**3GPP TSG RAN WG1 Meeting #107bis-e R1-xxxxxxx**

**E-meeting, January 17th – 25th, 2022**

**Agenda Item: 8.3.4**

**Source: Moderator (Huawei)**

**Title: Feature lead summary#1 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][10], and aims to discuss a set of issues in RAN1#107bis-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#107b-e.

## Issue #2-1: Whether or not SRS for Positioning should be supported for RTT-based PDC?

* ***Option 1:*** *SRS for positioning is not supported for RTT-based PDC,* *regardless of whether TRS or PRS is used for RTT-based PDC.*
	+ *Huawei, HiSilicon, ZTE, OPPO*
	+ *Pros*
		- *Low specification impact*
		- *Not necessary from performance perspective*
	+ *Cons*
		- *May result in a waste of SRS air interface resources for a UE supporting both PDC and a Positioning service*
* ***Option 2:*** *SRS for positioning is supported for RTT-based PDC, regardless of whether TRS or PRS is used for RTT-based PDC, i.e. SRS for positioning can be used along with either TRS or PRS.*
	+ *Intel, [LG]*
	+ *Pros*
		- *Avoid unnecessary waste of SRS resource*
		- *More flexibility*
			* *Note that SRS for positioning can be used independent of PRS in Rel-16/17 positioning*
	+ *Cons*
		- *High specification impact*
* ***Option 3:*** *SRS for positioning is supported for RTT-based PDC and only along with PRS.*
	+ *Nokia, NSB,*
	+ *Pros*
		- *Avoid unnecessary waste of SRS resource when both PRS and SRS for positioning are used for positioning purpose already*
	+ *Cons*
		- *Medium specification impact*

**Feature lead:** More views are needed before making any decision here.

### First round discussion

The following questions are set for the first round email discussions.

**Question 2-1-1: Which option among the above three options do you prefer? Please explain your reasons for your choices also.**

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| *Company* | *View* |
| Nokia, NSB | Option 1 (first preference) or Option 3 (if SRS for PDC is supported). Option 1 should be sufficient, but if SRS for positioning is supported, then Option 3 gives the best compromise as it avoids the waste of resource in case a UE has been configured with SRS for positioning and is simple to specify by just adding a PDC usage indicator in the SRS Resource Set configuration. |
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**Question 2-1-2: If option 2 or option 3 is supported, is it also necessary to use PRS along with SRS for MIMO for RTT-based PDC also?**

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| *Company* | *View* |
| Feature lead | Note that if option 1 is agreed, then it is clear that PRS should be used along with SRS for MIMO. However, if option 2 or option 3 is agreed, then it is not really necessary for PRS to work along with SRS for MIMO, e.g. PRS can always along with SRS for positioning, while TRS can always work along with SRS for MIMO.  |
| Nokia, NSB | We don’t see that is necessary to use PRS along with SRS for MIMO for RTT-based PDC.As FL says, TRS can be used along SRS for MIMO. |

## Issue #2-2: Whether measurement gap should be mandatory for a UE to process PRS for PDC purpose?

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| Nokia R1-2200019Additionally, it will need to be discussed if same processing constraints as present for PRS for Positioning also applies for PRS for PDC purposes. For example 38.214 states that: “UE is not expected to process DL PRS without configuration of measurement gap”, which we think is an undesired property considering the IIoT use case and that the PRS transmission only comes from the serving cell. **Proposal 4: Measurement gaps should not be mandatory for a UE to process PRS for PDC purposes.** |

**Feature lead**: According to TS38.214 g80 copied below, UE is not expected to process DL PRS without configuration of measurement gap in Rel-16 positioning. However in Rel-17 positioning, this sentence is removed accordingly in the TS38.214 h00 copied below, and the CR is in [12] for your information. It seems the corresponding behaviors for Rel-16 PRS reception and Rel-17 PRS reception are a little bit different. Regardless of the reasons for positioning, for PDC it seems the reason given by Nokia is reasonable, considering that the PRS transmission only comes from the serving cell for IIoT use case. However, let’s hear more views from companies.

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| **Copied from TS38.214 g80**If the UE is configured with *DL-PRS-QCL-Info* and the QCL relation is between two DL PRS resources, then the UE assumes those DL PRS resources are associated with the same *dl-PRS-ID*. If *DL-PRS-QCL-Info* is configured to the UE with QCL set to 'type-D' with a source DL PRS resource then the *nr-DL-PRS-ResourceSetId* and the *nr-DL-PRS-ResourceId* of the source DL PRS resource are expected to be indicated to the UE.UE is not expected to process DL PRS without configuration of measurement gap.Within a positioning frequency layer, the DL PRS resources are sorted in the decreasing order of priority for measurement to be performed by the UE, with the reference indicated by *nr-DL-PRS-ReferenceInfo* being the highest priority for measurement, and the following priority is assumed:- Up to 64 *NR-SelectedDL-PRS-IndexPerTRP* of the frequency layer are sorted according to priority if *nr-SelectedDL-PRS-IndexListPerFreq* is provided, or up to 64 *NR-DL-PRS-AssistanceDataPerTRP* of the frequency layer are sorted according to priority otherwise;- Up to 2 *DL-SelectedPRS-ResourceSetIndex* per *dl-PRS-ID* of the frequency layer are sorted according to priority if *dl-SelectedPRS-ResourceSetIndexList* is provided, or up to 2 *NR-DL-PRS-ResourceSet* per *dl-PRS-ID* of the frequency layer are sorted according to priority otherwise. |
| **Copied from TS38.214 h00****5.1.6.5 PRS reception procedure****……**If the UE is configured with *DL-PRS-QCL-Info* and the QCL relation is between two DL PRS resources, then the UE assumes those DL PRS resources are associated with the same *dl-PRS-ID*. If *DL-PRS-QCL-Info* is configured to the UE with QCL set to 'type-D' with a source DL PRS resource then the *nr-DL-PRS-ResourceSetId* and the *nr-DL-PRS-ResourceId* of the source DL PRS resource are expected to be indicated to the UE.The UE is expected to measure the DL PRS outside the measurement gap, subject to UE capability, if the DL PRS is inside the active DL BWP and has the same numerology as the active DL BWP and is within the DL PRS processing window indicated by higher layer parameter [*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.Within a positioning frequency layer, the DL PRS resources are sorted in the decreasing order of priority for measurement to be performed by the UE, with the reference indicated by *nr-DL-PRS-ReferenceInfo* being the highest priority for measurement, and the following priority is assumed:- Up to 64 *NR-SelectedDL-PRS-IndexPerTRP* of the frequency layer are sorted according to priority if *nr-SelectedDL-PRS-IndexListPerFreq* is provided, or up to 64 *NR-DL-PRS-AssistanceDataPerTRP* of the frequency layer are sorted according to priority otherwise;- Up to 2 *DL-SelectedPRS-ResourceSetIndex* per *dl-PRS-ID* of the frequency layer are sorted according to priority if *dl-SelectedPRS-ResourceSetIndexList* is provided, or up to 2 *NR-DL-PRS-ResourceSet* per *dl-PRS-ID* of the frequency layer are sorted according to priority otherwise.**……****9 UE procedures for transmitting and receiving for RTT-based propagation delay compensation**For 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 question are set for the first round email discussions.

**Question 2-2-1: Do you agree that measurement gaps should not be mandatory for a UE to process PRS for PDC purposes? Please explain your reasons also.**

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| *Company* | *View* |
| Nokia, NSB | We agree.As per explanation from our tdoc highlighted by the FL above. |
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## Whether to clarify the TA value for PDC in case multiple TAGs exist?

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| *Ericsson (R1-2200443)*For the legacy TA-based PDC, one issue is to select the timing advance command of a specific timing advance group (TAG) for PDC purpose, if multiple TAGs exist.First, regardless of the PDC method, the propagation delay should be measured between the UE and the TRP associated with *referenceTimeInfo*. Thus, similar to the conclusion below, with the legacy TA-based method, the timing advance value should also be associated with the PCell.

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| **Conclusion (RAN1#107e)**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 |

Thus, it should be clarified in the specification that the TA value for PDC is the timing advance associated with the timing advance group (TAG) of the PCell, i.e., the Primary Timing Advance Group (PTAG). When in dual-connectivity operation, both master cell group (MCG) and secondary cell group (SCG) have PTAG. In this case, it needs to be clarified that the TA value is associated with PTAG of MCG.**Proposal 1: Specify that the TA value for PDC is the timing advance value associated with the PTAG of MCG.** |

**Feature lead:** According to the description about the *referenceSFN* IE below, the SFN of PCell is used as the reference for the reference time information. According to TAG definition in TS38.321 copied below, the PCell belongs to PTAG. Therefore, it looks to me that the current spec is already clear, and there is no need to do further clarifications. However, let’s hear more views from other companies.

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| **Copied from 38.331**– *ReferenceTimeInfo*The IE *ReferenceTimeInfo* contains timing information for 5G internal system clock used for, e.g., time stamping, see TS 23.501 [32], clause 5.27.1.2.***ReferenceTimeInfo* information element**-- ASN1START-- TAG-REFERENCETIMEINFO-STARTReferenceTimeInfo-r16 ::= SEQUENCE { time-r16 ReferenceTime-r16, uncertainty-r16 INTEGER (0..32767) OPTIONAL, -- Need S timeInfoType-r16 ENUMERATED {localClock} OPTIONAL, -- Need S referenceSFN-r16 INTEGER (0..1023) OPTIONAL -- Cond RefTime}ReferenceTime-r16 ::= SEQUENCE { refDays-r16 INTEGER (0..72999), refSeconds-r16 INTEGER (0..86399), refMilliSeconds-r16 INTEGER (0..999), refTenNanoSeconds-r16 INTEGER (0..99999)}-- TAG-REFERENCETIMEINFO-STOP-- ASN1STOP

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| ***ReferenceTimeInfo field descriptions*** |
| ***referenceSFN***This field indicates the reference SFN corresponding to the reference time information. If *referenceTimeInfo* field is received in *DLInformationTransfer* message, this field indicates the SFN of PCell. |

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| **Copied from 38.321****Timing Advance Group:** A group of Serving Cells that is configured by RRC and that, for the cells with a UL configured, using the same timing reference cell and the same Timing Advance value. A Timing Advance Group containing the SpCell of a MAC entity is referred to as Primary Timing Advance Group (PTAG), whereas the term Secondary Timing Advance Group (STAG) refers to other TAGs. |

### First round discussion

**Question 2-3-1: Do we need to further clarify in RAN1 spec that the TA value for PDC is the timing advance value associated with the PTAG of MCG?**

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| *Company* | *View* |
| Nokia, NSB | No need for clarification - we agree with FL.We think that a decent UE implementation should obviously use the TA of the TAG to which the PCell is associated, which is PTAG, so we don’t see a strong need for such clarification. |
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## Other issues

**Issue #2-4: Whether to include SRS-Resource-ID and/or dl-PRS-ID/csi-RS (The ID of a CSI-RS resource) in the Rx-Tx measurement report?**

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| New H3C R1-2200013In our view, if TRS and PRS are configured for PDC measurement simultaneously, SRS-Resource-ID should be included in the Rx-Tx measurement report provided from the gNB to the UE in order to pair the SRS and TRS/PRS for a gNB Rx-Tx time difference. It is also beneficial for mitigating the Rx/Tx timing errors.**Proposal 1: The Rx-Tx measurement report provided from the gNB includes SRS-Resource-ID.**In addition, if TRS and PRS are configured for PDC measurement simultaneously, dl-PRS-ID/csi-RS (The ID of a CSI-RS resource) should be included in the Rx-Tx measurement report provided from the UE to the gNB in order to pair the SRS and TRS/PRS for a gNB Rx-Tx time difference.**Proposal 2: The Rx-Tx measurement report provided from the UE includes dl-PRS-ID/csi-RS (The ID of a CSI-RS resource).** |

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

**Agreement**

If RTT-based propagation delay compensation is supported,

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

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| *Company* | *View* |
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**Issue #2-5: Whether LS reply is needed for LS in from RAN4 on enhanced TA-based PDC in R1-2200011?**

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| Nokia R1-2200019RAN1 requested feedback from RAN4 in R1-2108635 on possible enhancements to TA-based PDC and received the reply LS in R1-2200011. As during RAN1#107-e it was decided to support only TA-based PDC based on legacy TA mechanism (without any additional enhancements), the feedback received from RAN4 does not require any additional work on the RAN1 and RAN4 side for the support of TA-based PDC. Moreover, as RAN1 already informed the related RAN1#107-e decision in the LS to RAN2 & RAN4 in R1-2112834 to not further pursue enhanced TA-based PDC, there seems to be no need to further discuss or react on this LS. ***Observation 2: There is no further RAN1 actions needed on the incoming LS from RAN4 in R1-2200011, as enhanced TA-based PDC is not supported in Rel-17 and RAN4 has been informed about the related decision already in the LS to RAN2 / RAN4 in R1-2112834.*** |

**Feature lead view**: Agree with Nokia that LS reply is not needed.

# Miscellaneous issues on RRC parameters

Several issues on RRC parameters are raised in the contributions submitted to RAN1#107b-e.

**RRC parameters for SRS for MIMO**

## Issue #3-1: RRC parameters for SRS for MIMO

RRC parameters for SRS for MIMO was discussed in RAN1#107-e, but no consensus achieved yet. The two candidate options are summarized as below based on the views in the paper.

* **Option 1**: Modify *usage-r17* in *SRS-ResourceSet* to indicate that this ResourceSet is used for PDC purposes as below:
	+ *usage-r17 ENUMERATED {beamManagement, codebook, nonCodebook, antennaSwitching, PDC}*
	+ *Huawei, HiSilicon*
	+ Pros
		- Low specification impact
	+ Cons
		- Would reduce the total number of SRS resource sets that can be used for other purposes for MIMO, e.g. Beam management
* **Option 2**: Add new “*usage-pdc-r17*” field to *SRS-ResourceSet* to indicate that this ResourceSet is used for PDC purposes, meanwhile also indicate that this ResourceSet is used for other purpose by *usage-r17*.
	+ *Nokia, NSB*
	+ Pros
		- Low specification impact
	+ Cons
		- Avoid reducing the total number of SRS resource sets that can be used for other purposes for MIMO, by reusing one of the SRS resource sets for MIMO
* **Option 3**: Introduce a new *SRS-PDCResourceSet* for SRS for MIMO.
	+ *Ericsson, [Samsung], [OPPO],*
	+ Pros
		- No impact on the total number of SRS resource sets that can be used for other purposes for MIMO
		- Separate SRS configuration is that *pathlossReferenceRS* and *spatialRelationInfo* can be easily customized for PDC



* + Cons
		- More specification impact
		- Potential more RRC signaling overhead

**Feature lead**: There are pros and cons for each of the above options. In addition, it may also depend on the outcome from issue 2-1. For example, if SRS for positioning is not supported, then SRS for MIMO will have to be used along with PRS, in which case we may need to change *pathlossReferenceRS* and *spatialRelationInfo* for more flexibility, though it seems not really necessary.

### First round discussion

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

**Question 3-1-1: Which option among the above three options do you prefer? Please explain your reasons for your choices also.**

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| *Company* | *View* |
| Nokia, NSB | Option 2As this has least restrictions and specifications impact. @FL, what is in Cons of Option 2 should be in Pros in our view, as the usage indication for PDC should not exclude that the SRS resource set is also used for MIMO, thus not impacting the total number of SRS resource set for MIMO. |
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**RRC parameters for PRS for PDC**

## Issue #3-2: Whether to include RRC parameters *dl-PRS-ResourceRepetitionFactor-r16* and *dl-PRS-ResourceTimeGap-r16* for PRS for PDC?

The candidate options and company positions based on the contributions are summarized as below:

* **Option 1**: Do not include *dl-PRS-ResourceRepetitionFactor-r16* and *dl-PRS-ResourceTimeGap-r16* from 37.355 in the PRS PDC configuration in 38.331.
	+ *Nokia, NSB*
	+ Reasons
		- *dl-PRS-ResourceRepetitionFactor-r16*. Indeed useful for coverage limited use cases, or when extended coverage is needed for PRS, which are not the case when the UE only needs PRS from the serving cell.
		- *dl-PRS-ResourceTimeGap-r16*. Only needed if *dl-PRS-ResourceRepetitionFactor-r16* is provided, as it indicates the time between the same PRS Resource ID is repeated.
* **Option 2**: Add “*dl-PRS-ResourceRepetitionFactor-r16* and *dl-PRS-ResourceTimeGap-r16* in the RRC parameters list for RTT-based PDC
	+ *Ericsson, Huawei, HiSilicon, Intel,*
	+ Reasons
		- According to the current specification for positioning, it seems that theses parameters can be used for any serving cell, including serving cell and neighbor cell, therefore it should be straightforward to include unless problems identified.
		- PRS may need to rely on repetition to achieve the desired reception accuracy, especially when the PRS bandwidth is limited. Parameter *dl-PRS-ResourceTimeGap* is a companion to *dl-PRS-ResourceRepetitionFactor*.

### First round discussion

The following questions are set for the first round email discussions.

**Question 3-2-1: Which option among the above two options do you prefer? Please explain your reasons for your choices also.**

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| *Company* | *View* |
| Nokia, NSB | Option 1.We think this is simpler, as in our view, these parameters are mainly useful for improving the detection of PRS of neighbor cells, while we don’t see a big relevance of these features for serving cell.  |

## Issue #3-3: Whether to include RRC parameter *dl-PRS-ResourcePower-r16* for PRS for PDC?

The candidate options and company positions based on the contributions are summarized as below:

* **Option 1**: Do not include dl-PRS-ResourcePower-r16 from 37.355 in the PRS PDC configuration in 38.331.
	+ *Nokia, NSB*
	+ Reasons
		- *dl-PRS-ResourcePower-r16*. This specifies the transmission power for the PRS signal, which is useful for PL estimation based on PRS transmitted from neighbour cells. For PRS used for PDC, it would be sufficient to give the UE the PRS transmission power relative to another DL RS (e.g. SSB).
* **Option 2**: Include *dl-PRS-ResourcePower-r16”* in the RRC parameters list for RTT-based PDC
	+ *Huawei, HiSilicon*
	+ Reasons
		- It is true that *dl-PRS-ResourcePower-r16* can be applied for the case of receiving PRS from neighbor cells, but in our understanding it is also used for the case of receiving PRS from the serving cell, therefore it should be straightforward to include this parameter to enable receiving PRS from the serving cell, otherwise we need a new RRC parameter as indicated in option 3.
* **Option 3**: Do not include *dl-PRS-ResourcePower-r16”* in the RRC parameters list for RTT-based PDC, and add an new relative value (e.g., *powerControlOffsetSS*) to signal the EPRE of PRS for PDC
	+ *Ericsson*
	+ Reasons
		- *dl-PRS-ResourcePower-r16* is also used for receiving PRS from neighbor cell, thus the range of values to indicate is very wide. A relative value can be introduced to indicate receiving PRS from the serving cell.

### First round discussion

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

**Question 3-3-1: Which option among the above three options do you prefer? Please explain your reasons for your choices also.**

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| *Company* | *View* |
| Nokia, NSB | Option 1 or Option 3.We don’t see the need of *dl-PRS-ResourcePower-r16* with a large range of values for serving cell only. A fixed value relative to e.g. SSB is sufficient. |

## Issue #3-4: Whether to update dl-PRS-QCL-Info-r16 to a new RRC parameter for PRS for PDC?

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| *Ericsson (R1-2200443)*The QCL configuration of PRS should be updated for PDC purpose, since the PRS is no longer sent from multiple cells. Specifically, *NR-DL-PRS-Resource-r16* has a field *dl-PRS-QCL-Info-r16*, where the following changes are needed for PDC purpose:1. Remove ‘pci-r16’ since only one cell (i.e., PCell) is involved in PDC, and its cell ID is already known to the UE.
2. Add ‘typeA’ to rs-Type-r16. rs-Type indicates the QCL type between the PRS and the SSB. For PDC, the PRS is expected to be sent from the same TRP as the given SSB, and have the same average propagation delay. Thus ‘typeA’ is a typical QCL type for FR1.
3. Replace dl-RS by CSI-RS as a choice of QCL source.
	1. For time synchronization use cases, only one PRS configuration (PRS#1) is provided. It cannot be assumed that the UE will also perform positioning at the same time. In other words, it cannot be assumed that the UE has another DL PRS (PRS#2, for positioning) which could possibly be used as QCL source for PRS of PDC (PRS#1). Thus *dl-PRS-r16* field should be eliminated from *DL-PRS-QCL-Info-r16*.
	2. In contrast, CSI-RS can be relied on as a QCL source for PRS of PDC. The CSI-RS may or may not be a TRS configured for PDC purpose (i.e., it may or may not have ‘trs-info’ and ‘pdc-info’ set to true), as long as this CSI-RS has the same average delay as the desired SSB-index, e.g., this CSI-RS has qcl-Type set to ‘typeA’, or ‘typeC’, or ‘typeD’ with reference to the desired SSB-Index. Thus CSI-RS should be added as a QCL choice in *DL-PRS-QCL-Info-r16*.

**Proposal 3 For PDC purpose, *DL-PRS-QCL-Info-r16* is revised by removing ‘pci-r16’, adding ‘typeA’ to rs-Type-r16, and replace *dl-PRS-xx* by CSI-RS.**In summary, the *DL-PRS-QCL-Info-r16* is suggested to be updated as below, where *NZP-CSI-RS-ResourceId* refers to a proper CSI-RS as discussed above.* DL-PRS-QCL-Info-r16 ::= CHOICE {
* ssb-r16 SEQUENCE {
* ~~pci-r16 NR-PhysCellID-r16,~~
* ssb-Index-r16 INTEGER (0..63),
* rs-Type-r16 ENUMERATED {typeA, typeC, typeD, typeC-plus-typeD}
* },
* csi-RS-Index NZP-CSI-RS-ResourceId
* ~~dl-PRS-r16 SEQUENCE {~~
* ~~qcl-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16,~~
* ~~qcl-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16~~
* ~~}~~
* }
 |

**Feature lead**: My original thinking is that there is no harm to keep pci-r16 there, since gNB can always indicate the ID of the serving cell here. For DL-PRS-r16, the basic assumptions for PDC is also to include more than one PRS resources in the PRS resource set, considering beamforming case, therefore my understanding is that DL-PRS-r16 is still applicable for PRS for PDC. For CSI-RS, it is not listed as the QCL source for PRS for positioning, then the motivation to add it for PRS for PDC is not that clear to me. But let’s hear more views from companies.

### First round discussion

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

**Question 3-4-1: Do you think it is really necessary to make the following changes to *DL-PRS-QCL-Info-r16*? Please provide your reasons.**

* DL-PRS-QCL-Info-r16 ::= CHOICE {
* ssb-r16 SEQUENCE {
* ~~pci-r16 NR-PhysCellID-r16,~~
* ssb-Index-r16 INTEGER (0..63),
* rs-Type-r16 ENUMERATED {typeA, typeC, typeD, typeC-plus-typeD}
* },
* csi-RS-Index NZP-CSI-RS-ResourceId
* ~~dl-PRS-r16 SEQUENCE {~~
* ~~qcl-DL-PRS-ResourceID-r16 NR-DL-PRS-ResourceID-r16,~~
* ~~qcl-DL-PRS-ResourceSetID-r16 NR-DL-PRS-ResourceSetID-r16~~
* ~~}~~
* }

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| --- | --- |
| *Company* | *View* |
| Feature lead | Note that if any of the changes is needed, then we will add a new RRC parameter for QCL for PRS for PDC.  |
| Nokia, NSB | No.We agree with FL arguments above. |

**RRC parameters for TRS for PDC**

## Issue #3-5: Whether to further clarify the QCL type for CSI for tracking (TRS) for PDC?

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| --- | --- |
| *Ericsson (R1-2200443)*TRS is CSI-RS for tracking. Currently TRS can be periodic or aperiodic, where the configuration of aperiodic TRS depends on that of periodic TRS. Aperiodic TRS and periodic TRS resource have the same bandwidth (with same RB location) and the aperiodic TRS being configured with qcl-Type set to 'typeA' and 'typeD', where applicable, with the periodic TRS resources. When used for time synchronization purpose (i.e., ‘pdc-info’ = true), the gNB should ensure that the NZP CSI-RS resource to be configured as QCL with SSB of PCell. This ensures that the transmission of DL TRS, UL SRS, and reference time information are associated with a same TRP via the SSB-Index. Furthermore, the qcl-Type of periodic TRS can be set to ‘typeA’, ‘typeC’, or ‘typeD’ with the SSB, where typeD is useful for FR2.According to TS 38.214 section 5.1.5, the quasi co-location types corresponding to each DL RS are given by the higher layer parameter *qcl-Type* in *QCL-Info* and may take one of the following values. For propagation delay compensation, the key metric is average delay. Thus ‘typeB’ is not appropriate for PDC purpose.- 'typeA': {Doppler shift, Doppler spread, average delay, delay spread}- 'typeB': {Doppler shift, Doppler spread}- 'typeC': {Doppler shift, average delay}- 'typeD': {Spatial Rx parameter}NZP-CSI-RS-Resource ::= SEQUENCE { ... qcl-InfoPeriodicCSI-RS TCI-StateId OPTIONAL, -- Cond Periodic ...}TCI-State ::= SEQUENCE { tci-StateId TCI-StateId, qcl-Type1 QCL-Info, qcl-Type2 QCL-Info OPTIONAL, -- Need R ...}QCL-Info ::= SEQUENCE { cell ServCellIndex OPTIONAL, -- Need R bwp-Id BWP-Id OPTIONAL, -- Cond CSI-RS-Indicated referenceSignal CHOICE { csi-rs NZP-CSI-RS-ResourceId, ssb SSB-Index }, qcl-Type ENUMERATED {typeA, typeB, typeC, typeD}, ...}Since the existing TRS configuration already allows the desired configuration described above, it is sufficient to describe the proper setting when the TRS is configured for PDC. For example, one sentence can be added to the field description of *qcl-InfoPeriodicCSI-RS* in 38.331 as shown below.

|  |
| --- |
| ***qcl-InfoPeriodicCSI-RS***For a target periodic CSI-RS, contains a reference to one *TCI-State* in TCI-States for providing the QCL source and QCL type. For periodic CSI-RS, the source can be SSB or another periodic-CSI-RS. When the periodic CSI-RS is in a *NZP-CSI-RS-ResourceSet* with ‘trs-info’ set to true and ‘pdc-info’ set to true, the QCL source is expected to be an SSB-Index in the PCell, and the QCL type is expected to be typeA, typeC, or typeD. Refers to the *TCI-State* which has this value for *tci-StateId* and is defined in *tci-StatesToAddModList* in the *PDSCH-Config* included in the *BWPDownlink* corresponding to the serving cell and to the DL BWP to which the resource belongs to (see TS 38.214 [19], clause 5.2.2.3.1). |

For aperiodic TRS, it is adequate to reuse the existing mechanism, i.e., aperiodic TRS has qcl-Type set to ‘typeA’ (for FR1) or ‘typeD’ (for FR2) with the periodic TRS.1. When configured for PDC purpose, periodic TRS has qcl-Type set to ‘typeA’, ‘typeC’, or ‘typeD’ with an SSB of PCell.
 |

**Feature lead:** Based onthe spec below, the QCL type for periodic TRS is already only type C or type D, thus seems no additional clarifications needed. However, let’s hear views from other companies first.

|  |
| --- |
| **Copied from section 5.1.5 in 38.214**For a periodic CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *trs-Info*, the UE shall expect that a TCI-State indicates one of the following quasi co-location type(s):- 'typeC' with an SS/PBCH block and, when applicable, 'typeD' with the same SS/PBCH block, or- 'typeC' with an SS/PBCH block and, when applicable,'typeD' with a CSI-RS resource in an *NZP-CSI-RS-ResourceSet* configured with higher layer parameter *repetition*. |

### First round discussion

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

**Question 3-5-1: Do we need to further clarify in TS 38.331 to preclude ‘type B’ for TRS for PDC?**

|  |  |
| --- | --- |
| *Company* | *View* |
| Nokia, NSB | No.We agree with FL that RAN1 specs seems already to preclude it for TRS. |
|  |  |

## Issue #3-6: Whether to introduce *a PDC-specific configuration container (e.g., configured in ServingCellConfig) has one field referring to the DL-RS used for PDC*?

|  |
| --- |
| OPPO (R1-2200345)***Configuration of CSI-RS for tracking in PDC***RAN1 #107e agreed in RRC discussion to add a new “pdc-info” field to existing NZP-CSI-RS-ResourceSet, where the presence of “enumerate {true}” for this field means the corresponding NZP-CSI-RS-ResourceSet should be used to measure UE-side RTT in the RTT-based PDC. However, this settlement may have some issues: * RAN1 agreed that UE is configured with only one TRS configuration; however, the above RRC signaling format itself does not prevent UE from being configured with more than one NZP-CSI-RS-ResourceSet with “pdc-info=true”.
* RAN2 may certainly restrict the UE to be configured with just one NZP-CSI-RS-ResourceSet with “pdc-info=true” by adding such restriction in the way of RRC configuration (such as in RRC parameter field description), instead of instantiating such restriction by RRC signaling format. But this may introduce an implicit competition among different NZP-CSI-RS-ResourceSets (with trs-info=true), which may add additional complexities, for example, in case the network wants to switch the TRS for PDC – the network has to release the original NZP-CSI-RS-ResourceSets before setting up the new one with “pdc-info=true”, even though the original NZP-CSI-RS-ResourceSets could be in support of some functionalities other than PDC.
* The RAN1’s agreement of configuring only one DL-RS between TRS and PRS but not the both is also not reflected in the current RRC framework for PDC.

***Observation-1: The RRC configuration agreed in RAN1 #107e for TRS in PDC does not fully match RAN1 agreements of supporting no more than one TRS configuration and configuring just one RS between TRS and PRS.*** So we suggest the RAN1 group to review the earlier agreement made in RRC discussion session for the configuration of TRS for PDC, and to consider the following configuration method which avoids the issues mentioned above. ***Proposal-1: RAN1 revisits the RAN1 #107e agreement of introducing new RRC field of “pdc-info” in NZP-CSI-RS-ResourceSet, taking into account another configuration solution where a PDC-specific configuration container (e.g., configured in ServingCellConfig) has one field referring to the DL-RS used for PDC, as a “CHOICE” between an existing NZP-CSI-RS-ResourceSetID (corresponding to trs-info=true) and the PRS.*** Such PDC-specific configuration container could be beneficial or needed anyway from RAN2 perspective to hold RAN2-defined PDC configurations if any. |

**Feature lead:** based on the RAN1 spec below, it is already clear that the UE may be configured with one TRS or one PRS, we also included the agreement on only configuring one TRS or one PRS in the comment column to RAN2, RAN2 would be able to implement it appropriately. As to the switching between TRS for PDC and normal TRS, in my understanding it may only happen in some very corner case, e.g. all the resource set(s) are already configured for other purposes, otherwise no need to release the current one in order to configure one set for PDC. However, let’s hear more views whether there is any change needed here.

|  |
| --- |
| Copied from 38.214For 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*. |

### First round discussion

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

**Question 3-6-1: Do we need to introduce *a PDC-specific configuration container (e.g., configured in ServingCellConfig) has one field referring to the DL-RS used for PDC, as a “CHOICE” between an existing NZP-CSI-RS-ResourceSetID (corresponding to trs-info=true) and the PRS*?**

|  |  |
| --- | --- |
| *Company* | *View* |
| Nokia, NSB | Not needed.We think the way it has been agreed and informed to RAN2 already meets the purpose, although maybe the container in the first place may not have been a bad idea as such.  |
|  |  |

## Issue #3-7: for PRS configuration for RTT-based PDC, whether to include some parameter(s) in *NR-DL-PRS-PositioningFrequencyLayer-r16*?

|  |
| --- |
| **Copied from 37.355**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, ...}, ...} |

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Copied from 38.211*** 7.4.1.7.3 Mapping to physical resources in a downlink PRS resource

For each downlink PRS resource configured, the UE shall assume the sequence  is scaled with a factor and mapped to resources elements according to when the following conditions are fulfilled:- the resource element is within the resource blocks occupied by the downlink PRS resource for which the UE is configured;- the symbol is not used by any SS/PBCH block used by a serving cell for downlink PRS transmitted from the same serving cell or any SS/PBCH block from a non-serving cell whose time frequency location is provided to the UE by higher layers for downlink PRS transmitted from the same non-serving cell;- the slot number satisfies the conditions in clause 7.4.1.7.4.and where - the antenna port - is the first symbol of the downlink PRS within a slot and given by the higher-layer parameter *dl-PRS-ResourceSymbolOffset*;- the size of the downlink PRS resource in the time domain is given by the higher-layer parameter *dl-PRS-NumSymbols*;- 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}*;*- the resource-element offset is obtained from the higher-layer parameter *dl-PRS-CombSizeN-AndReOffset*;- the quantity is given by Table 7.4.1.7.3-1.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*.**Table 7.4.1.7.3-1: The frequency offset as a function of .**

|  |  |
| --- | --- |
|  | **Symbol number within the downlink PRS resource**  |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** |
| 2 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 1 |
| 4 | 0 | 2 | 1 | 3 | 0 | 2 | 1 | 3 | 0 | 2 | 1 | 3 |
| 6 | 0 | 3 | 1 | 4 | 2 | 5 | 0 | 3 | 1 | 4 | 2 | 5 |
| 12 | 0 | 6 | 3 | 9 | 1 | 7 | 4 | 10 | 2 | 8 | 5 | 11 |

 |

**Feature lead:** In positioning, some PRS parameters e.g. the bandwidth, start RB, point A is not included in the *NR-DL-PRS-Resource-r16* configuration. These parameters are included in *NR-DL-PRS-PositioningFrequencyLayer-r16* according to the 37.355. Note that the reference point for the PRS frequency mapping is the point A which is configured by dl-PRS-PointA in positioning according to the 38.211. In order to complete the PRS configuration for PDC purpose, we need to discuss whether and how to configure these parameters also.

### First round discussion

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

**Question 3-7-1: for the PRS configuration for RTT-based PDC, do we need to also introduce the parameter(s) in NR-DL-PRS-PositioningFrequencyLayer-r16? If yes, then which parameter(s) to be included?**

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, ...},

 ...

}

|  |  |
| --- | --- |
| *Company* | *View* |
| Nokia, NSB | Not fully clear to us.Is it the intention to pick some of the parameters and add to PRS config in RRC spec? Or is it to check whether to copy-paste the IE NR-DL-PRS-PositioningFrequencyLayer into RRC?dl-PRS-ResourceBandwidth-r16, dl-PRS-StartPRB-r16 and dl-PRS-PointA-r16 seems to be needed. |
|  |  |

# 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. R1-2200013 Discussion on propagation delay compensation enhancements New H3C Technologies Co., Ltd.
3. R1-2200019 On remaining issues of propagation delay compensation Nokia, Nokia Shanghai Bell
4. R1-2200110 Discussion on propagation delay compensation enhancements ZTE
5. R1-2200200 Remaining issues for propagation delay compensation enhancements Samsung
6. R1-2200345 Enhancement for support of time synchronization OPPO
7. R1-2200375 Remaining issues for RTT-based propagation delay compensation Intel Corporation
8. R1-2200677 Propagation Delay Compensation Enhancements for Time Synchronization Ericsson
9. R1-2200574 Discussion on propagation delay compensation enhancements LG Electronics
10. R1-2200650 Enhancements for support of time synchronization Huawei, HiSilicon
11. R1- 2112978 Summary of Email discussion on Rel-17 RRC parameters for LS to RAN2 Moderator (Ericsson)
12. R1-2112953 Introduction of NR Positioning Enhancements

# Appendix Agreements in the past meetings

**RAN1#102-e**

Agreements:

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

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

Agreements:

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

Agreements:

For 5GS synchronicity budget requirement,

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

Agreements:

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

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

Agreements:

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

Agreements:

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

Agreements:

100 ns is assumed for BS detecting error.

Agreements:

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

Agreements:

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

Agreements:

Send an LS to RAN2 with the content including

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

Agreements:

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

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

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

**RAN1#103-e**

Agreements:

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

Agreements:

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

Agreements:

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

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

**RAN1#104-e**

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

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

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

**RAN1#104b-e**

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

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



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



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

Agreements:

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

Working assumption:



Agreement:

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

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

Agreement:

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

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

**Conclusion:**

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

**RAN1#106-e**

**Agreement**

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

**Agreement**

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

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

**Agreement**

If RTT-based propagation delay compensation is supported,

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

**Agreement**

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

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

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

**Agreement**

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

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

**Agreement**

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

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

**Agreement**

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

* **Alt. 1:**



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



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

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

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

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

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

Final LS is approved in R1-2108635.

**RAN1#106bis-e**

Agreement

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

* Alt.1 for RTT-based PDC

Agreement

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

* Alt.1 for TA-based PDC

Agreement

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

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

Agreement

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

Agreement

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

* UE Rx-Tx time difference at a given granularity

Conclusion

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

Agreement

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

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

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

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

Agreement

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

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

Agreement

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

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

Agreement

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

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

Agreement

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

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

**RAN1#107-e**

Agreement

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

Agreement

For Rel-17

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

Agreement

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

Agreement

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

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

Conclusion

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

Note: No RAN1 specification impact is expected for this conclusion

Agreement

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

Conclusion

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

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

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