**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*

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# Discussion

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

|  |
| --- |
| 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:

|  |
| --- |
| **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 |  |
| Nokia | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes | Per RAN1 agreements. |
| Qualcomm | Yes | Agree with CATT |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| LGE | Yes | However, we should minimize the specification impact by considering the Rel-17 timeline. |
| Futurewei | Yes |  |

**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:

|  |  |
| --- | --- |
| **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. |
| Nokia | Option 1 | We do not see any technical benefits of the gNB to combine the two Rx-Tx measurements (as needed in Option 2 and 3), and afterwards delivering a PD value to the UE (Option 3), contrary the UE combining the measurement itself. We think that there should be a clear technical benefit to justify the additional overhead it brings for gNB-side PDC with RTT.  We also must note that according to the previous LS from RAN3, more specification impacts are foreseen in RAN3 is gNB-based PDC is supported. Considering that we are approaching the end of this Rel-17 WI, we think RAN2 should make the best use of time to focus on UE-based PDC which is more beneficial. |
| Huawei, HiSilicon | Option 3 | Agree with Rapporteur on RAN1 assumption. |
| Fujitsu | Option 3 | Per RAN1 discussions. |
| Qualcomm | Option 1 or at least prioritize UE-side | We think that UE-side PDC support is a must, since SIB9 can be broadcast and UE-side is the natural way to ensure support for any timing delivery scenario, let alone that it is much easier to implement since it relies on DL signaling instead of a UE measurement report.  It is also not clear what exactly the extra benefits gNB-side compensation brings it seems to be an additional more complicated method to do the same task as UE-side, thus we do not see a reason for the extra effort since the gNB questions related to gNB-side (Q5a and Q5b0 are already the most technically intensive since they include measurement reports discussions).  We hope that regardless of whether option 1 or option 3 get a majority that RAN2 would prioritize getting a complete UE-side solution given the remaining time and then work on gNB side solution if there is enough support, other than undertaking effort in supporting both within the limited remaining time. |
| OPPO | Option 1 | We do not see much benefit to also supporting gNB-side RTT-based PDC. If gNB-side RTT-based PDC is enabled, it always requires the network to send the RTI via the dedicated signaling in the case of different gNB-UE distances in one cell, which increase signaling overhead. While such unnecessary singling overhead for RTI can be avoided by using UE-side RTT-based PDC. In addition, more discussion and effort are needed on the support of gNB-side RTT-based PDC, e.g. how/when to trigger the UE Rx – Tx time difference report. |
| Xiaomi | Option 1 | It seems that the RTT-based UE-side PDC is the only solution for the SIB-based reference time provisioning, and the RTT-based UE-side PDC can also be used for the dedicated signaling based reference time provisioning. Then from the UE point of view, the UE would have to support the RTT-based UE-side PDC. For the RTT-based gNB-side PDC, we need extra standard efforts which increases the complexities at both the UE and the gNB. |
| LGE | Option1 | At least we should prioritize UE-side PDC considering the possible impact to RAN3 by gNB-side PDC and the Rel-17 timeline. |
| Futurewei | Option 3 | Per RAN1 discussions. |

**Conclusion:**

### Common measurement configuration for RTT-based PDC

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

Chart

Description automatically generated with medium confidence

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:

|  |  |
| --- | --- |
| **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 |  |
| Nokia | Yes |  |
| Huawei, HiSilicon | Yes | We shall just follow RAN1 agreement, also second Ericsson’s motion on use of terms. |
| Fujitsu | Yes | Per RAN1 agreements. |
| Qualcomm | Yes | Follow RAN1 direction as much as possible |
| OPPO | Yes | Per RAN1 agreements |
| Xiaomi | Yes |  |
| LGE | Yes | It’s already decided by RAN1. |
| Futurewei | Yes |  |

**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 |  |
| Nokia | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Fujitsu | Yes |  |
| Qualcomm | Yes |  |
| OPPO | Yes |  |
| Xiaomi | Yes |  |
| LGE | Yes |  |
| Futurewei | Yes |  |

**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**

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Nokia | “other option” | We discourage options where PD estimation related signaling (which is UE specific) is mixed with ReferenceTimeInfo delivery options, as the latter can be cell specific. That is the point of supporting SIB9 via broadcast. So we prefer to rely on dedicated RRC signaling to the UE provided in a new gNB Rx-Tx measurement IE to the UE. The content of the Rx-Tx measurement report can be based on the outcome of the RAN1 discussion on the topic (copying below). RAN1 has also discussed the need for timestamping and SRS-Resource ID and reached consensus that these additional information is not needed in the measurement report as only a single pair of TRS/PRS and SRS is configured for RTT based PDC.   |  | | --- | | 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   **Agreement**  If RTT-based PDC is supported, a single granularity 32Tc (i.e. k=5) is supported for Rx-Tx measurement report.  **Agreement**  For RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signaling.  **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. | |
| Huawei, HiSilicon | Option 3 |  |
| Fujitsu | Option 3 | Agree with CATT. |
| Qualcomm | Option 3 |  |
| OPPO | Option 3 or other option | In our understanding, such information can be delivered via DLInformationTransfer or other dedicated RRC signaling.  Regarding Option1, we understand that what we need is only parts of information in NR-Multi-RTT-SignalMeasurementInformation. It is better not to reuse this IE. Regarding Option 2, simultaneous delivery is required between NW Rx-Tx time difference and RTI, which restricts the delivery flexibility. |
| Xiaomi | Option 3 |  |
| LGE | Option 3 |  |
| Futurewei | Option 3 |  |

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**

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Nokia | Option 2 | In our view, as the UE needs to be configured to be able to conduct Rx-Tx measurements, it can just as well use this to also determine if it should do UE-side PDC.  On the comment from ZTE on Option 2, we do not think that both UE-side and gNB-side PDC should be allowed to be simultaneously configured, hence the UE will either receive Rx-Tx measurements (UE-side PDC) or transmit Rx-Tx measurements (gNB-side PDC). |
| Huawei, HiSilicon | Option 3 | We understand last meeting agreement “The gNB can enable/disable UE-side PDC via unicast and broadcast RRC signalling.” has already provided answer to this question, that the activation is via explicit RRC signaling. |
| Fujitsu | Option 1 | It works. |
| Qualcomm | Option 3/Option 1/2 | Prefer explicit RRC signaling but fine if the companies choose to do it implicitly via configuration. |
| OPPO | Other option | The picture in our mind is that RTT-based PDC is performed if the measurement configuration needed for RTT is configured. TA-based PDC is performed if the measurement configuration needed for RTT is not configured.  Above this, explicit RRC signaling is used to enable/disable UE-side PDC. Such RRC signaling is unified to RTT-based and TA-based PDC, and can be delivered via unicast and broadcast RRC. In detail,   * If the UE receives UE-side PDC enabling indication, and   + If the measurement configuration needed for RTT is configured, the UE performs UE-side RTT-based PDC.   + If the measurement configuration needed for RTT is not configured, the UE performs UE-side TA-based PDC. * If the UE receives UE-side PDC disabling indication:   + If the measurement configuration needed for RTT is configured, the UE reports UE RX-TX time difference, i.e. The gNB may perform RTT-based pre-compensation for this case.   + If the measurement configuration needed for RTT is not configured, it means the UE does not need to do anything. The gNB may perform TA-based pre-compensation for this case.   In this way, we can have a simple and unified solution for all cases.  Thus, we propose the following:  UE-side RTT-based PDC is enabled when the network enables UE-side PDC via RRC signaling and the measurement configuration for RTT-based PDC is configured. |
| Xiaomi | Option 1 |  |
| LGE | Option1 |  |
| Futurewei | Option 3, open to Opt. 1/2. | Prefer explicit RRC signaling but fine if the companies choose to do it implicitly via configuration. |

**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**

|  |  |  |
| --- | --- | --- |
| **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 |  |
| Nokia | Option 1 | Along with periodic delivery of referenceTimeInfo, it makes sense to also support a periodic PD estimation procedure. The periodicity can be adjusted if the gNB identified that the UE is moving slower/faster than anticipated. Therefore, we do not need any framework to dynamically activate or deactivate PD estimation – along with Rx-Tx measurements. |
| Huawei, HiSilicon | Option 1 |  |
| Fujitsu | Option 1 | Similar with Q4b. |
| Qualcomm | Option 1 | Don’t see the need for additional activation after configuration |
| OPPO | Option 1 | The UE performs the measurement once the parameters for the measurement are configured. |
| Xiaomi | Option 1 | The UE can start the RX-TX measurement upon reception of measurement configuration. |
| LGE | Option 1 |  |
| Futurewei | Option 1 |  |

**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:

|  |  |
| --- | --- |
| **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**

|  |  |  |
| --- | --- | --- |
| **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. |
| Nokia | None of the above options | As commented for Q2, we prefer RAN2 to focus on UE-based PDC. We still want to see what the technical benefits are of supporting gNB-based PDC with RTT, as the UE and gNB can equally well combine the two Rx-Tx measurements. The drawback is, additional overhead on the air interface as well as not being able to use SIB9. |
| Huawei, HiSilicon | Option 2a | Agree with Ericsson’s view.  If the UE is stationary or moving slowly, the RTT measurement result can be used for a period of time. Periodical reporting seems not friendly signaling overhead. Instead, event triggered report will be more suitable, which will trigger report on-demand. |
| Fujitsu | Option 2a | For IIoT, accuracy of PD seems to be essential. Event trigger reporting seems to improve the accuracy. |
| Qualcomm | Option 4 | We do not prefer gNB side. However if needed, we think the idea of option 2a is fine that the UE would send a measurement when it detects a large difference between current and previous measurements but we think that this can wholly left to UE implementation to trigger such a report and no need for standardizing a certain UE behavior. |
| OPPO | See comments | Firstly, we do not prefer gNB-side RTT-based PDC.  Secondly, if gNB-side RTT-based PDC is finally agreed in RAN2, we prefer network-based solution, i.e. option 1a or 3, since we face to gNB-side PDC. |
| Xiaomi | Option 1a | We do not think the RTT-based gNB-side PDC is needed. If the majority really wants the solution, we think that Option 1a is simpler for the UE implementation. We should avoid too complex event for this solution, considering that the UE-side PDC is a must. |
| LGE | Option1 | We do not support gNB-side PDC.  If it is supported, option1 seems sufficient but open to option 2 as well if option2 is left up to UE implementation as mentioned by QC. |
| Futurewei | Option 2a | Agree with Ericsson. |

**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 |  |
| Nokia | None of the above | We do not see any benefits of supporting support gNB-based PDC with RTT. |
| Huawei, HiSilicon | Option 3 |  |
| Fujitsu | Option 2 | Given that UE Rx-Tx time difference reporting is different from existing RRC measurement framework, using Option 2 looks good. |
| Qualcomm | Option 3 | No different from other measurement reports. |
| OPPO | See comments | Firstly, we do not prefer gNB-side RTT-based PDC.  Secondly, if gNB-side RTT-based PDC is finally agreed in RAN2, we think option 3 can be taken as a baseline. |
| Xiaomi | Option 3 |  |
| LGE | Option 3 | We do not support gNB-side PDC.  If it is supported, option3 should be the baseline. |
| Futurewei | 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 |  |
| Nokia | Option 1 | Beside that we do not support gNB-based PDC based on RTT, we must be careful to not overcomplicate the specification. If other information is needed, there must be a good reason for it.  We propose that RAN2 follows the outcome of the RAN1 discussion on the content of the Rx-Tx measurement report. |
| Huawei, HiSilicon | Option 1 | Agree with ZTE. |
| Fujitsu | Option 1 | RAN1 seems not discussing additional information. |
| Qualcomm | Option 1 | Agree with ZTE unless otherwise specified by RAN4 |
| OPPO | Option 1 | Depend on RAN1/RAN4 deciding the need for any additional information. |
| Xiaomi | Option 1 |  |
| LGE | Option 1 | We do not support gNB-side PDC.  If it is supported, nothing else is needed. |
| Futurewei | Option 1 |  |

**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 |  |
| Nokia | Yes, but we prefer R2-2201016 | We prefer the signaling flows presented in R2-2201016 instead.  We think the signaling from in R2-2200991 indicates that dynamic activation/deactivation of Rx-Tx measurements is needed for the RTT based PD estimation procedure, which we don’t agree with. We believe it is sufficient to make the measurements periodic. |
| Huawei, HiSilicon | No | We are suspicious on the benefit of having a high level signaling flow in the spec. It is sufficient to specify the detailed UE behavior, RRC configurations, and signaling. There will be no ambiguity without signaling flow. |
| Fujitsu | Yes | Only in Stage 2 is enough. If there is concern, capturing the flow can be captured in informative annex in Stage 2. |
| Qualcomm | Yes | Stage 2 to capture any necessary agreements here, e.g., explicit vs implicit activation |
| OPPO | Yes, but we prefer the one in Fig 1 of R2-2201016 | We are fine to capture a simple example for signaling flow in the stage 2 spec, but we prefer the signaling flows in Fig 1 of R2-2201016 instead.  In addition, we agree with Nokia, there is no need to dynamically ask UE to start UE Rx-Tx time difference measurement. We understand the measurement can be performed when the RTT configuration is configured, and no additional activation/deactivation is needed. |
| Xiaomi | Yes | The details can be polished further in the stage-2 running CR. |
| LGE | No | It seems not essential as long as it is clear from stage-3 specification. However, if captured, 0991 is fine. |
| Futurewei | No strong view | Can go along with the majority. |

**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 |  |
| Nokia | Option 1 | We propose to have an explicit activation for UE-side PDC that is carried in RRC. We prefer a unicast version of the activation indication to the UE. If a broadcast version is to be supported (we don’t see the need for that), it can be as an optional bit in referenceTimeInfo carried in SIB9.  A RTT based PDC configuration will complement the above UE-side PDC activation implicitly indicating to the UE if the UE-side PDC is TA-based or RTT-based. Then, this configuration can overrule the indication to use TA-based PDC, the UE may have already in use, based on the above activation. That is the following can be indicated with a UE-side PDC indication bit and the RTT configuration:   * If the UE receives a UE-side PDC indication: UE activates TA-based PDC. * If the UE receives a disable for UE-side PDC: UE will not do PDC at all. * If the UE receives a UE-side PDC indication and RTT configuration: UE activates RTT-based PDC. If the UE was using previously TA-based method, it will switch to RTT-based. * If the field for UE-side PDC is not set at all, the UE may behave as in R16. |
| Huawei, HiSilicon | Other option (common indication combined with RTT-based configuration) | RRC parameter “UE-sidePDC” as optional with True/False values:   1. “UE-sidePDC” = “True”, UE performs RTT based PDC. 2. “UE-sidePDC”= “False” + RTT measurement configuration as implicit additional indication =>gNB performs RTT based PDC. 3. “UE-sidePDC” absent=> UE performs TA based PDC. |
| Fujitsu | Option 1 | No mixture with other PDC method. |
| Qualcomm | None | If we are to follow the legacy TA behavior, we think the whole TA procedure can be left to implementation similar to Rel-16 and an explicit indication will not be needed. |
| OPPO | Option 2 with clarification | We are not sure we correctly understand the question, i.e. does it actually focus on activating UE-side TA-based PDC?  If so, we think UE-side TA-based PDC is enabled, if the network enables UE-side PDC(explicit RRC indication) and the measurement configuration needed for RTT is not configured. Such explicit RRC indication is unified to TA-based and RTT-based PDC and it can be delivered via unicast and broadcast RRC.  The picture in our mind is that RTT-based PDC is performed if the measurement configuration needed for RTT is configured. TA-based PDC is performed if the measurement configuration needed for RTT is not configured.  Above this, an explicit RRC signaling is used to enable/disable UE-side PDC.  In detail,   * If the UE receives UE-side PDC enabling indication, and   + If the measurement configuration needed for RTT is configured, the UE performs UE-side RTT-based PDC.   + If the measurement configuration needed for RTT is not configured, the UE performs UE-side TA-based PDC. * If the UE receives UE-side PDC disabling indication:   + If the measurement configuration needed for RTT is configured, the UE reports UE RX-TX time difference, i.e. The gNB may perform RTT-based pre-compensation for this case.   + If the measurement configuration needed for RTT is not configured, it means the UE does not need to do anything. The gNB may perform TA-based pre-compensation for this case. |
| Xiaomi | Option 1 | For the SIB-based reference time provisioning, we can include the activation indication in the SIB.  For the dedicated-signaling based reference time provisioning, we can include the activation indication in the dedicated RRC message. |
| LGE | Option1 | It shouldn’t be mixed with RTT-based PDC activation. In our view, RTT-based UE-side PDC will be activated implicitly based on configuration or reception of gNBRx-Tx without any explicit indication. |
| Futurewei | Option 1 | However, NW needs to ensure that it will not “accidentally” activate both RTT-based and TA-based PDC at the same time for a UE. Or, we can specify that the most recently activated PDC method always overwrites any previously activated PDC method. |

**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. |
| Nokia | No | We do not think there is a need to specify |
| Huawei, HiSilicon | Maybe | We think RAN1/4 shall specify if needed. |
| Fujitsu | Yes | Maybe in somewhere in RAN1 specifications. |
| Qualcomm | No | Agree with CATT. This follows not specifying a formula in Rel-16 UE-side TA PDC |
| OPPO | No | No need to specify at least in RAN2. |
| Xiaomi | No strong view | For the test purpose, we may need to specify it somewhere. |
| LGE | No | No need to specify at least in RAN2. |
| Futurewei | No | No need to specify at least in RAN2. |

**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:

|  |  |
| --- | --- |
| **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. |
| Nokia | No | We do not see any reason that a UE can be configured for both RTT and TA based PDC simultaneously. It can be that different UEs are configured for TA and RTT, but not both simultaneously. If the gNB needs to change the PDC method (e.g. from RTT to TA), e.g. if the TS error budget has changed, we think there is sufficient time for the gNB to first deconfigure RTT before activating UE-side PDC based on TA. |
| Huawei, HiSilicon | No | We don’t understand why the network shall activate RTT-based PDC and TA-based PDC at the same time. If TA-based PDC is sufficient, there is no point to waste resource on RTT based PDC. When RTT-based PDC is adopted for high accuracy scenario, there is no use of TA based PDC. As our answer to Q7, we think common indication combined with RTT-based configuration will clearly indicate which PDC mechanism shall be adopted by the UE without ambiguity. |
| Fujitsu | No | Co-existence of procedures seems to make IIoT system complex. |
| Qualcomm | No | Agree with CATT and Ericsson |
| OPPO | No | Agree with Ericsson, Nokia and Huawei. |
| Xiaomi | No | Agree with Ericsson. |
| LGE | No | For TA-based PDC, we think it should be explicitly activated and deactivated. Regardless of whether the RTT-based PDC is activated implicitly or not, it can be controlled by the network so that RTT-based PDC and TA-based PDC are not activated simultaneously. |
| Futurewei | No | Agree with CATT and 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 |  |
| Nokia | Option 3 |  |
| Huawei, HiSilicon | Option 3 |  |
| Fujitsu | Option 3 |  |
| Qualcomm | Option 2 | We think it is important for the UE to indicate to the NW support for RTT based PDC. Since TA is up to UE implementation anyway and UEs naturally support TA we do not see how UE applying TA PDC is a capability that needs to be indicated. It is fine however if majority support Option 3. |
| OPPO | Option 1 | Two steps involve in a PDC procedure, one is the PD estimation and another is the PD compensation. Introducing one capability on PD compensation is sufficient since it can be a common behavior no matter TA-based or RTT-based PDC is used. But, if majority wants, we are fine with Option 3. |
| Xiaomi | Option 3 |  |
| LGE | Option3 |  |
| Futurewei | 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:**

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| --- | --- | --- |
| **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. |
| Nokia | No | This has already been discussed and it is clear that dedicated signalling takes priority. The issue mentioned in R2-2200952 is not clear to us why such signalling is needed and why it is not sufficient to simply provide unicast information to the UE. |
| Huawei, HiSilicon | No | In Rel-16, it was agreed that the UE follows the latest received reference time info, no matter it is from unicast or broadcast RRC signaling. The accuracies of reference time in both SIB9 and unicast signaling are the same. We’d insist that the Rel-16 principle should be followed. |
| Fujitsu | Yes | Proposal 9 in R2-2200320[5] looks good. |
| Qualcomm | No | Agree with Huawei and Nokia. This is a Rel-16 issue not applicable to PDC |
| OPPO | No | Agree with Nokia |
| Xiaomi | No | Agree with Nokia. |
| LGE | No | Agree with Nokia and Huawei. |
| Futurewei | No | Agree with Nokia and Huawei. |

**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. |
| Nokia |  | If RAN2 agrees to work on gNB-based PDC then we are okay to send the LS. However, as commented earlier, we think RAN2 should focus on UE-based PDC. |
| Huawei, HiSilicon | Yes | Can send LS to RAN3 to inform our progress. |
| Fujitsu | Yes | Can send an LS to RAN3. |
| Qualcomm | No | Prefer to discuss what exactly will be agreed to regarding gNB-side PDC be it TA or RTT before communicating that to RAN3 |
| OPPO | - | It can be discussed later when we have progress on the design. |
| Xiaomi | Yes | Can send an LS to RAN3. |
| LGE |  | We do not support gNB-side PDC.  If it is supported, however, the LS should be sent to RAN3. |
| Futurewei | Yes | Can send an LS to RAN3. |

**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. |
| Nokia | No | We do not see any issue here. |
| Huawei, HiSilicon | No |  |
| Fujitsu | Yes | However, gNB can deal with the PDC by implementation. |
| Qualcomm | No | gNB implementation should handle that to ensure that PDC is always valid. |
| OPPO | No |  |
| Xiaomi | No |  |
| Futurewei | No |  |

**Conclusion:**

**Q11d: Any other issue?**

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| --- | --- |
| **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 conclusion  RAN2 can first discuss if there is any need to specific in RRC to support this conclusion. |
| Qualcomm | RAN2 to confirm that TA-based PDC is left to implementation and no new enhancements are introduced to legacy Rel-16 TA.  Given the RAN1 agreements, we do not think that any improvement is possible for TA-based PDC other than an activation/deactivation signal. Thus, if companies agree on that we propose agreeing to introduce no new changes to TA PDC. |
| OPPO | As we agreed, the enabling/disabling indication can be delivered via unicast and broadcast RRC signalling. Also, *referenceTimeInfo* can be delivered via SIB 9 and *DLInformationTransfer*. For a specific UE, it is possible that both unicast and broadcast enabling/disabling indications are received, which may provide the opposite message. Is it a correct understanding?  If so, we would like to confirm whether the following is RAN2 common understanding, i.e. the broadcast enabling/disabling indication applies to the broadcast reference time info, and the unicast enabling/disabling indication applies to the unicast and broadcast reference time info. If the UE receives the enabling/disabling signaling via both unicast and broadcast RRC, the UE will follow the unicast enabling/disabling signaling. |

**Conclusion:**

# Conclusion

**TBD**

# References

[1] [R2-2111282](file:///C:\Users\panidx\OneDrive%20-%20InterDigital%20Communications,%20Inc\Documents\3GPP%20RAN\TSGR2_116-e\Docs\R2-2111282.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