it to gNB implementation to avoid the collision?**

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| Company | View |
| OPPO | As mentioned earlier, tools to avoid collision include:1. use TRS; or
2. put PDC-PRS in a isolated scheduling time unit (from a single UE perspective) like Rel-16 positioning PRS;
3. mark sufficient symbols holding PDC-PRS as reserved (supported since Rel-15), and leave other symbols in the scheduling time unit usable for other DL signals.
 |
| Samsung | UE does not expect such collision.  |
| ZTE | The network implementation can void the collision at first. In case collision occurs, the current rate matching pattern covering PRS can be used, where the rate matching pattern is configured by the network. |
| vivo | We support gNB implication to avoid the collision.  |
| Intel | Agree with OPPO examples |

### Third round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Proposal 2.3-2: For a UE configured with DL PRS for RTT-based PDC, the UE doesn't expect to be configured/scheduled to receive any other DL channel/signal in the PRBs that overlap those of the DL PRS for PDC in the OFDM symbols occupied by the DL PRS for PDC.**

* **Spec change(s) is up to the editor**

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| *Company* | *View* |
| Feature lead | Based on the discussion in the previous two rounds, it seems the views are diverse, and it is impossible to agree with either doing rate matching similar as that for TRS or handling collision following the Rel-17 positioning procedure. It seems more companies would like to go to the direction that introducing some restriction to avoid the collision. Therefore, the above proposal is made for further discussion.  |
| OPPO | Under current circumstance the latest proposal is better than going toward new rate matching around PRS or Rel-17 PRS prioritization. But maybe an even better choice is to say nothing new in Rel-17 spec at all, because: * Current RAN1 spec already gives sufficient and well-categorized solutions to prevent PDSCH from stepping on “unavailable resources” per both symbol level and RE level. The coexistence between PRS and PDSCH in the same PRB is possible (if gNB ensures this PRS does not join in positioning LMF) as long as the “legacy-reserved” REs makes PRS fully invisible to PDSCH allocation. I did not check in detail whether ZP CSI-RS pattern can work at least in some cases but it is commented by ZTE to be an available solution. From this perspective, the proposal could be over-conservative and unnecessary because the proposal comes from event of collision which is however avoidable even without configuration/scheduling restriction.

Feature lead: If we don’t want to introduce rate matching, then we need to make it clearer that DL PRS for PDC and PDSCH cannot be in the same PRB, otherwise there would be ambiguity at both gNB and UE side on whether they can be in the same PRB or not. Note that in my understanding, we cannot use ZP CSI-RS pattern to cover PRS, e.g. they actually have totally different patterns. If we want to introduce restriction to avoid the collision, it is better to make it clearer in the spec.[OPPO-2] Our understanding on using ZP CSI-RS could be different. For example,if PRS takes ={4,4}, the PRS pattern in a PRB would look like in figure below (horizontal axis is time, vertical axis is frequency), where the PRS REs are shaded REs. The given proposal from FL seems to say all the REs, including the non-shaded REs, are not available for PDSCH. In contrast, by using four ZP CSI-RS resources, each of which follows “Row 1” in Table 7.4.1.5.3-1 of 38.211, all non-shaded REs in the figure are available to PDSCH. Please note people may not need to check the matching between all PRS patterns and all ZP CSI-RS patterns to challenge the proposal, only a few matching could be enough. Even the ZP CSI-RS resource pattern or resource set pattern that covers a bit more than the shaded REs could be better than the given proposal.

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 * The current spec leaves a chance of giving the avoidance of potential collision between positioning-PRS and other DL signal, if that collision cannot be fully avoided by existing tools, to gNB implementation, without saying “UE does not expect to...”. The same logic could be applicable to PDC PRS as well.

Feature lead: The problem is that if we say nothing, then gNB doesn’t knows that it needs to avoid the collision, then there is ambiguity at both gNB and UE side. [OPPO-2] Why doesn’t the gNB know? In the collision case, the gNB has to transmit both PRS RE and other DL signal RE in the same RE location. The gNB cannot do such if it fully follows the behaviors defined in 38.211. So our preference is not to introduce new text at all to Rel-17 for this collision concern. If people do prefer to land on something for this discussion, our suggestion is to have a following conclusion: ***Suggested conclusion: Rely on existing specification solutions and gNB implementation to avoid collision between PDC-PRS and other DL signals.*** [OPPO update] For now we see mainly two logic directions: * Logic-1 (FL Proposal): the collision is defined directly between PRS PRB+symbol and PDSCH (without using any existing tools). We see it would waste more resources than Logic-2.
* Logic-2 (OPPO, ZTE): the collision (if any) is defined between PRS RE and PDSCH RE (after applying the existing tools such as rate matching around ZP CSI-RS).

With Logic-2, the decision could be made between the following two options: * Option-1: Rel-17 spec says nothing for avoidance of collision between PDC PRS and other DL signals. RAN1 can end up with a conclusion as we suggested above. The collision could be avoided by using existing tools and/or in a way as gNB avoids the PDSCH collision on the Rel-16 positioning PRS transmission from its own.
* Option-2 (if the group cannot go with Option-1): Rel-17 RAN1 spec could say something like “***UE does not expect RE level overlapping between reception of PDC PRS and reception of other DL signals***”, i.e., this alert is on RE level (instead of PRB+symbol level as provided in FL proposal).
 |
| Samsung | We support FL’s proposal. We think rely on existing solution to avoid collision is an implementation issue.  |
| Ericsson | We support the proposal above.After further checking, we also agree that it is not desirable to discuss how to rate match. The ongoing rate matching discussion for PRS of positioning is complicated and not applicable to PDC. For positioning, the PRS come from different gNBs. For PDC, there only one PRS resource set from serving cell, and the gNB can easily avoid collision by scheduling. |
| ZTE | We are fine with the suggested conclusion from OPPO or the following updates. If the views are diverse, using the current mechanism is the best choice. For the proposal, there may be a risk to restrict the network implementation.**For a UE configured with DL PRS for RTT-based PDC, the UE doesn't expect to be configured/scheduled to receive any other DL channel/signal in the PRBs that overlap those of the DL PRS for PDC in the OFDM symbols occupied by the DL PRS for PDC.*** **~~Spec change(s) is up to the editor~~ The current mechanism is used and on spec impact is expected.**

Feature lead: Please see my replies to OPPO above. The working “the current mechanism” from your suggestion is not clear. If the main bullet is the common understanding, it would be already good to make it clearer to avoid any potential ambiguity.  |
| Nokia/NSB | We support the proposal. On the sub-bullet (if there is a need for specs change), I guess this could be further looked at but let’s try to focus on first seeing what we want to have here. But leaving this to editor for now (incl. if there is a need to capture this or not), could be an option. If the editor does not see a need for this (after this meeting), we can still discuss in future meetings based on individual company TPs.  |
| ZTE2 | As in our comments provided in the second round, the current mechanism is that the network can configure ZP CSI-RS to cover PRS, just like the ZP CSI-RS configured for UE 1 can cover the downlink RS configured for UE 2 so that the rate matching can be performed around the DL RS for UE 2. Regrading the comment that the ZP CSI-RS cannot cover PRS, we don’t think so. Actually, a PRS resource and a ZP CSI-RS resource may have the different pattern. But multiple ZP CSI-RS resources can be configured so that they can match to the PRS. For example, for the PRS pattern in the example provided by OPPO, four ZP CSI-RS resources with density 3 in the frequency can be configured. The first one is in the first symbol with frequency shift=0. The second one is in the second symbol with frequency shift=2. The third one is in the third symbol with frequency shift=1. The fourth one is in the fourth symbol with frequency shift=3. Then the UE can perform rate matching correctly. Is there any issue?In addition, we agree with OPPO that ZP CSI-RS can cover a bit more than PRS. Anyway, the network and the UE have the same understanding on the rate matching. So could you please give a detailed example that ZP CSI-RS cannot be used.At last, if the intention of the proposal is to avoid the PRS and the other signals/channels in the same PRB, then we don’t think it is needed since it can rely on rate matching with RB level. |

## 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.Feature lead: As discussed in previous meeting, even with the time stamp information, inconsistent cannot be ensured. We agreed to ensure it by other way.  |
| 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.  |
| Intel | It is unclear how the timestamp would help if the UE Rx-Tx time difference is measured over multiple PRS occasions. |
| ZTE | The benefit and motivation of the time stamp is not clear.  |
| Nokia/NSB | Do not include timestamp in the Rx-Tx measurement report,We agree with other companies that it is not needed. |
| HW/HiSi | Currently we don’t see a need to include a time-stamp. It would be great if proponents could elaborate on the advantages and disadvantages with/without using a time-stamp. |
| LG | We prefer not to add the timestamp for PDC signaling. |
| Ericsson | Support. The purpose is to ensure that gNB side measurement and UE side measurement are taken at (approximately) the same time, so that the derivation of propagation delay is meaningful. This assumption was fundamental in the RAN1 evaluations. Otherwise, the propagation delay has an uncontrolled error component which was never accounted for. This is a big issue if the UE is mobile.If the time stamp is not included, then RAN1 specification should ensure this implicitly. For example, specify that the (gNB or UE) RxTxTimeDiff measurement carried in the measurement report is performed using the last available instance of (UL or DL) reference signal configured for PDC.Feature lead: As discussed in previous meeting, even with the time stamp information, inconsistent cannot be ensured. In the end RAN1 concluded no any further enhancements for it.  |

**Summary of the status for question 2.4-1 based on inputs for the first round**

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| Support including time stamp in the measurement report of Rx-Tx time difference  | *New H3C, Ericsson*  |
| Don’t support including time stamp in the measurement report of Rx-Tx time difference | *OPPO, Samsung, vivo, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, LG* |

**FL recommendation**: Majority companies prefer not to include time stamp in the measurement report of Rx-Tx time difference. Indeed RTT inconsistent was discussed in previous meeting and concluded with no further enhancements in RAN1. Therefore, it is recommended to follow the majority view.

**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* |
| Ericsson | Yes |
|  |  |

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Proposed conclusion 2.4-1**:  **No need to include time stamp in the measurement report of Rx-Tx time difference for PDC.**

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| Support | *OPPO, Samsung, vivo, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, LG* |
| Objecting companies  |  |

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| --- | --- |
| Company | View |
| Feature lead | @ New H3C @ Ericsson Please check my replies above and see if it is ok for you. |
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**Summary of the status for proposed conclusion 2.4-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this conclusion. It is stable, thus it will be recommended to chairman for email approval.

## 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.

|  |
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| 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. Feature lead: RAN1 sometimes discusses the procedure for RRC inactive or idle mode also. If we can achieve consensus, it is still beneficial to conclude. It is not clear to me yet whether any RAN1 spec changes needed or not, companies view are welcome also.  |
| New H3C | We are fine with this proposal. |
| Samsung | Yes.  |
| vivo | Fine with the proposal. |
| Intel | Agree |
| ZTE | We think it is reasonable. But we wonder if this has spec impact. From our view, a conclusion is enough.Feature lead: For safer, let’s make it as a proposal first. If in the end no any RAN1 specification, that would be fine also. |
| Nokia/NSB | Agree |
| HW/HiSi | Agree |
| LG | Agree |
| Ericsson | SupportIn our view, an agreement is needed. This should be reflected in the specification, since the UE behavior is different from that in the existing spec, see TS 38.214 section 5.1.6.5.  |

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

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

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

* **Spec change if any is up to the editor**

|  |  |
| --- | --- |
| Support | *New H3C, Samsung, vivo, Intel, Nokia, NSB, Huawei, HiSilicon, LG, Ericsson, ZTE (fine)*  |
| Objecting companies  |  |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ OPPO @ ZTEPlease check my replies above and see if the proposal is fine for you. |
| OPPO | Given FL’s response to OPPO and ZTE, we are fine to the proposal with following tune-up: **Proposal 2.5-1: For RTT-based PDC, the UE is expected to receive PRS only in RRC\_CONNECTED mode.** * **The above does not imply from RAN1 perspective that UE can receive or maintain valid PRS configuration for PDC purpose outside of RRC\_CONNECT mode.**
* **It is up to spec editor whether to have RAN1 spec impacts.**

 Feature lead: I will include the second sub-bullet. But can you clarify why we need the first sub-bullet? From the main bullet of the proposal, it should be clear that UE will only receive PRS for PDC in connected mode, i.e. won’t receive PRS for PDC outside of connected mode, right? [OPPO] If UE cannot have PRS configuration outside of RRC\_CONNECT, there is certainly no PRS for UE to measure and the proposal itself provides no useful information. Then we do not want this proposal to be treated by RAN2 in a way that: in order to make this RAN1 proposal meaningful, UE should have a chance to maintain PRS configuration outside of RRC\_CONNECT. Feature lead: The intention of this proposal is to differentiate the case for positioning, where PRS can be measured in RRC inactive state. I see your worry but I think RAN2 should not get that kind of interpretation, otherwise RAN1 doesn’t need to draw this conclusion.  |
| ZTE | We are fine with this proposal but we prefer not to have any spec impact. Feature lead: Thanks for being flexible. In the note it says “if any”, it is up to editor’s discretion. |

### Third round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

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

* **Spec change if any is up to the editor**

|  |  |
| --- | --- |
| Support | *New H3C, Samsung, vivo, Intel, Nokia, NSB, Huawei, HiSilicon, LG, Ericsson, ZTE (fine)*  |
| Objecting companies  |  |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ OPPO Please check my replies above and see if the proposal is fine for you. |
| OPPO | We can accept the proposal.  |
|  |  |

**Feature lead**: Based on the discussion, Revised Proposal 2.5-1 is stable. It is recommended for email approval.

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

|  |
| --- |
| *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.**

|  |  |
| --- | --- |
| *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.** Feature lead: Both ways actually achieve the same thing, i.e. UE will only measure within the active BWP. And the point that really cares is the measurement due to measurement gap. So let’s try the original proposal.  |
| New H3C | We are fine with FL proposal with OPPO’s modification. |
| Intel | We agree with the intention. |
| ZTE | We think this is the UE implementation. We don’t need such restriction. Feature lead: Since we agreed that no measurement gap, it seems the restriction is reasonable. |
| Nokia/NSB | We support the proposal from FL.  |
| HW/HiSi | Agree |
| LG | Agree |
| Ericsson | Support |

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

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

|  |  |
| --- | --- |
| Support | *Samsung, vivo, Intel, Nokia, NSB, Huawei, HiSilicon, LG, Ericsson, OPPO (acceptable), ZTE (fine)* |
| Objecting companies  |  |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ OPPO @ ZTECan you check and see if the proposal can be acceptable for you? |
| OPPO | The proposal is acceptable to us.  |
| ZTE | We are fine to follow the majority view. |

**Summary of the status for proposal 2.6-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this conclusion. It is stable, thus it will be recommended to chairman for email approval.

## Other issues

|  |
| --- |
| 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.

|  |  |
| --- | --- |
| *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 |
| Intel | No need for clarification |
| ZTE | Seems reasonable. If both PRS and CSI-RS are configured, which signal used for PDC is up to UE implementation. But we wonder why both RS is configured. |
| Nokia/NSB | We agree with the FL assessment that this issue does not exist. The UE is configured with either PRS or CSI-RS for RTT based PDC, and in case the DL RS is not available, the measurement will simply not be made.  |
| HwHiSi | Agree with the assessment, |
| LG | Agree with the FL.  |
| New H3C2 | If majority views think this issue needn’t be addressed, we are also fine with it. |

# 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

|  |
| --- |
| ***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.

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

|  |  |  |
| --- | --- | --- |
| *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).**

|  |  |
| --- | --- |
| *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. |
| Intel | Agree, PRS for PDC purposes should derive necessary parameters from the active DL BWP. |
| ZTE | In our understanding if a physical signal is configured based on a BWP or associated with a BWP, then the configuration of the CP and SCS are not needed for the signal and are the same with the associated BWP. For PRS for PDC, we don’t configure an associated BWP for PRS. Is our intention to introduce an associated BWP for PRS for PDC? Feature lead: No intention to introduce any associated BWP, just follow the normal behavior to receive the DL signals from the serving cell. If not, what if the BWP switching occurs with SCS change? If yes, then I guess this may be a bit impact for PRS for PDC. In general, if a physical signal is configured based on a BWP, the frequency resource is determined based on the BWP and the bandwidth should not exceed the associated BWP. But, for PRS for PDC, the frequency resource is determined based on point A. There is no restriction that PRS should be within the a BWP. Of course, PRS for PDC can be seen as an exception. However, from our view, we prefer to keep these two parameters to minimize the spec impact. Therefore, we don’t support this proposal.Feature lead: The two parameters exist for positioning is just because of receiving PRS from neighbor cell, for PDC there is no this kind of case. In addition, all the procedure here is just to follow the existing behavior to receive the DL signals, the SCS for the signals should be aligned with that for the active BWP unless indicated specifically.  |
| Nokia/NSB | Support the proposal. |
| HE/HiSi | Agree |
| Ericcson | Support |

**Summary of the status for proposal 3.1-1 based on inputs for the first round**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, Samsung, vivo, Intel, Nokia, NSB, Huawei, HiSilicon, Ericsson*  |
| Not support | *ZTE*  |

**FL recommendation**: Almost all companies agree with proposal 3.1-1, while ZTE has some questions for clarification.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**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).**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, Samsung, vivo, Intel, Nokia, NSB, Huawei, HiSilicon, Ericsson, ZTE (fine)*  |
| Objecting companies  |  |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ ZTEIn the first round, only ZTE doesn’t agree with the proposal. Please check my replies to your comments and see if the proposal is ok for you.  |
| ZTE | Given the current situation, we are fine with the majority view. |
|  |  |

**Summary of the status for proposal 3.1-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this proposal. It is stable, thus it will be recommended to chairman for email approval.

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

|  |  |  |  |
| --- | --- | --- | --- |
| *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.

|  |
| --- |
| **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.**

|  |  |
| --- | --- |
| *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. |
| Intel | No strong preference |
| ZTE | We are fine with this proposal.  |
| Nokia/NSB | Support the proposal. |
| HW/HiSi | Agree |
| Ericsson | Agree.We don’t think the concept of ***dl-PRS-ID*** exists for PDC. |

**Summary of the status for proposal 3.2-1 based on inputs for the first round**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, vivo, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, Ericsson*  |
| Not support |  |

**FL recommendation**: All companies agree with proposal 3.2-1 and the proposal is stable.

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

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

|  |  |  |
| --- | --- | --- |
| *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.

|  |
| --- |
| **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.**

|  |  |
| --- | --- |
| *Company* | *View* |
| OPPO | Agree. |
| New H3C | We are fine with this proposal  |
| vivo | We are fine with the proposal. |
| Intel | Agree |
| ZTE | We are fine with this proposal.  |
| Nokia/NSB | Support, but we think an exception in 38.214 is needed as the parameter is expected by the UE. Proposal provided in Question 3.3-1. |
| HW/HiSi | Agree |
| Ericsson | AgreeWe do not think this parameter exist for PRS of PDC, since this PRS is only sent from the serving cell.  |

**Summary of the status for proposal 3.3-1 based on inputs for the first round**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, vivo, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon, Ericsson*  |
| Not support |  |

**FL recommendation**: All companies agree with proposal 3.3-1 and the proposal is stable.

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

|  |  |
| --- | --- |
| *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. |
| Intel | OK to clarify |
| ZTE | We think it can be up to the editor.  |
| Nokia/NSB | Yes,We prefer to collect the exceptions in 38.214 Section 9 along with the one for PointA, and possible for SCS and CP as discussed in Proposal 3.1-1 and 3.2-1;

|  |
| --- |
| - 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:- *NR-DL-PRS-SFN0-Offset* is set to 0. |

 |
| HW/HiSi | Do not think so. |
| Ericsson | No need to clarify. This parameter does not exist for PRS of PDC, since only one PRS resource set is sent, and this PRS is only sent from the serving cell. |

**FL recommendation**: Though I think no clarification is fine for this particular parameter, it is also fine to do some clarifications as preferred by some companies. 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. Accordingly, we can revise proposal 3.3-1 as below to reflect this, I think it should be agreeable to all.

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

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

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##  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.

|  |  |  |  |
| --- | --- | --- | --- |
| 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:

|  |
| --- |
| 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:

|  |
| --- |
| **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.”Feature lead: I think both could work. The one you proposed can work also. The on in the original TP is used in the existing 38.211 also. Since more companies prefer the original one, let’s keep the original one first. 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. Feature lead: In our RRC parameter list to RAN2, the following description “This field specifies the start PRB index defined as offset with respect to reference Point A.” is included, and according to the agreement below, it should be clear to RAN2 that there is no *dl-PRS-PointA-r16*, and thus RAN2 can implement the RRC parameter appropriate I think. Agreement*"dl-PRS-PointA-r16"* is not included for the PRS configuration for RTT-based PDC.* Note: RAN1 specification change is expected

We can update the description below to make it clearer, “This field specifies the start PRB index defined as offset with respect to reference Point A, where the reference point A is the point A of the serving cell defined in Clause 4.4.4.2 in TS 38.211”. Depending on what TP to be adopted, e.g. whether “subcarrier 0 in common resource block 0” will be taken instead, then we can further decide how to update the RRC description.  |
| New H3C | We slightly prefer the original TP from FL proposal |
| Intel | When mentioning ‘propagation delay compensation’ potentially nice to refer to PDC procedures section in 38.214. |
| ZTE | We are fine with this proposal. |
| Nokia/NSB | There could still be the UE configured with PRS for POS and PRS for PDC. So the suggested change is not correct, because the point A for POS is still defined by the RRC parameter, and point A for PRS for PDC is only changed. Maybe we could leave this also to the specs editor (as suggested in several parts for 214) – or alternatively: For PRS reception configured for RTT based propagation delay compensation, for the reference point for is the location of the point A of the serving cell defined in Clause 4.4.4.2. Otherwise, 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: Not sure if I get your point correctly, however “if the downlink PRS is not configured for RTT based propagation delay compensation” is only to define “the DL PRS resource” that is configured for RTT based PDC, nothing related to other PRS resource(s) configured for positioning. For example, if PRS 1 is for PDC, while PRS 2 is for positioning, then when receiving or transmitting PRS 1, the spec will go to the PDC branch. That is, the spec in TS 38.211 here will check the DL PRS resource one by one, without considering what other PRS resource will look like. Again, the condition “if the downlink PRS resource is not configured for RTT based propagation delay compensation” is only applied to a certain PRS resource, not the overall PRS resources. Therefore, I think the current TP works.  |
| Hw/HiSi | Fine with the proposal form the FL |
| Ericsson | Fine with the intention of the TP.Slightly prefer using “the point A of the serving cell defined in Clause 4.4.4.2”, i.e., either FL version or Nokia version. |

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Revised 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 resource 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----------------------- |

**Further revised 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>If the downlink PRS resource is configured for RTT based propagation delay compensation as described in clause 9 of [6, TS 38.214], the reference point for is subcarrier 0 in common resource block 0; Otherwise, the ~~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*.< Unchanged parts are omitted >--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ OPPO @NokiaPlease check my replies to your comments and see if the proposal is ok for you.@allThe original Proposal 3.4-1 is further revised per the comment from Nokia/NSB and OPPO below. Note that “the location of the point A of the serving cell defined in Clause 4.4.4.2” and “subcarrier 0 in common resource block 0” are actually the same thing, so either one of them is fine. |
| Nokia/NSB | Support the proposal.Thanks to the FL for clarifying further, and we agree that it should work, despite not being the most straightforward TP to read. So we would still prefer to have the order change which makes it easier to read, i.e., If the downlink PRS resource is configured for RTT based propagation delay compensation by RRC, the reference point for is the location of the point A of the serving cell defined in Clause 4.4.4.2. Otherwise, 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: I think both can work, but since you do have a preference here, let me update accordingly.  |
| OPPO | We still prefer to use “subcarrier 0 of common resource block 0” instead of “Point A”. Here is the picture in current spec for DL signal allocation (before introducing PDC-PRS): * Positioning PRS: allocated per frequency layer which has its own Point-A, and every subcarrier k is located relative to that Point-A.
* All DL signal other than PRS, including PDCCH/PDSCH/CSI-RS/SSB: allocated per common resource block, and every subcarrier k is located relative to subcarrier 0 of common block 0. On top of this common rule, the subcarrier 0 of common block 0 is located by aligning the center of this subcarrier to Point-A determined for the serving cell.

Now the above proposal generates something new: * A new DL signal allocated with every subcarrier k located relative to serving cell Point-A (where k=0 is) -- it has nothing to do with common resource block. **It looks like PDC-PRS is on a resource layer that is neither PRS frequency layer nor relating to common resource block, and it just happen to share the same Point-A with the common resource block.** This could be a fundamental concept add-on in 38.211.
* The proposal may lead to some forward-compatibility issue if someday RAN1 will introduce an offset between PointA and subcarrier 0 of common resource block 0.
* Further, the proposal bypasses the precise description of “center of subcarrier k=0” coming from following existing 38.211 text:

“*The center of subcarrier 0 of common resource block 0 for subcarrier spacing configuration coincides with 'point A'*”Then the proposal does not make it clear which part of subcarrier k=0 aligns to Point A. So we suggest companies take a second thought on above conceptual issue despite of value equivalence at present.Our preference for the TP is as following: If the downlink PRS resource is configured for RTT based propagation delay compensation as described in clause 9 of [6, TS 38.214], the reference point for is subcarrier 0 in common resource block 0~~the location of the point A of the serving cell defined in Clause 4.4.4.2~~; Otherwise, the ~~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: I am not sure if I get your point correctly or not, but in my understanding “location of the point A of the serving cell defined in Clause 4.4.4.2” is actually the same thing as “subcarrier 0 in common resource block 0”, that’s why I said before that both can work and both are correct. I don’t think there is any new thing introduced by the proposal here. Anyway, since you seems have strong preference with “subcarrier 0 in common resource block 0”, let’s use it, since both actually the same thing. [OPPO] Thanks for trying as we suggested. Yes, both ways are equivalent, but if you look through the 38.211 section for PRS resource allocation, there is no “common resource block” there. Then the question is whether to keep PDC-PRS conceptually independent from common resource block.  |
| ZTE | We are fine with the updated proposal. |
| LG | We are fine with revised proposal.  |
| Intel | Agree |
| Ericsson | Support  |

**Feature lead:** It seems the revised proposal 3.4-1 agreeable. Since it would have impact on the RRC parameter, I would recommend to chairman to approve it by email, then we can update the RRC parameter before the deadline of the RRC.

**Proposal 3.4-2: Update the description for dl-PRS-StartPRB-r16 as highlight in Red below:**

* This field specifies the start PRB index defined as offset with respect to point A of the serving cell defined in Clause 4.4.4.2 in TS 38.211.

**Revised Proposal 3.4-2: Update the description for dl-PRS-StartPRB-r16 as highlight in Red below:**

* This field specifies the start PRB index defined as offset with respect to subcarrier 0 in common resource block 0.

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| --- | --- |
| *Company* | *View* |
| Feature lead | The original proposal 3.4-2 is updated per the comment from OPPO. Note that “the location of the point A of the serving cell defined in Clause 4.4.4.2” and “subcarrier 0 in common resource block 0” are actually the same thing, either is fine.  |
| Nokia/NSB | Support  |
| OPPO | As explained above, we prefer to use subcarrier 0 in common resource block 0, instead of Point A.**Proposal 3.4-2: Update the description for dl-PRS-StartPRB-r16 as highlight in Red below:*** This field specifies the start PRB index defined as offset with respect to ~~point A of the serving cell defined in Clause 4.4.4.2 in TS 38.211~~subcarrier 0 in common resource block 0.

  |
| ZTE | We are fine with the proposal. |
| LG | We are fine with revised proposal.  |
| Intel | OK |
| Ericsson | Fine with the proposal |

**Feature lead:** It seems the revised proposal 3.4-2 agreeable. Since it would have impact on the RRC parameter, I would recommend to chairman to approve it by email, then we can update the RRC parameter before the deadline of the RRC.

## 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. |
| Intel | We are a bit confused where > 1 PDC PRS resources come from since we agree to only one PRS configuration. Maybe we misunderstand something but would like clarification.Feature lead:We agreed one PRS set, but multiple PRS resources can be included in the set.  |
| ZTE | Maybe we can place the parameter *dl-PRS-StartPRB-r16* and *dl-PRS-ResourceBandwidth-r16* in *NR-DL-PRS-PDC-ResourceSet-r17* so that the PRS resources have the same value?Feature lead: Both ways could work. However, since the structure was agreed last meeting and RAN1/2 both may have implemented or started to implement it, to avoid more big change, let’s keep the current agreed structure, and just make the conclusion to clarify the intention. Always simpler to add some new thing compared to revise the agreed ones. Of course, in the end can up to RAN2 also how to implement it.  |
| Nokia/NSB | We are OK with the restriction. |
| HW/HiSi | Tend to agree, the provided reason seem feasible. |
| Ericsson | We agree with the intention. But this can be better fixed by moving these parameters out of NR-DL-PRS-Resource-r16, and make them part of NR-DL-PRS-PDC-ResourceSet-r17. That is, fix this in the RRC parameter list.Feature lead: Both ways could work. However, since the structure was agreed last meeting and RAN1/2 both may have implemented or started to implement it, to avoid more big change, let’s keep the current agreed structure, and just make the conclusion to clarify the intention. Always simpler to add some new thing compared to revise the agreed ones. Of course, in the end can up to RAN2 also how to implement it.  |

**Summary of the status for question 3.5-1 based on inputs for the first round**

|  |  |
| --- | --- |
| Agree | *OPPO, New H3C, vivo, Nokia, NSB, Huawei, HiSilicon* |
| Don’t agree |  |

**FL recommendation**: It seems all companies agree with it in principle.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Proposal 3.5-1: 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.**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, vivo, Nokia, NSB, Huawei, HiSilicon, ZTE, Intel* |
| Objecting companies  |  |

|  |  |
| --- | --- |
| *Company* | *View* |
| Feature lead | @ ZTE @ Intel @ Ericsson Please check my replies to your comments and see if the proposal is ok for you.  |
| ZTE | We are fine with this proposal. |
| Intel | We are OK after clarifications |

**Summary of the status for proposal 3.5-1 based on inputs for the second round**

**Feature lead:** There is no company objecting this proposal. It seems stable, thus it will be recommended to chairman for email approval.

|  |  |
| --- | --- |
| Ericsson | **Regarding earlier comment “moving these parameters out of NR-DL-PRS-Resource-r16, and make them part of NR-DL-PRS-PDC-ResourceSet-r17”:**Actually we think this corrects an error in previous RRC parameter list.Checking 37.355, these parameters are part of positioning frequency layer, i.e., one level above PRS resource set. For PDC, only one PRS resource set is defined, and no frequency layer is defined. Thus these parameters should be set as parameters of PRS resource set.37.355: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, ...}, ...}38.214 section 5.1.6.5:“A DL PRS positioning frequency layer is defined as a collection of DL PRS resource sets which have common parameters configured by *NR-DL-PRSPositioningFrequencyLayer*.”Also, we don’t think it’s a concern to correct this in the RRC parameter list. After all, Proposal 3.4-2 is being discussed to update the description of a parameter, when the previous description was actually correct. It just didn’t use exact phrase in 38.211. |
| Ericsson2 | **A follow up suggestion based on the newly endorsed agreement and above understanding:****Proposal:**Parameters dl-PRS-ResourceBandwidth-r16 and dl-PRS-StartPRB-r16 are information elements of NR-DL-PRS-ResourceSet-r16 for the PRS configuration of PDC.Although this proposal is only about how to describe in RRC spec, it’s useful to have this to avoid future confusion in RAN1 and RAN2. This proposal can be considered a replacement of previous RAN1 agreement.AgreementInclude dl-PRS-ResourceBandwidth-r16 and dl-PRS-StartPRB-r16 in NR-DL-PRS-Resource-r16 for the PRS configuration for RTT-based PDC. |

## 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.**

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| ---------------------------------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 RTT based 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. |
| Intel | Agree |
| ZTE | We are fine with this TP. |
| Nokia/NSB | Do not agree. As for we commented on Proposal 3.4-1: There could still be the UE configured with PRS for POS and PRS for PDC. So the suggested change is not correct, because the point A for POS is still defined by the RRC parameter, and point A for PRS for PDC is only changed. 🡪 cannot just be based on the configuration! Feature lead: Please check my replies to your comment under proposal 3.4-1, to see if it makes sense to you. I updated the TP a little bit to make it clearer that the conditions are applied for a certain PRS resource, not the overall PRS resources. |
| HW/HiSi | For the part in 7.4.1.7.3: We don’t think that the combination is given by dl-PRS-CombSizeN-AndReOffset, this IE is only used for comb size and offset configuration, but not related to the combination. May be modifications below makes it more clear?“Otherwise, the comb size ~~combination~~  is given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* and has the same set of ~~candidate~~ combinations .”Feature lead: Yes there would be some misunderstanding.  |
| Ericsson | Support.To HW/HiSi, the intention is, “same set of candidate combinations” refers to “{2, 2},{4, 2}, {6, 2}, {12, 2}, {4, 4}, {12, 4}, {6, 6}, {12, 6}”. That is, the RRC configuration gives , which can only take the candidate combinations as the existing ones.Feature lead: The current wording may result in some misunderstanding that the RRC parameter configure the combination directly. I updated the TP a little bit for check. |

**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. |
| Intel | Agree |
| ZTE | We are fine with this proposal. |
| Nokia/NSB | Agree |
| HW/HiSi | Agree |

**Summary of the status for proposal 3.2-1 based on inputs for the first round**

|  |  |
| --- | --- |
| Support | *OPPO, New H3C, vivo, Intel, ZTE, Nokia, NSB, Huawei, HiSilicon* |
| Not support |  |

**FL recommendation**: All companies agree with proposal 3.6-2 and the proposal is stable.

### Second round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Revised 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* when the downlink PRS resource is not configured for RTT based propagation delay compensation and given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* otherwise, 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}<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 resource 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----------------------- |

**Further revised 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-AndReOffset* for a downlink PRS resource configured for RTT based propagation delay compensation and otherwise 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}<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 for RTT based propagation delay compensation, the UE shall assume the downlink PRS resource being transmitted as described in clause 9 of [6, TS 38.214]; otherwise, the UE shall assume the downlink PRS resource being transmitted as described in clause 5.1.6.5 of [6, TS 38.214].< Unchanged parts are omitted >--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

|  |  |
| --- | --- |
| *Company* | *View* |
| **Feature lead** | Revised Proposal 3.6-1 is further revised per the comment from Nokia below. |
| Nokia/NSB | In general, would be maybe better to leave this to the 38.211 editor – anyhow. Feature lead: Yes my original intention is to leave it to editors also. But since there is TP proposed from companies, I think ok to check also and if consensus achieved we can provide it to editors. If in the end we cannot achieve consensus then maybe leave it to editor. For both appearances, we are not sure if it would be easier to prevent negative formulations, i.e., the comb size is given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* for a downlink PRS configured by RRC for RTT based propagation delay compensation and otherwise given by the higher-layer parameter *dl-PRS-CombSizeN* For a downlink PRS resource in a downlink PRS resource set configured by LPP, the UE shall assume the downlink PRS resource being transmitted as described in clause 5.1.6.5 of [6, TS 38.214]. For a downlink PRS resource in a downlink PRS resource set configured by RRC for RTT based propagation delay compensation, the UE shall assume the downlink PRS resource being transmitted as described in clause 9 of [6, TS 38.214].Feature lead: Yes we can do that. I updated the proposal accordingly with some modification. It is not clear to me whether LPP is appropriate used in physical layer spec or not.  |
| OPPO | HW/HiSi is right on the 1st-round proposed text. Some editorial improvements to the 2nd-round TP, taking into account following: * change “for ... otherwise” to “if ... otherwise”.

Feature lead: I was hesitating whether to use “for…otherwise” or “if…otherwise” also, but in the end it looks to me that “for…otherwise” more aligned with the overall section description. Anyway, even we endorse the TP here, the editor can still change as appropriate, therefore it is recommended not to spend too much time on this and can rely on the editors to pick the way he feels the best. * remove “such that” to avoid long sentence and improve readability.

Feature lead: “such that” is from the previous release and it is to say the configuration of comb size needs to meet those combination. I would prefer to keep it for now, and editor can see if any further update needed or not. * remove duplicated wordings before and after “otherwise”.

Feature lead: The change from your suggestion below may result in the impression that a PRS resource set can include a PRS resource for PDC and the other PRS resource for positioning. <Unchanged parts are omitted>- the comb size is given by the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset* if the downlink PRS resource is ~~not~~ configured for RTT based propagation delay compensation, and ~~given~~ by the higher-layer parameter *dl-PRS-CombSizeN* otherwise. ~~such that the~~The combination is one of {2, 2},{4, 2}, {6, 2}, {12, 2}, {4, 4}, {12, 4}, {6, 6}, {12, 6} and {12, 12}<Unchanged parts are omitted><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 9 of [6, TS 38.214] if the downlink PRS resource is ~~not~~ configured for RTT based propagation delay compensation, and in clause 5.1.6.5 of [6, TS 38.214] otherwise.< Unchanged parts are omitted > |
| ZTE | We are fine with the first change.After further checking, we don’t think the second change is needed since there is no difference on the PRS transmission between clause 9 and clause 5.1.6.5.Feature lead: Clause 9 is for PDC PRS, though it refer to 5.1.6.5 for some basic procedure, but there are different aspects, otherwise we don’t need to introduce new clause 9 for PRS PDC.

|  |
| --- |
| Clause 9The 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. |

 |
| LG | We are fine with revised TP |

**Feature lead**: Since there is no RRC impact for the TP and there are questions raised in the second round, it seems better to leave a little bit more time for companies to check.

### Third round email discussion

Based on the inputs and analysis above, the following proposals and/or conclusions are made for further discussion. Please all companies check the discussion/analysis above to understand the reason to make these proposals before providing your views here.

**Further revised 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-AndReOffset* for a downlink PRS resource configured for RTT based propagation delay compensation and otherwise 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}<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 for RTT based propagation delay compensation, the UE shall assume the downlink PRS resource being transmitted as described in clause 9 of [6, TS 38.214]; otherwise, the UE shall assume the downlink PRS resource being transmitted as described in clause 5.1.6.5 of [6, TS 38.214].< Unchanged parts are omitted >--------------------------------- End of Text Proposal to TS 38.211 v17.0.0----------------------- |

|  |  |
| --- | --- |
| Support | *LG, Ericsson, ZTE* |
| Objecting companies  |  |

|  |  |
| --- | --- |
| Company | View |
| Feature lead | Please all check the replies to comments in the second round, and see if the proposal now is acceptable for you.  |
| Nokia/NSB | In general, we still believe this could be left to the 38.211 editor instead of here, but we are OK with the proposal. |

# 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%5C%5CUsers%5C%5Cc00387628%5C%5CAppData%5C%5CLocal%5C%5CTemp%5C%5CDocs%5C%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%5C%5CUsers%5C%5Cc00387628%5C%5CAppData%5C%5CLocal%5C%5CTemp%5C%5CDocs%5C%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%5C%5CUsers%5C%5CL00367611%5C%5CAppData%5C%5CLocal%5C%5CTemp%5C%5CDocs%5C%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%5C%5CUsers%5C%5CL00367611%5C%5CAppData%5C%5CLocal%5C%5CTemp%5C%5CDocs%5C%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%5C%5CUsers%5C%5CL00367611%5C%5CAppData%5C%5CRoaming%5C%5CMicrosoft%5C%5CDocs%5C%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%5C%5CUsers%5C%5CL00367611%5C%5CAppData%5C%5CRoaming%5C%5CMicrosoft%5C%5CDocs%5C%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.