**3GPP TSG-RAN WG2 Meeting #116bis electronic  *R2-210xxxx***

**Online, Jan 17th – 25th 2022**

**Agenda item: 8.5.2**

**Source: ZTE (email discussion rapporteur)**

**Title: Report of [AT116bis-e][503][IIoT] Tsynch open issues (ZTE)**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the offline email discussion “*[AT116bis-e][503][IIoT] Tsynch open issues*”, as indicated below:

* *[AT116bis-e][503][IIoT] Tsynch open issues (ZTE)*

 *Scope: Remaining open issues*

 *Deadline: Comments from companies by Thursday, 20 Jan 1200 UTC*

*Proposals by rapporteur by Friday, 20 Jan 1200 UTC*

# Contact information

Please provide your contact information when feedback:

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# Discussion

In RAN2#115 e-meeting, RAN2 has had the following agreements:

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| Agreements:......*3. RAN2 shall wait for RAN1 to decide the measurement framework for RTT based PDC method and does not preclude UE-side PDC or gNB based pre-compensation at this point. RAN2 is expecting guidance from RAN1 on what is needed.*  |

After long discussion and comparison, RAN1 has achieved agreements on supporting RTT based PDC method. In RAN1 LS [3], the following agreements have been mentioned:

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| **Agreement** For Rel-17 * Support RTT-based PDC method
* Support PDC method based on legacy TA-based mechanism
	+ No RAN1/RAN4 specification impact expected
 |

It can be seen that both RTT-based and legacy TA-based PDC method are supported. In RAN2 #116e meeting, some issues of RTT-based PDC have been discussed. But due to lack of RAN1 agreements, not much agreements have been achieved. In this email discussion, we will focus on the RAN2 impacts of the RTT-based PDC method and some remaining issues of legacy TA-based PDC method. Coexistence of these two PDC methods and some other issues would also be discussed.

## Whether to support both RTT-based and TA-based PDC

Per rapporteur’s understanding, almost all the companies think RAN2 can support both RTT-based PDC and legacy TA-based PDC method per RAN1 agreements. Company also mentions that support of both makes sense to support use cases with difference accuracy requirements while minimizing the radio interface overhead involved in PD estimation.

So rapporteur suggests we firstly have a quick discussion on whether RAN2 can confirm to support both RTT-based and legacy TA-based PDC. The details about coexistence of these two PDC methods would be discussed later, e.g., after we discuss the details of both methods.

**Q1: Whether RAN2 can confirm to support both RTT-based and legacy TA-based PDC per RAN1 agreements?**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Yes |  |
| CATT | Yes | Yes, R17 networks will support both PDC methods. Note though that only RTT-based PDC will be specified since TA-based PDC is left to UE implementation.  |
| Ericsson | Yes |  |
| DOCOMO | Yes |  |
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**Conclusion:**

## RTT-based PDC method

### Which side performs RTT-based PDC

According to RAN1 agreements, RAN1 assumes that RTT-based PDC can be performed at UE side or at gNB side. The following observations or proposals mentioned in the contributions are related to the issue on which side is suitable to perform RTT-based PDC, UE side or network side or both:

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| **Contributions** | **Related proposals** |
| R2-2200182[4] | **Observation 2: No technical benefits can be identified with gNB PD pre-compensation despite the drawbacks of heavier air interface overhead and need for unicast delivery of RTI.****Proposal 1: RAN2 should focus on UE-side PDC only for Rel-17 specification.**If the majority of companies wants to support gNB pre-compensation, then this should be focused on TA-based PDC. |
| R2-2200477[6] | **Observation 1**: **If the UE is configured with the RTT-based solution, it performs the PDC by applying the RTT-based solution when *UE-sidePDC* is ‘True’ and does not perform the PDC when *UE-sidePDC* is ‘False’.** In **Observation 1**, once the gNB sends the RRC parameter *UE-sidePDC* witha value of ‘False’ to the UE, it is highly possible for the gNB to perform the pre-compensation. In order to support the RTT-based pre-compensation at the gNB side, UE shall report the Rx-Tx difference to the gNB.**Proposal 1: UE reports the measured Rx-Tx difference to the gNB to support the RTT-based pre-compensation at the gNB side.** |
| R2-2200611[7] | **OptionA (one step exchange)**: gNB decides sends gNB Rx-Tx timing difference to UE when it is needed. UE directly calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference.**OptionB** **(two step exchange)**: This requires two steps. 1st step is UE sends UE Rx-Tx timing difference to gNB when it is needed. 2nd step is gNB calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference, and send the calculated PDC to UE.Since in RAN2 115e meeting, we agreed that gNB pre-compensation is not precluded for RTT measurement as following. Therefore both Option A and B should be supported.**Proposal3: For RTT based PDC procedure, RAN2 to discuss and agree the following two options.** |
| R2-2200761[9] | **Proposal 2: for UE side PDC, RTT is calculated in UE and gNB measured Rx-Tx time difference is send to UE****Proposal 3: for gNB side PDC, RTT is calculated in gNB and UE measured Rx-Tx time difference is send to gNB** |
| R2-2200926[11] | **Proposal 1 RAN2 agrees to support UE-side PDC for the RTT-based PDC method. The network uses an RRC signaling to enable/disable UE-side PDC, which is common to RTT-based and TA-based PDC methods.**From our point of view, it is unnecessary to support NW-side RTT-based PDC |
| R2-2200952[12] | **Proposal 3 Support gNB-based compensation for RTT-based PDC method.** |
| R2-2200991[13] | **Proposal 1**: RAN2 to confirm that network side PDC is supported. |
| R2-2201016[14] | **Observation 4: UE-side PDC should be supported since it can work with unicast and broadcast reference timing delivery unlike network-side PDC which can only work with unicast reference timing delivery.****Proposal 8: RAN2 to only focus on UE-side PDC.**  |
| R2-2201263[15] | **Proposal 4: For RTT based PDC, UE-side PDC and gNB based pre-compensation are both supported.** |

It can be seen a bit more companies suggest to support RTT-based PDC in both UE side and gNB side.

**Q2: Companies are invited to indicate which option below is preferred?**

* **Option1: Only support RTT-based UE side PDC**
* **Option2: Only support RTT-based gNB side PDC**
* **Option3: Support both RTT-based UE side PDC and RTT-based gNB side PDC**

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| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option3** | This is aligned with RAN1 assumption. |
| CATT | Option 3 | Same view as Rapporteur. |
| Ericsson | Prefer Option 2, but can accept option 3 | We prefer option 2 but would be okay for option 3 if majority wants, for the sake of progress. The argument to support option 1 is less signalling overhead and less spec impact to RAN3. However, RAN3 impact is inevitable in both UE-based and gNB-based compensation. Moreover, to introduce a mechanism to ensure that the sync target is met, such as measurement reporting from the UE, would also introduce signalling overhead for option 1.  |
| DOCOMO | Option 3 | Agree with ZTE. |
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**Conclusion:**

### Common measurement configuration for RTT-based PDC

As mentioned in [4], the Rx-Tx based PD estimation procedure can be illustrated as below:



Figure: Illustration of the Rx-Tx based PD estimation procedure.

No matter which option in Q2 (UE side, gNB side or both) would be agreed, the measurement configuration for Rx – Tx time difference measurement need to be provided to UE by gNB. The following observations or proposals mentioned in the contributions are related to the details of measurement configuration:

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| **Contributions** | **Related proposals** |
| R2-2200320[5] | In TS38.305 and TS37.355 for positioning, multiple TRPs are involved. So RAN2 discussed TRP identification and PRS/SRS pair identification in [2]. However, RAN1 agreed that only one pair of TRS/PRS and SRS can be configured to UE for RTT-based PDC.**Observation 1: Only one pair of TRS/PRS and SRS is configured to UE for RTT-based PDC via unicast RRC signalling.****Observation 2: The pair of TRS/PRS and SRS configured for RTT-based PDC shall not be reused for positioning.****Proposal 1: Configuring a UE with one pair of TRS/PRS implicitly activates the measurement of Rx-Tx time difference for RTT-based PDC purpose. No need to introduce activation/deactivation mechanism.** |
| R2-2200611[7] | **Proposal4: RAN2 to discuss the RRC IEs for PRS/SRS configuration for RTT based PDC.** |
| R2-2200872[8] | **Proposal 4: The measurement objective for Rx – Tx time difference measurement configured by gNB via RRC includes one CSI-RS for tracking (TRS)/PRS configuration and one SRS configuration.** |
| R2-2200991[13] | In RAN1#107-e meeting, it was agreed that “For RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signaling”. In RAN1 RRC parameter list (R1-2112976), RAN1 has agreed on RRC parameters for TRS (*pdc-Info*) and PRS (*DL-PRS-PDC-Info-r17*, *NR-DL-PRS-PDC-ResourceSet-r17*, *dl-PRS-NumSymbols-r16*, *dl-PRS-Periodicity-and-ResourceSetSlotOffset-r16*, and *dl-PRS-ResourceList-r16*).**Proposal 3: RAN2 to introduce RRC IE for Rx-Tx time difference measurement report, and related measurement configuration for TRS and PRS according to RAN1 RRC parameter list.** |
| R2-2201016[14] | RAN1 has indicated that RTT can support both TRS and PRS for DL signalling, we propose that RAN2 prioritizes CSI-RS (TRS) in the discussion for two reasons: 1. TRS support is more available across UEs, since not every UE supports PRS. 2. PRS configuration and measurement usually involves some extent of LMF signalling, however, RAN2 has agreed that: *The timing synchronization in I-IoT should focus on the signalling between the UE and gNB, i.e. different from Multi-RTT based signalling flow which involving LMF and AMF.***Proposal 2: RAN2 to prioritize discussing the expected spec. impact from RTT based on the CSI-RS (TRS)-SRS exchange.****Proposal 4: New RRC signalling is introduced in-order to configure the CSI-RS/SRS exchange and measurement procedure at the UE.** |

According to RAN1 agreements, companies suggest to provide TRS/PRS and SRS configuration to the UE. Only one company explicitly indicate provision of PRS configuration can be deprioritized. As in RAN1 LS, RAN1 already ask RAN4 to define UE Rx-Tx time difference measurement accuracy based on PRS (including reuse existing spec if appropriate), rapporteur assume PRS configuration also need to be supported.

It seems all the related companies think these configurations are provided via RRC signalling.

**Q3: Do companies agree that one CSI-RS for tracking (TRS) configuration/PRS configuration and one SRS configuration need to be provided via RRC signaling for RTT-based PDC? If companies think PRS configuration doesn’t need to be supported, please indicate in the comments column.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Yes |  |
| CATT | Yes | Per RAN1 agreements |
| Ericsson | Yes | However, we prefer re-using the RAN1 agreed terminology to avoid potential misunderstanding, i.e., a single pair of TRS/PRS and SRS is configured for RTT-based PDC. |
| DOCOMO | Yes |  |
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**Conclusion:**

### Details of RTT-based UE side PDC

In this section, we will mainly discuss the details of RTT-based UE side PDC procedure. The following figure in [5] is cited here for reference:



**Figure: The procedure of RTT-based PDC for UE-based PDC**

The following observations or proposals mentioned in the contributions are related to the RTT-based UE side PDC procedure, e.g., how to activate/deactivate RTT-based UE side PDC and how to provide gNB RTT measurement to the UE:

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| **Contributions** | **Related proposals** |
| R2-2200182[4] | **Proposal 2: RAN2 only needs to support Rx-Tx measurement report from gNB to UE for RTT based PDC.****Proposal 3: UE combines the latest received gNB Rx-Tx measurement with the latest UE Rx-Tx measurement.****Proposal 4: RAN2 to adopt the RAN1 agreement to deliver Rx-Tx measurements over RRC.****Proposal 5: Support only a unicast activation/deactivation of UE-side PDC for Rx-Tx based PDC. A broadcasted activation/deactivation mechanism is redundant for the Rx-Tx based PDC method which anyway needs to be configured on each UE.****Proposal 6: Activation of UE-side RTT-based PDC should be implicit and unicast delivered and derived by the configuration or reporting framework for Rx-Tx measurements.** |
| R2-2200320[5] | **Proposal 2: The new explicit signaling enabling/disabling UE-side PDC is applied to TA-based PDC only. For RTT-based PDC, it is implicitly implemented by the gNB measurement report containing gNBRx-Tx.****Proposal 3: For RTT-based PDC in UE side, gNB measurement report containing gNBRx-Tx can be included in *DLInformationTransfer* message.** |
| R2-2200611[7] | **Proposal3: For RTT based PDC procedure, RAN2 to discuss and agree the following two options.****Option A: gNB decides when to conduct PDC and sends gNB Rx-Tx timing difference to UE when it is needed. UE calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference.****Option B: This requires two steps. 1st step is UE decides when to conduct PDC and sends UE Rx-Tx timing difference to gNB when it is needed. 2nd step is gNB calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference, and send the calculated PDC to UE.** |
| R2-2200678[8] | **Proposal 1: It’s suggested that UE can be activated RTT measurements based on gNB indication and then periodically performs RTT measurements.****Proposal 2: It’s suggested that gNB configures a periodicity for RTT measurement with a value that matches the update period of the reference time.** **Proposal 3: It’s suggested to use MAC signaling to activate/deactivate RTT measurement.** |
| R2-2200761[9] | **Proposal 1: RAN2 introduce RRC signalling procedure for both RTT based PDC enable/disable and measurement reporting.****Proposal 5: Unified RRC measurement framework can be reused for both UE reporting measured Rx-Tx time difference and gNB reporting measured Rx-Tx time difference** |
| R2-2200926[11] | **Proposal 1 RAN2 agrees to support UE-side PDC for the RTT-based PDC method. The network uses an RRC signaling to enable/disable UE-side PDC, which is common to RTT-based and TA-based PDC methods.****Proposal 2 If UE-side RTT-based PDC is enabled, the network sends the gNB Rx-Tx time difference to the UE, which is used by the UE to calculate the PD value.****Proposal 3 For UE-side PDC, in the case that the parameters that are needed by RTT-based PDC are configured, the UE can apply RTT-based PDC. Otherwise, the UE applies the legacy TA-based PDC.** |
| R2-2201016[14] | **Proposal 5: gNB Tx-Rx time difference measurement is transmitted from gNB to UE via RRC signalling.****Proposal 6: Tx-Rx time difference measurement exchange via MAC CE is not supported.** |
| R2-2201263[15] | **Proposal 5: For RTT based PDC, if UE-side PDC is enabled, NW shall provide the NW Rx-Tx time difference to UE via RRC signaling.****Proposal 6: Take *NR-Multi-RTT-SignalMeasurementInformation* IE as baseline, RAN2 to discuss which field(s) can be reused to indicate the UE/NW Rx-Tx time difference for RTT based PDC.****Proposal 7: The enable/disable UE-side PDC indication is broadcasted in SIB1.** |
| R2-2201367[16] | In order to guarantee the accuracy of the synchronization between gNB and UE, *ReferenceTimeInfo* should be periodically signalled to the UE. The measurement RX-TX time difference can be carried in the same message without introducing a new message.**Proposal 1. RX-TX measurement at gNB is signalled to UE via *ReferenceTimeInfo*.****Proposal 2. Activation/deactivation of PD measurement is not supported, i.e. only RRC-based PD configuration is supported in Rel-17.****Proposal 3. *ReferenceTimeInfo* configures the PDC option which UE should perform among the following:**1. **No UE-side PDC and UE reports RX-TX measurement at UE.**
2. **No UE-side PDC nor UE reporting TX-RX measurement.**
3. **Explicit indication that UE performs UE-side RTT-based PDC.**
4. **Explicit indication that UE performs UE-side TA-based PDC based on legacy TA value.**
5. **Up to UE implementation (proprietary solution including TA-based PDC), i.e. Rel-16.**
 |

It seems all the companies can agree that for RTT-based UE side PDC, gNB needs to provide gNB Rx-Tx time difference to UE via RRC signaling. One company mentions Tx-Rx time difference measurement exchange via MAC CE is not supported.

**Q4a: For RTT-based UE side PDC, do companies agree that gNB shall provide the gNB Rx-Tx time difference, e.g., gNBRx-Tx to UE via RRC signaling?**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Yes |  |
| CATT | Yes |  |
| Ericsson | Yes |  |
| DOCOMO | Yes |  |
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**Conclusion:**

Some companies have suggested different options for providing NW Rx-Tx time difference to UE for RTT based PDC.

**Q4d: For RTT-based UE side PDC, companies are invited to indicate which option below for providing NW Rx-Tx time difference to UE is preferred?**

* **Option1: Take *NR-Multi-RTT-SignalMeasurementInformation* IE as baseline for further discussion**
* **Option2: via *ReferenceTimeInfo*.**
* **Option3: via *DLInformationTransfer***
* **Other option**

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| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option1****+Option3 or other option** | If gNB RTT measurement is provided in ***ReferenceTimeInfo***, that may means time information should be provided together with provision of gNB RTT measurement. As we assume there is the case that UE needs to perform RTT-based PDC for the time information provided in SIB, we think such process is not needed and cause unnecessary signaling overhead. So option 2 isn’t preferred. For option 1, it can be merged with other options. It just means we need to check what’s field (s) in ***NR-Multi-RTT-SignalMeasurementInformation*** can be referred. We still need to construct an IE in RRC signaling to carry gNB RTT measurement. In our thinking, the RRC signaling can be *DLInformationTransfer* or *RRCReconfiguration.* |
| CATT | Option 3 | *DLInformationTransfer* is typically designed for such type of information. |
| Ericsson | Option 3 | The other two options do not work. Option 1: this is an IE, and it is in the signalling protocol between UE and LMF, i.e., not used for gNB Rx-Tx time diff. Option 2: ReferenceTimeInfo is an IE and cannot be extended  |
| DOCOMO | Option 3 |  |
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All the related companies think UE side PDC or RTT-based UE side PDC needs to be activated. But different options have been mentioned.

**Q4b: For RTT-based UE side PDC, companies are invited to indicate which option below for activating** **RTT-based UE side PDC is preferred?**

* **Option1: Provision of gNB Rx-Tx time difference, e.g., gNBRx-Tx (see Q4a) can implicitly activate RTT-based UE side PDC. This option implies the activation indication is unicast.**
* **Option2: Provision of measurement configuration (see Q3) can implicitly activate RTT-based UE side PDC. This option implies the activation indication is unicast.**
* **Option3: An explicit indication is introduced in unicast or broadcast signaling to activate RTT-based UE side PDC.**
* **Other option**

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| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option1** | Since configuration needs to be provided to UE in RTT-based PDC method, we think implicit activation for UE side RTT-based PDC is feasible. So Option 3 is not needed. For Option2, it may cause confusion if both UE side RTT-based PDC and gNB side RTT-based PDC is supported, e.g., UE cannot differentiate whether UE-side PDT should be performed. In other word, it may be feasible if only UE side RTT-based PDC is supported. As we suggest to support both UE side PDC and gNB side PDC (see Q2), we don’t prefer Option 2. |
| CATT | Option 1 | The UE is supposed to be first configured with a TRS/PRS pair in order to continuously maintain the measurement of the Rx-Tx time difference at the UE. Then, upon receiving the gNB Rx-Tx time difference, gNBRx-Tx, from gNB, UE uses it, on top of the above measurement, to perform the PDC on its reference time. |
| Ericsson | Option 1 |  |
| DOCOMO | Option1 |  |
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**Conclusion:**

One company has mentioned in order to timely perform RTT-based PDC, UE and gNB may need to perform RTT measurement in advance and acquire the measurement results of peer side if needed. Company further suggest such activation can be provided via MAC signaling.

**Q4c: For RTT-based UE side PDC, companies are invited to indicate which option below for activating RTT measurement in UE side is preferred?**

* **Option1: No additional activation for RTT measurement in UE side. That means UE doesn’t need to be explicitly trigger RTT measurement. Another understanding may be that upon reception of measurement configuration (see Q3) or gNB RTT measurement (see Q4a), UE can just trigger RTT measurement.**
* **Option2: An explicit activation indication in MAC is introduced to trigger RTT measurement in UE side.**
* **Other option**

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| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option2** | We think UE needs to prepare RTT measurement in itself before it receives **gNBRx-Tx** and performs RTT-based PDC.As we think it may take some time for UE to perform measurement, it’s better that UE can be triggered RTT measurement a bit earlier. Then the PDC can be performed timely, e.g., upon reception of gNB RTT measurement.  |
| CATT | Option 1 | The configuration of the TRS/PRS pair is for RTT-based measurement only, so it is enough to unambiguously trigger UE performing the measurement of the Rx-Tx time difference at the UE (based on the configured TRS/PRS pair).  |
| Ericsson | Option 1 | The UE shall measure the UE Rx-Tx time difference once the reference signals are configured.  |
| DOCOMO | Option1 |  |
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**Conclusion:**

### Details of RTT-based gNB side PDC

In this section, we will mainly discuss the details of RTT-based gNB side PDC procedure. The following figure in [5] is cited here for reference:



Figure: The procedure of RTT-based PDC for gNB-based PDC

The following observations or proposals mentioned in the contributions are related to the RTT-based eNB side PDC procedure, e.g., how to activate/deactivate RTT measurement report from UE to gNB and how to perform RTT measurement report:

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| **Contributions** | **Related proposals** |
| R2-2200320[5] | **roposal 4: For gNB-based PDC, UE measurement report containing UERx-Tx should be triggered by RRC signaling explicitly (via *DLInformationTransfer* or *RRCReconfiguration*).****Proposal 5: Neither periodic UE measurement report nor event trigger UE measurement report is needed.** **Proposal 6: UE measurement report containing UERx-Tx should be introduced and it can be included in *UEAssistanceInformation.*** |
| R2-2200477[6] | **Proposal 1: UE reports the measured Rx-Tx difference to the gNB to support the RTT-based pre-compensation at the gNB side.** |
| R2-2200611[7] | **Proposal1: RAN2 to discuss the trigger condition for UE to start RX-TX time different measurement and reporting.*** **Option1: Periodical UE Rx-Tx time difference measurement/reporting.**
* **Option2: gNB explicitly indicate UE to conduct RTT measurement/reporting using dedicated signaling.**
* **Option3: event based trigger e.g. UE start RTT measurement/reporting when UE is far away from gNB.**

**Proposal2: Introduce event triggered RX-TX time different measurement and reporting.****Proposal3: For RTT based PDC procedure, RAN2 to discuss and agree the following two options.****Option A: gNB decides when to conduct PDC and sends gNB Rx-Tx timing difference to UE when it is needed. UE calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference.****Option B: This requires two steps. 1st step is UE decides when to conduct PDC and sends UE Rx-Tx timing difference to gNB when it is needed. 2nd step is gNB calculates the PDC based on gNB Rx-Tx timing difference and UE Rx-Tx timing difference, and send the calculated PDC to UE.** |
| R2-2200678[8] | **Proposal 4: It’s suggested that gNB sends a RTT measurement reporting indication to trigger UE to send the UE Rx-Tx time difference to network.** |
| R2-2200761[9] | **Proposal 4: RRC measurement framework can be reused for UE reporting measured Rx-Tx time difference.****Proposal 5: Unified RRC measurement framework can be reused for both UE reporting measured Rx-Tx time difference and gNB reporting measured Rx-Tx time difference** |
| R2-2200872[10] | **Proposal 2: It is proposed to introduce RRC signaling for Rx-Tx time difference measurement report.****Proposal 3: The selection of RRC or L1/MAC signalling for Rx-Tx time difference measurement (de)activation depends on the frequency of the PD actions, which needs confirmed by RAN1.****Proposal 5:** **event type UE Rx-Tx time difference measurement reporting could be introduced with high priority, while the periodically UE Rx-Tx time difference measurement reporting can be introduced as backup approach.** |
| R2-2200952[12] | [**Proposal 5 Support event-triggered report of UE Rx-Tx time difference.**](#_Toc92793201)[**Proposal 6 UE report Rx-Tx time difference if the difference between the current measurement value and the previous reported measurement value is larger than a configurable threshold.**](#_Toc92793202)[**Proposal 7 The measurement report contains beside Rx-Tx time difference at least RSRP of the DL reference signals.**](#_Toc92793203) |
| R2-2200991[13] | **Proposal 2**: Field description of IE *time-16* is updated to support network pre-compensation.**Proposal 3**: RAN2 to introduce RRC IE for Rx-Tx time difference measurement report, and related measurement configuration for TRS and PRS according to RAN1 RRC parameter list. |
| R2-2201263[15] | **Proposal 6: Take *NR-Multi-RTT-SignalMeasurementInformation* IE as baseline, RAN2 to discuss which field(s) can be reused to indicate the UE/NW Rx-Tx time difference for RTT based PDC.** |

For RTT-based gNB side PDC, several options have been mentioned for triggering report of UE Rx-Tx time difference to the NW.

**Q5a: For RTT-based gNB side PDC, companies are invited to indicate which option below for triggering report of UE Rx-Tx time difference to the NW is preferred? If there are sub-options, companies can further indicate which sub-option is preferred?**

* **Option1: An explicit indication is sent from eNB to UE to trigger one-shot UE Rx-Tx time difference report. The possible ways can be:**
	+ **Option1a: the trigger in RRC signaling explicitly, e.g., in *DLInformationTransfer* or *RRCReconfiguration*.**
	+ **Option1b: the trigger in L1/MAC signaling**
* **Option2: Event-triggered report of UE Rx-Tx time difference. The possible event may be:**
	+ **Option2a:** **if the difference between the current measurement value and the previous reported measurement value is larger than a configurable threshold.**
	+ **Option2b: UE start RTT measurement/reporting when UE is far away from gNB**
* **Option3: An indication is sent from eNB to UE to trigger periodical report of UE Rx-Tx time difference**
* **Option4: No need of explicit trigger, UE decides when to conduct PDC and sends UE Rx-Tx timing difference to gNB when it is needed.**
* **Other option**

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| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option3** | We prefer an explicit indication in RRC signaling to trigger periodical report of UE Rx-Tx time difference. Such indication can also be in measurement configuration, e.g., also for indicating the periodicity. But as we assume it should be allowed that the start of UE RTT measurement report is later than the time point of provision of measurement configuration, we prefer a separate indication. For example, it can be in the *UEInformationRequest*. |
| CATT | Option 1a | This is related to the gNB-based PDC procedure and so no one but gNB knows better when the reference time needs to be adjusted for the UE due to either clock drift or UE moving around. This has already been extensively discussed in R16. And anyways these adjustments are not expected to be often. Therefore, the simplest and most efficient approach is to let gNB requesting the measurement from the UE via an explicit request carried e.g. in *DLInformationTransfer* or *RRCReconfiguration*.  |
| Ericsson | Option 2a | One thing that RAN2 should keep in mind is that the moment to deliver the reference time and the moment to perform the PDC should be in close time proximity. Otherwise, the PDC would be inaccurate. * Option 1 does not work, since the gNB is not aware that the UE propagation delay compensation has changed. gNB may only be aware within the CP for data transmission, but this is not accurate enough for 100-200 ns sync target.
* Option 3 could work only for the case that the gNB periodically transmits the reference time and the reference signals are periodic. Note RAN1 has not precluded aperiodic/semi-persistent CSI-RS for tracking. This also limits a network implementation in which the gNB chooses to transmit the reference time a-periodically. Compared to option 2, this also has extra signalling overhead, e.g., what if the UE is stationary and UE Rx-Tx diff is always the same.
* Option 4 does not work, as the condition to trigger the report is unclear and not possible to ensure the sync target can be met.

RAN2 can assume that a reasonable gNB implementation that once the DL reference signals are configured, the intention is to acquire the UE Rx-Tx time difference measurements. The baseline is that the UE reports the measurement whenever there is a CSI-RS for tracking or PRS transmission in the DL. On top of it, RAN2 can discuss event-based triggering to save signalling overhead, i.e., option 2.  |
| DOCOMO | Option2a or 2b | For saving signaling overhead, we believe event-triggered of UE Rx-Tx reporting is necessary. |
|  |  |  |

**Conclusion:**

RAN1 has agreed For RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signaling. For RTT-based gNB side PDC, several options have been mentioned for providing UE Rx-Tx time difference report to NW.

**Q5b: For RTT-based gNB side PDC, companies are invited to indicate which option below can be used to provide UE Rx-Tx time difference report, e.g., UERx-Tx?**

* **Option1: Take *NR-Multi-RTT-SignalMeasurementInformation* IE as baseline for further discussion**
* **Option2: *UEAssistanceInformation***
* **Option3: RRC measurement framework can be reused**
* **Option4: Other RRC signaling**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option3 or Option4** | We think Option 1 can be combined with other options, e.g., with reference to ***NR-Multi-RTT-SignalMeasurementInformation*,** we can define an RRC IE which can be put in a RRC signaling. The RRC signaling in our thinking may be *MeasurementReport* (we assume this is option3) or *UEInformationRequest.* |
| CATT | Option 2 | The only information needed is UERx-Tx which is quite simple Considering the mandatory fields in *MeasResults* are not needed for UERx-Tx report, we prefer *UEAssistanceInformation*. |
| Ericsson | Option 3 | This is clearly a measurement from the UE that would be reported to the gNB. Option 3 can be taken as the baseline.  |
| DOCOMO | Option 3 |  |
|  |  |  |

**Conclusion:**

There are also some discussion on the content of UE Rx-Tx time difference report, e.g., besides the UERx-Tx(note that the reporting range, the granularity of the report, and the achievable accuracy are up-to RAN4), is there any other thing to be reported to NW? Some companies suggest to further check the measurement report from UE to LMF in the LTE positioning protocol (LPP) protocol. One company indicates the DL RSRP result of the measurement may be additionally needed to report.

**Q5c: For RTT-based gNB side PDC, companies are invited to indicate, besides UERx-Tx, what additional information needs to be reported to NW?**

* **Option1: None**
* **Option2: DL RSRP result of the measurement**
* **Option3: Wait for RAN4**
* **Other option**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option1** | Besides UE RTT measurement, we see no need for other information. The details of UE RTT measurement can be wait for RAN4 |
| CATT | Option 1 | Same view as ZTE |
| Ericsson | Option 2 | At least measurement qualities should be indicated to the network so that the network can configure correspondingly, e.g., the bandwidth and the frequency of the reference signals.  |
| DOCOMO | Option1 |  |
|  |  |  |

**Conclusion:**

### RTT-based PDC procedure

In some contributions [R2-2200320], [R2-2200678], [R2-2200761], [R2-2200872], [R2-2200991] and [R2-2201016], the example RTT-based PDC procedures are provided. Among them, [R2-2200991] provide complete procedures and description for steps for both of UE side RTT-based PDC and gNB side RTT-based PDC. Per rapporteur’s understanding, it would be better to capture the signaling flow in the specification, at least in stage-2 specification.

**Q6: Do companies agree to capture signalling flows of RTT-based PDC procedures in the specification, e.g., in stage-2 specification? If yes, companies are invited to further indicate whether you are fine to take the example flows in [R2-2200991] as baseline to further discussion? Other suggestion can also be indicated.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Yes | We are fine to take the example signaling flows in [R2-2200991] as baseline for further discussion. |
| CATT | Yes | In stage 2? |
| Ericsson | Yes | We are fine to capture a simple signaling flow chart in the stage 2 spec.  |
| DOCOMO | Yes |  |
|  |  |  |

**Conclusion:**

## TA-based PDC method

### Activation/deactivation of TA-based UE-side PDC

In previous meetings, RAN2 has agreed to use unicast and broadcast RRC signaling to enable/disable PDC. Besides the discussion of activation RTT-based PDC in section 3.2.3 and section 3.2.4, the following proposals have been mentioned about how to activate TA-based UE-side PDC:

|  |  |
| --- | --- |
| **Contributions** | **Related proposals** |
| R2-2200182[4] | **Proposal 7: Introduce a new RRC IE to activate/deactivate UE-side TA-based PDC for unicast activation/deactivation, and an optional bit in RTI carried over SIB9 for a broadcast activation/deactivation of UE-side TA-based PDC.**  |
| R2-2200320[5] | **Proposal 2: The new explicit signaling enabling/disabling UE-side PDC is applied to TA-based PDC only. For RTT-based PDC, it is implicitly implemented by the gNB measurement report containing gNBRx-Tx** |
| R2-2200926[11] | **Proposal 1 RAN2 agrees to support UE-side PDC for the RTT-based PDC method. The network uses an RRC signaling to enable/disable UE-side PDC, which is common to RTT-based and TA-based PDC methods.** |

**Q7: Companies are invited to indicate which option below for activating TA-based PDC is preferred?**

* **Option1: An explicit indication to only activate UE side TA-based PDC**
* **Option2: A common indication to activate UE-side PDC, RTT-based PDC or TA-based PDC**
* **Other option**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Option1 | We prefer Option 1. That means an explicit activation indication is specifically defined for TA-based PDC (separate from the implicit activation indication for RTT-based PDC). Such indication could be explicitly provided to the UE in unicast signaling or in SIB.  |
| CATT | Option 1 | As discussed in Q4b/c, for RTT-based PDC, both the measurements and the PDC application can be implicitly activated by reusing the signaling from the RTT procedure itself. |
| Ericsson | Option 1 |  |
| DOCOMO | Option 1 |  |
|  |  |  |

**Conclusion:**

### Calculation of TA-based UE-side PDC

The following proposals have been mentioned on how to perform TA-based PDC method:

|  |  |
| --- | --- |
| Contributions | Related proposals |
| R2-2200952[12] | **Proposal 1 When using legacy TA-based PDC method, the propagation delay is (NTA + NTA,offset)Tc/2 of PCell.**Since the reference time information always refers to the PCell, the UE can only compute the propagation delay if the *timeAlignmentTimer* associated with the PTAG of the MCG is running. Otherwise, the used TA commands at the UE are not valid/up to date.**Proposal 2 When using legacy TA-based PDC method, the UE computes the propagation delay only if the timeAlignmentTimer associated with the PTAG of the MCG is running.** |
| R2-2201016[14] | **Observation 3: RAN1 agreed to support legacy TA without adding new enhancements to increase accuracy.** **Proposal 7: TA-based PDC is left to UE implementation and no new enhancements are introduced to legacy Rel-16 TA.**  |

During R16 discussion, there are already some discussion on how to calculate TA-based PDC, but no agreement is achieved. Companies are invited to quickly check whether the **proposal1** in [12] can be agreed for Release 17.

**Q8: Do companies agree to specify PD as (NTA + NTA,offset)Tc/2 of PCell for TA-based PDC method?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | No? | The proposals are technically correct. But we have no strong view and think it’s not so necessary to specify. |
| CATT | No | We don't think anything needs to be specified for TA-based PDC, except its activation/deactivation. |
| Ericsson | Yes | If the network configures the UE a specific feature, shouldn’t the UE actions be clear and specific? If nothing is specified, then there is no way to test and in practice, it means that all UEs can claim it supports TA-based PDC at the UE side. This means that this feature is useless, or ?? |
| DOCOMO | Yes | We see no demerit to specify it. |
|  |  |  |

**Conclusion:**

## Coexistence of RTT-based PDC and TA-based PDC

The following proposals give suggestion on how to handle the scenarios of coexistence of RTT-based PDC and TA-based PDC:

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| --- | --- |
| **Contributions** | **Related proposals** |
| R2-2200320[5] | **Proposal 2: The new explicit signaling enabling/disabling UE-side PDC is applied to TA-based PDC only. For RTT-based PDC, it is implicitly implemented by the gNB measurement report containing gNBRx-Tx.**Per Proposal 2, the UE applies TA-based PDC when enabled by gNB. Then the question is: can RTT-based and TA-based PDC be configured concurrently?* Option 1: gNB is not expected to both configure RTT-based PDC and enable TA-based PDC.
* Option 2: when RTT-based PDC parameters are configured, UE starts measuring UERx-Tx but implements TA-based PDC (if enabled) until it receives gNBRx-Tx measurement from gNB, which triggers a reference time adjustment in the UE based on the RTT procedure. FFS whether the TA-based procedure continues after that or is suspended.

So option 1 is preferred. For option 1, when RTT-based PDC is configured, UE shall not perform TA-based PDC and gNB does not need to disable UE-side PDC explicitly.**Proposal 8: When RTT-based PDC is configured, UE shall not perform TA-based PDC.** |
| R2-2200477[6] | **Observation 1: If the UE is configured with the RTT-based solution, it performs the PDC by applying the RTT-based solution when *UE-sidePDC* is true and does not perform the PDC when *UE-sidePDC* is false.** **Observation 2: If the UE is not configured with the RTT-based solution, it performs the PDC by applying the TA-based solution when *UE-sidePDC* is true and does not perform the PDC when *UE-sidePDC* is false.** **Proposal 1: UE reports the measured Rx-Tx difference to the gNB to support the RTT-based pre-compensation at the gNB side.****Proposal 2: When the RRC parameter *UE-sidePDC* is absent, the UE shall fall back to the Rel-16 behaviour, i.e. UE-implementation to apply TA-based PDC.** |

**Q9: Do companies agree that there is the scenario where both RTT-based PDC and TA-based PDC are activated at the same time? If yes, whether you agree with the proposed solution as mentioned above or any other suggestion?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| ZTE | Yes | Based on our answers to the previous questions, we prefer that RTT-based PDC can be implicitly activated while TA-based PDC can be explicitly activated. The activation indications of these two methods are separate. Based on that, we think the case that RTT-based PDC and TA-based PDC are activated by unicast signaling at the same time can be avoided by NW implementation. But it may be possible that TA-based PDC is activated by broadcast and later RTT-based PDC is activated by unicast (e.g., upon reception of gNB RTT measurement). Then activation of UE side RTT-based PDC can implicitly deactivate the TA-based PDC for the certain UE.  |
| CATT | No | Although we agree with above comment by ZTE, we disagree that, per Q9, both RTT-based PDC and TA-based PDC are activated at the same time. We rather understand the question as: both can be configured concurrently (although it might be a NW misconfiguration), but configuring a UE with RTT-based PDC shall implicitly deactivate the TA-based PDC.  |
| Ericsson | No as the baseline | The two methods are introduced to meet different sync targets and so typically, it should not be activated at the same time for one UE. |
| DOCOMO | No | Same view with Ericsson. |
|  |  |  |

**Conclusion:**

## UE capability

The following proposals or description have been mentioned on the issue of UE capability report.

|  |  |
| --- | --- |
| **Contributions** | **Related proposals** |
| R2-2200678[8] | **Proposal 5: R17 UE needs to report its capability of supporting PDC.** |
| R2-2200761[9] | Capability transfer procedure maybe needed to indicate gNB that UE has RTT based PDC capability.  |
| R2-2200926[11] | Proposal 6 Introduce a new UE feature to report whether the UE supports the propagation delay compensation. Meanwhile, it depends on RAN1 to decide whether any UE capability is needed on the propagation delay estimation.  |
| R2-2201016[14] | **Proposal 3: A new RTT high-accuracy PDC UE capability is introduced.**  |
| R2-2201263[15] | **Proposal 10: Introduce separate UE capabilities on the support of legacy TA-based PDC and RTT-based PDC, respectively.** |

**Q10: Companies are invited to indicate which option below can be agreed for R17 UE capability of supporting PDC?**

* **Option1: Only a capability of supporting PDC**
* **Option2: Only a capability of supporting new RTT-based PDC (also means high-accuracy PDC)**
* **Option3: Two capabilities, one is of supporting new RTT-based PDC and the other is of supporting legacy TA-based PDC**
* **Other option**

|  |  |  |
| --- | --- | --- |
| **Company** | **Preferred Option** | **Additional comment(s)** |
| ZTE | **Option3** | We think maybe Option 3 is feasible and flexible. Only after UE reports the capability of supporting legacy TA-based PDC, the network can send explicit activation indication of TA-based UE-side PDC (see Q7) to the UE. |
| CATT | Option 3 |  |
| Ericsson | Option 3 |  |
| DOCOMO | Option 3 |  |
|  |  |  |

**Conclusion:**

## Other issue

The following proposals (maybe not as essential as above issues) have been mentioned in only one or a few contributions. Rapporteur invite companies to indicate their comments on them, e.g., whether the related issues need to be addressed and whether the proposed solution is feasible? If some issues can have more support, they can be listed as FFS for further discussion.

|  |  |  |
| --- | --- | --- |
| Other issue | Contributions | Related proposals |
| **Issue#1** using time info in dedicated signaling vs SIB | R2-2200320[5] | Proposal 9: As soon as a UE receives its reference time information via dedicated signaling, it ignores all further reference time information received over SIB9. |
| R2-2200952[12] | Proposal 10 The network can indicate to the UE that any previously received dedicated time information from the network is invalid, i.e., UE can acquire reference time information from SIB9. |
| **Issue#2** RAN3 impacts of two PDC method | R2-2200952[12] | **Proposal 8 Send an LS to RAN3: RAN3 to specify support of gNB-based pre-compensation for the legacy TA-based method based on the NR TADV measurement of PRACH.****Proposal 9 Send an LS to RAN3: RAN3 to specify the support of gNB Rx-Tx time difference delivery on the F1 interface.** |
| **Issue#3** mismatch between propagation delay value and reference time information | R2-2201263[15] | **Observation1: If the distance between where one UE obtains the propagation delay value and where the UE obtains the reference time information is longer than a valid distance, the PDC cannot be performed as the propagation delay value and reference time information are not match.****Proposal2: A valid time is introduced. If the time difference between when propagation delay value is obtained and when the reference time information is received is shorter than the valid time, the propagation delay value and the reference time information are considered as a match and the PDC can be performed. Otherwise, the PDC cannot be performed.****Proposal3: Network always configures UE with a valid time for PDC when UE-side PDC is enabled and may determine the value of the valid time based on UE’s moving speed.**  |

**Q11a: Companies are invited to provide your comments on the other issue#1:**

|  |  |  |
| --- | --- | --- |
| **Company** | **Agree with Issue?****Yes or No** | **Additional comment(s)** |
| ZTE | No? | We think P9 in R2-2200320[5] could be the common understanding. In our assumption, if previously UE is provided with time information via dedicated signaling, e.g., due to security reason, and if later network needs to provide new time info due to some reason, e.g., clock drift in NW, NW still need to provide the time info via dedicated singling to this UE, e.g., with security. As we assume such case is rare case, the singling overhead is not big issue.  |
| CATT | Yes (proponent) | We think P9 from [5] should be discussed to check at least that this is the common understanding of the earlier RAN2 agreement. Then, if it is the case, we think the Ericsson’s proposal makes sense as there should also be a way to go back to SIB-based reference time. |
| Ericsson | Yes (proponent) | Agree with CATT that RAN2 should at least discuss and reach a common understanding. The intention is to clarify the UE action when reference time is provided in both unicast and broadcast message. We see benefits in allowing the network to switch between unicast and broadcast to a particular UE, see details in R2-2200952 [12]. |
| DOCOMO | Yes | Agree with CATT. |
|  |  |  |

**Conclusion:**

**Q11b: Companies are invited to provide your comments on the other issue#2:**

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| --- | --- | --- |
| **Company** | **Agree with Issue?****Yes or No** | **Additional comment(s)** |
| ZTE | Yes | As gNB RTT measurement is performed in gNB-DU while gNB PDC calculation is performed in gNB-CU, RAN3 spec need to be enhanced in F1 interface for RTT-based PDC. So at least Proposal 9 in R2-2200952[12] can be agreed and RAN2 can send LS to RAN3 based on RAN2 progress for RTT-based PDC.  |
| CATT | - | Can be discussed after we have progressed the design. |
| Ericsson | Yes (proponent)  | RAN3 previously sent an LS to RAN2 to indicate that for RTT-based gNB pre-compensation, there is RAN3 impact. The proposal is to indicate that even with UE-based compensation, there is RAN3 impact. Would be okay not to send the LS, if the discuss has been kicked-off in RAN3.  |
| DOCOMO | Yes | As pre-compensation from gNB has RAN3 impact, the LS is necessary. |
|  |  |  |

**Conclusion:**

**Q11c: Companies are invited to provide your comments on the other issue#3:**

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| --- | --- | --- |
| **Company** | **Agree with Issue?****Yes or No** | **Additional comment(s)** |
| ZTE | No | We see no issue if frame synchronization can be kept. |
| CATT | No | This is part of the gNB implementation SW. No need to be specified. |
| Ericsson | Yes for the issue;No for the solution | We acknowledge the issue and agree that the moment of PDC and the moment of reference time delivery should be as close as possible in time proximity. However, since both the reference signals for PDC and the reference time delivery are under the control of gNB, we don’t see the necessity to introduce the valid time. |
| DOCOMO | No | Acknowledge the issue, PDC is expected to be kept valid (matched with reference time info) by gNB implementation. |
|  |  |  |

**Conclusion:**

**Q11d: Any other issue?**

|  |  |
| --- | --- |
| **Company** | **Additional comment(s)** |
| Ericsson | It is RRC spec rapporteur’s understanding that some RAN1 agreements/conclusions, beyond the RRC parameters, need to be captured in the RRC CR. One such agreement/conclusion related with PDC is the following:**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 conclusionRAN2 can first discuss if there is any need to specific in RRC to support this conclusion. |
|  |  |
|  |  |

**Conclusion:**

# Conclusion

**TBD**

# References

[1] [R2-2111282](file:///C%3A%5CUsers%5Cpanidx%5COneDrive%20-%20InterDigital%20Communications%2C%20Inc%5CDocuments%5C3GPP%20RAN%5CTSGR2_116-e%5CDocs%5CR2-2111282.zip), Summary of email discussion on Tsynch, CMCC, RAN2#116e

[2]R2-2200060, RE: LS on Time Synchronization, IEEE 1588 WG, LS in To:RAN, SA Cc:RAN2

[3] R2-2200080, LS on propagation delay compensation (R1-2112834; contact: Huawei) RAN1 LS in Rel-17 NR\_IIOT\_URLLC\_enh To:RAN2, RAN4, , RAN2#116e

[4] R2-2200182, Signalling for Support of Propagation Delay Compensation, Nokia, Nokia Shanghai Bell, RAN2#116bise

[5] R2-2200320, RTT-based PDC and TA-based PDC, CATT, RAN2#116bise

[6] R2-2200477, Discussion about propagation delay compensation for accurate time synchronization, Huawei, HiSilicon, RAN2#116bise

[7] R2-2200611, Discussion on propagation delay compensation for TSN, NTT DOCOMO INC, RAN2#116bise

[8] R2-2200678, Discussion on RTT-based PDC, ZTE Corporation, Sanechips, China Southern Power Grid Co., Ltd, RAN2#116bise

[9] R2-2200761, Signaling procedure of RTT based propagation delay compensation, Lenovo, Motorola Mobility, RAN2#116bise

[10] R2-2200872, Discussion on RTT-based PDC Enhancement, CMCC, RAN2#116bise

[11] R2-2200926, Remaining issues on time synchronization enhancement, OPPO, RAN2#116bise

[12] R2-2200952, Propagation delay compensation enhancements, Ericsson, RAN2#116bise

[13] R2-2200991, Remaining issues of timing synchronization, Intel Corporation, RAN2#116bise

[14] R2-2201016, Propagation Delay Compensation for TSN, Qualcomm Incorporated, RAN2#116bise

[15] R2-2201263, Discussion on propagation delay compensation, vivo, RAN2#116bise

[16] R2-2201367, Issues on PDC, Samsung, RAN2#116bise