**3GPP TSG-RAN WG2 Meeting #117 electronic R2-220xxxx**

**Online, Feb 21st – Mar 3rd, 2022**

**Agenda item: 8.5.2**

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

**Title: [DRAFT] Report of [AT117][503][IIoT] Tsynch additional open issues (Qualcomm)**

**WID/SID:** **NR\_IIOT\_URLLC\_enh – Release 17**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the offline email discussion “*[AT117-e][503][IIoT] Tsynch additional open issues*”, as indicated below:

* [AT117-e][503][IIoT] Tsynch additional open issues (Qualcomm)

Remaining Tsynch open issues

Deadline: Comments from companies by Thursday, 24 Feb 23:59 UTC

Proposals by rapporteur by Friday, 25 Feb 23:59 UTC

# Contact information

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# Discussion

This email discussion is to cover the list of open issues presented in the contributions in RAN2 117e and to follow up on the FFS items identified of the first session of the RAN2 #117e meeting. The agreements reached in the meeting so far are copied below.

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| Agreements:   1. UE Rx-Tx time difference measurement report is triggered by an explicit request. FFS if both one shot and periodic will be supported. Email discussion on details of periodic configuration 2. As soon as a UE receives its reference time information via dedicated signaling, it ignores all further reference time information received over SIB9. gNB can only rely on dedicated signalling afterwards. FFS, when the UE fallback to receiving SIB9 with the existing procedure (e.g., handover, RLF, etc.) – clarify details and how best to capture in RRC 3. RAN2 to introduce separate signalling procedures for UE-side PDC, one for TA, and another one for RTT. RRC field description restricts the network from configuring both 4. UE-side TA PDC is activated/de-activated by a Boolean. No need to specify PD calculation in RAN2 spec. 5. UE-side TA PDC activation/de-activation is supported in both RRC unicast and SIB9 6. No RAN2 spec impact due to RAN1 conclusion that “for RTT-based PDC, the transmission of DL TRS/PRS, UL SRS and reference time information are associated with a same TRP.” 7. RAN2 does not introduce optional capability for dedicated signalling takes priority (13/14). 8. The optional UE capability for survival time is per-UE 9. A UE supporting survival time feature shall also support at least CA duplication for DRB (pdcp-DuplicationMCG-orSCG-DRB) or DC duplication for DRB (pdcp-DuplicationSplitDRB). (10/17) 10. A UE supporting survival time feature shall also support at least configured grant type 1 (configuredUL-GrantType1-v1650) or configured grant type 2 (configuredUL-GrantType2-v1650). |

## High Priority Issues

This section is to cover the topics are essential to specify for the feature to work

### gNB-side RTT PDC

During last meeting, the following agreement was reached due to some difference in opinions on whether gNB should be supported.

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| Both RTT-based UE side PDC and RTT-based gNB side PDC are supported. RRT-based gNB side PDC has to be a simple solution and converge by February meeting. |

This follows an earlier agreement from RAN2 #115e that stated:

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| RAN2 assumes that gNB can perform pre-compensation. RAN2 agrees to introduce signalling to enable/disable UE-side PDC. |

The latest agreement language is conditional on February meeting progress, however most inputs in the email discussion [1] and companies’ contributions already discuss different aspects of gNB-side PDC [3][5][6][9] with the exception of one company [11] that still proposed gNB-side PDC not be supported. It is useful to verify that companies have a common understanding regarding the status of gNB-side support.

**Q1-1a: Do companies agree to confirm that gNB-side RTT-based PDC is supported?**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Apple | Yes |  |
| Ericsson | Yes | It is agreed that “UE Rx-Tx time difference measurement report is triggered by an explicit request.” What remains to be discussed is the type of the explicit request. No matter which options in the Q1-1b is agreed, the solution is simple and the spec impact is limited. |
| CATT | Yes | An LS to RAN3 capturing this agreement was sent out already. It is not necessary for further re-discuss. |
| Fujitsu | Yes |  |
| vivo | Yes |  |
| MediaTek | Yes |  |
| Xiaomi |  | We can follow the majority view, but would consider that as the UE-side RTT-based PDC seems anyway needed, adding extra complexity for both the UE and the gNB to support the gNB-side RTT-based PDC is not essential. |
| Nokia | Yes |  |
| Qualcomm |  | Same as Xiaomi. We prefer having the UE solution only for simplicity and low overhead (esp. with one-shot measurement request since it is similar to UE-side with two-step PDC). We think gNB-side is an unnecessary addition, but we can agree if majority supports. |
| OPPO | Yes |  |

**Conclusion:**

During the email discussion in [1], there were a lot of opinions regarding the UE Rx-Tx time difference report trigger with no convergence besides a preference that the measurement report trigger be network controlled (as opposed to UE-initiated based on an event-trigger)

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| Proposal 1 UE Rx-Tx time difference measurement report is triggered by an explicit request (10/16). RAN2 to further discuss whether it is one shot, periodic or both.  a. Explicit request (10/16): one-shot, 7/16  b. Explicit request (10/16): periodic, 4/16 |

Several companies expanded on their views in RAN2 #117e contributions summarized below:

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| **Contributions** | **Related proposals** |
| [3] R2-2202580 | **Proposal 2: for gNB side RTT based PDC, UE send measurement report to gNB when 1) UE side PDC is disabled; 2) measurement configuration for gNB side RTT based PDC is received; 3) measurement results of time difference between configured pair of TRS/PRS and SRS is available. Neither event trigger nor periodical trigger is needed.** |
| [5]R2-2202728 | **Proposal 2: 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.** |
| [6]R2-2202750 | **Observation 1: Reporting UE Rx-Tx time difference based on an event trigger will cause additional error in PDC calculation.**  **Proposal 1: For gNB-based PDC, UE measurement report containing UERx-Tx should be triggered by an explicit request signaling from gNB. Such explicit signaling can be RRC signaling or MAC CE.**  **Proposal 2: If Proposal 1 is agreed, upon reception of the explicit signaling, UE can report UERx-Tx once. If a periodicity is additionally configured by gNB, UE can report UERx-Tx periodically.**  **Proposal 2a: The periodicity for UE RTT report can be provided in either measurement configuration or along with the explicit signaling for requesting UE RTT report.** |
| [9]R2-2203197 | *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*   From our perspective, Option 3 is preferred as a clean solution that allows the UE to report regularly. If there is any concern with the signaling overhead, the gNB can simply change the periodicity of the Rx-Tx time difference measurements.  **Proposal 3: For gNB-side RTT-based PDC, the UE Rx-Tx time difference reporting should be based on an indication from gNB to UE to configure a periodical report. It is up to the gNB to adjust the periodicity of the UE measurement.**  **Observation 3: UE trigger of Rx-Tx measurement Option 2a relies on the UE ability to properly track DL frame timing changes and with only initial timing error bounding this, it is not a good UE trigger mechanism. Further, a single side Rx-Tx measurement will not be able to properly reflect a full RTT.**  **Proposal 4: If an event-triggered report of UE Rx-Tx time difference for gNB-side RTT-based PDC is desired, it could be based on the UE detecting an CSI-RS configured for RTT-based PDC.** |

In the RAN2 #117e meeting this topic was again debated with the following FFS reached:

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| UE Rx-Tx time difference measurement report is triggered by an explicit request. FFS if both one shot and periodic will be supported. Email discussion on details of periodic configuration |

Given that the majority RAN2 #117e contributions and email discussion [1] agree that the network should configure the UE Rx-Tx time difference reporting, but there are still different opinions regarding whether to support one-shot explicit request, periodic configuration, or both. It is good to try and get an agreement on this issue (with the details covered in later questions)

**Q1-1b: For RTT-based gNB-side PDC, companies are invited to indicate which option below for providing the UE Rx-Tx time difference measurement report is preferred?**

* **Option 1: One-shot Request only.**
* **Option 2: Periodic Reporting only.**
* **Option 3: Both One-shot Request and Periodic reporting are supported.**
* **Other option**

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| **Company** | **Option** | **Additional comment(s)** |
| Apple | Event-based, but can accept option 1 | Our preference is still event-based reporting. Otherwise, one-shot seems sufficient (periodic is acceptable if majority prefers, it is last in the list). |
| Ericsson | 3 | Bothoptions would be useful. If only one is supported, then option 1 is the preference. Periodic reporting can save signalling overhead and useful in the below cases:   * Periodic DL reference signals might be configured for measuring UE Rx-Tx time difference. In this case, it is beneficial to have periodic reporting. Note that for PRS, only periodic is supported. * The network may periodically refresh the reference time. |
| CATT | Option1 | Option 1 is by far the simplest approach which can be sufficient to close the WI. Clearly, Option 2 should be ruled out because at the minimum Option 3 can be supported by configuring the RRC measurement report procedure with *reportType* = *periodical* and *reportAmount* = 1. As for the need to support a periodic report at all, we are still not convinced of the motivation. It was argued online that this could come in support of the scenario where the TSN clock (used as GM clock to be synchronized to) is of poor quality wrt the 5GS clock. This is discussed in TR23.734 Section 6.11.1 where it is shown that the gNB should then refresh the reference time periodically at least every 160ms to address the worst-case expected TSN clock accuracy. However, our understanding is that this sets the requirement on the refresh period of the reference time itself, not the PDC value. The PDC value, per its name, must be refreshed when the path delay changes, i.e. when the UE moves. And again we believe that such tracking of UE motion is best handled by gNB. |
| Fujitsu | Option 1 | We have originally supported event-based trigger as in [email discussion 503], but now it is not on the table. So Option 1 is simple and will be supported. |
| vivo | Option1 | Clock drift is not expected to change very fast, hence PDC does not to be performed frequently. Periodic reporting leads to more UE power consumption. |
| MediaTek | Option 1 | Once propagation delay is estimated and PDC is applied to 5GS reference time, we do not foresee a need to refresh the reference time frequently as the reference clocks in the various nodes of the TSN system (including the UE) are expected to have a very high accuracy. Therefore, only a simple one-shot report is needed. We should not introduce complicated procedures without justification. |
| Xiaomi | Option 1 | We think that Option 1 is sufficient, and use the periodical report seems not convincing, as the clock shifting at the UE is unknown to the gNB. |
| Nokia | Option 3 | We think periodic reporting is a safe option that strikes the balance between signaling overhead and the need for the gNB to track such measurement. Also, in RAN2 #116bis-e we already have the following agreement:   * For RTT-based gNB side PDC, RRC measurement framework can be reused as baseline to provide UE Rx-Tx time difference report.   In our understanding, periodic reporting is a common configuration for the existing RRC measurement framework, and we do not see why we should exclude such functionality when it comes to reporting to RX-TX time difference. |
| Qualcomm | Option 2/3 | Prefer the periodic approach since it is simple. The gNB can just configure periodic reporting from the UE, and thus guarantee a fresh PDC estimate is always available, and thus, it is guaranteed to work The issue with one shot reporting is that the gNB does not know when the UE has changed locations necessarily and thus it has no proper criteria to trigger that one-shot other than also do it somewhat periodically as well, but we are open to just supporting both. |
| OPPO | Option 3 | Both solutions can work and we prefer periodical report if only one is supported. We understand periodical report can save singling overhead and it is the way we normally used in the existing RRC measurement framework. |

**Conclusion:**

#### Periodic reporting

In this part we discuss more technical details of periodic measurement reporting (if supported).

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| **Contributions** | **Related proposals** |
| [2]R2-2202437 | **Observation 1: there are two options for the measurement periodicities setting: on e is that the periodicities are at least in the same order of SIB9, which delivery rate can be from 80ms up to 5s. The same set of periodicities can be applied to both TA and RTT based PDC methods (i.e. not be limited to a specific PDC method); another is that the regular RRM measurement periodicity can be reused.**  **Observation 2: Regardless of the two options, somehow needs the input from RAN4/RAN1.**  **Proposal 1: it is proposed to ask some assistant information for the measurement periodicities setting of Rx – Tx time difference measurement from RAN4/RAN1**. |
| [6] R2-2202750 | **Proposal 2a: The periodicity for UE RTT report can be provided in either measurement configuration or along with the explicit signaling for requesting UE RTT report.** |
| [9] R2-2203197 | . If there is any concern with the signaling overhead, the gNB can simply change the periodicity of the Rx-Tx time difference measurements.  **Proposal 3: For gNB-side RTT-based PDC, the UE Rx-Tx time difference reporting should be based on an indication from gNB to UE to configure a periodical report. It is up to the gNB to adjust the periodicity of the UE measurement.** |

If periodic reporting is supported, it is assumed that the gNB can configure the periodicity via RRC measurement framework based on the below agreement in RAN2 #116 bis-e, however [6] also proposed the possibility of explicit signaling to configure periodicity.

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| For RTT-based gNB side PDC, RRC measurement framework can be reused as baseline to provide UE Rx-Tx time difference report. |

**Q1-1c: if UE Rx-Tx time difference periodic reporting is supported, do companies agree that the UE reporting periodicity is configured by the gNB as part of RRC configuration? If other/additional options, e.g., explicit signalling, are preferred, please clarify.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Apple | Yes | Different UE may have different requirements for the reporting interval. The UE could indicate a preference in e.g., UE assistance information and the network can configure the periodicity via dedicated signalling. |
| Ericsson | Yes | If not supported, then the only (?) remaining option is that the periodicity is not configurable, i.e., a fixed value. |
| CATT | Yes | We agreed to leverage the RRC measurement framework as a baseline, so if periodic report is agreed, it should be configured via the RRC measurement framework (with *reportType* = *periodical* and *reportAmount* > 1). |
| Fujitsu | Yes, but | One question is if even there is no big changes of Rx-Tx time difference compared to the previous reporting, the UE needs to report it? |
| vivo | Yes | Reuse RRC measurement framework is preferred. |
| Nokia | Yes | Basically we think the mechanism should be aligned with the existing RRC measurement framework, based on the RAN2 #116bis-e agreement. |
| Qualcomm | Yes | RRC config is sufficient |
| OPPO | Yes | We prefer to use the existing RRC measurement framework. |

**Conclusion:**

One company [2] proposed to ask RAN1/RAN4 for some guidance regarding the value and range of needed periodicities. In rapporteur’s point of view, this is a gNB implementation issue that does not need any standards input, but we can also check if companies need to further discuss that.

**Q1-1d: if UE Rx-Tx time difference periodic reporting is supported, do companies agree that it is up to the gNB to select the periodicity of the measurement and reporting, and that no standards, e.g., RAN1/RAN4 input is required to specify periodicity values?**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Apple | No strong view | Some input from RAN1/4 can be helpful. Considering the time left for completion of the WI we think this is not a critical issue, RAN2 can start on its own and confirm the value range with RAN1/4 later. |
| Ericsson | Can confirm with RAN1/4 | Agree RAN2 needs to agree on the range/value. Even though not sure how RAN1/4 can provide guidance on the needed periodicities, it would be good to consult/confirm with them the values chosen by RAN2. One assumption can be that the smallest periodicity is the same as the smallest periodicity of the DL reference signals (i.e., CSI-RS for tracking and PRS). |
| CATT | Yes with comment | Not sure to get the question. In the end, if periodic report is agreed, the reporting period will be configured via the *reportInterval* parameter of the RRC measurement procedure. The current range of this parameter is {ms120, ms240, ms480, ms640, ms1024, ms2048, ms5120, ms10240, ms20480, ms40960, min1,min6, min12, min30 }. Given we don't see the need for periodic report, we have no preference on changing these values. In any case, we don’t see the need to consult RAN1/RAN4 about this. |
| Fujitsu | Yes | We are OK with LS exchange with RAN1/4. |
| vivo | Yes | The value range can be decided by RAN2. |
| Nokia | Yes | RAN1/RAN4’s input would be useful |
| Qualcomm | Yes |  |
| OPPO | Yes | RAN2 can decide the value and range, but can be revisited if we have further RAN1/4 input. |

**Conclusion:**

**Q1-1e: Please indicate any other issues that need to be addressed for periodic reporting, if supported?**

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| **Company** | **Issue** |
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**Conclusion:**

#### One-shot reporting

For one-shot request type reporting (if supported), [6] has proposed that this request can be via RRC and MAC CE. Given that this is slightly a new topic we can get the companies’ views on that issue as well

**Q1-1f: For one shot UE Rx-Tx measurement request, how can gNB request an Rx-Tx time difference measurement from the UE?**

* **Option 1: RRC.**
* **Option 2: RRC and MAC CE.**
* **Other option**

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| **Company** | **Option** | **Additional comment(s)** |
| Apple | Option 1 | We assume one-shot and the measurement is needed only occasionally. Therefore, RRC seems sufficient. |
| Ericsson | Option 1 | Agree with Apple above. If it is more frequent, then it would typically require periodic reporting. |
| CATT | Option1 | We think Option1 is the only option we can afford at this late stage. In addition we are not sure why MAC should be involved in this procedure. |
| Fujitsu | Option 1 | RRC is sufficient. |
| Vivo | Option1 | RRC is enough, optimization is not preferred. |
| MediaTek | Option 1 | Agree with Apple. |
| Xiaomi | Option 1 |  |
| Nokia | Option 1 | We prefer to keep all PDC-related signalling to RRC level, as we fail to see the motivation/benefits to allow more dynamic signaling using MAC. |
| Qualcomm | 1 | RRC is sufficient, no need to define new MAC CE for that |
| OPPO | Option 1 | Option 1 can be a most straightforward way. |

**Conclusion:**

**Q1-1g: Please indicate any other issues that need to be addressed for one-shot reporting, if supported?**

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| **Company** | **Issue** |
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**Conclusion:**

### Dedicated RTI vs SIB9

During the first session of the RAN2 117e meeting the following was agreed regarding dedicated RTI signalling vs SIB9

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| As soon as a UE receives its reference time information via dedicated signaling, it ignores all further reference time information received over SIB9. gNB can only rely on dedicated signalling afterwards. FFS, when the UE fallback to receiving SIB9 with the existing procedure (e.g., handover, RLF, etc.) – clarify details and how best to capture in RRC |

One company also had a contribution dedicated to this topic.

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| **Contributions** | **Related proposals** |
| [8]R2-2202894 | **Proposal 1: gNB is allowed to send the reference time info to a UE via SIB9 even it has sent reference time info to the same UE via dedicated signalling before.**  **Proposal 2: Upon the reception of dedicated signaling with reference time info, UE only applies reference time provided in dedicated signaling (i.e. ignores reference time info in SIB9) until a handover occurs.**  **Proposal 3: RAN2 to confirm the reference time provided in dedicated signaling takes priority only in the cell in which the dedicated signaling is provided, i.e. UE is allowed to apply the reference time provided via SIB9 in the target cell even it has applied a reference time provided in dedicated signaling in the source cell before handover.**  **Proposal 4: After one UE applies the reference time provided in dedicated signaling, its serving cell can indicate the UE to perform an intra-cell handover whenever the serving cell wants UE to apply the reference time provided in SIB9 afterwards. No spec change is needed.** |

Since this is left as FFS in the meeting, we try to collect companies’ views on the dynamic between dedicated RTI signalling vs SIB9.

**Q1-2a Do companies agree that a UE receiving dedicated RTI switches to receiving timing information via SIB9 after a handover if no dedicated RTI is available at the target cell? Please clarify if there are or should be other conditions needed for the statement to be true.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Okay to the principle, but no to the wording | How could UE know there is no RTI available at the target cell upon handover?? Perhaps, it means that after handover, the UE falls back to SIB9. |
| CATT | Yes |  |
| Fujitsu | Yes |  |
| vivo | Yes | Otherwise, the target cell has to deliver RTI via dedicated signalling if the UE has applied dedicated RTI in the source cell. What’s more, it requires the target cell to be informed whether dedicated RTI has been applied by UE in the source cell. Such dependence between source and target cell should be avoided. |
| MediaTek | No | Is there a need for such an optimization? Do we expect that an IIoT system (that is expected to be relatively local, geographically speaking) will comprise of a mix of cells that support dedicated RTI signalling and cells that do not support dedicated RTI signalling?  Even if such a situation exists (an extremely strange deployment), how is the UE expected to figure out whether dedicated RTI is going to be available on the target cell or not? |
| Xiaomi | Yes |  |
| Nokia | Yes | The UE may no longer receive dedicated RTI after handover, so it makes sense to receive RTI in SIB9 instead. |
| Qualcomm | Yes | While it may be useful for some cases for the UE to save the dedicated RTI during HO, since the target cell may take time to configure and perform PDC, at which time the UE may get an uncompensated RTI via SIB9, we think that late in the WI and given all the use cases where the UE needs to get a new SIB9 from the target cell as the source dedicated RTI may be inapplicable in the new cell (e.g. moving from a pre-compensated large cell edge to a small cell with no compensation needed). Thus, we think that a HO should make the UE obtain timing info from the SIB9 signalling of the target cell, at least initially. |
| OPPO | Yes |  |

**Conclusion:**

**Q1-2b: Similar to the last question, do companies agree that a UE receiving dedicated RTI switches to receiving timing information via SIB9 after an RLF? Please clarify if there are or should be other conditions needed for the statement to be true.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | No | After RLF, the UE can re-establish connection. If it succeeds and UE connects to the same cell, then it might still make sense not to fall back. |
| CATT | Yes |  |
| Fujitsu | No | After RLF the UE should re-establish the RRC connection. After the re-establishment, the UE should wait for RRC reconfiguration. If no dedicated RTI is indicated in the RRC reconfiguration, then the UE switches SIB9. |
| vivo | Yes | After RLF, the UE can setup RRC connection with a new serving gNB. It makes sense for the serving gNB to select how to provide RTI. |
| MediaTek | No | Agree with Ericsson above. |
| Xiaomi | No |  |
| Nokia | Yes |  |
| Qualcomm | Yes | We cannot assume that UE saves RTI after RLF so getting new timing info via SIB9 at least initially makes sense. |
| OPPO | Yes |  |

**Conclusion:**

**Q1-2c: Are there or should there be any other scenarios for a UE receiving dedicated RTI signalling to fallback to receiving timing information via SIB9 (aside from possibly HO and RLF)? If the answer is YES, please clarify those scenarios, e.g., new explicit indication, Too much time passed since last RTI update, etc.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Yes | We wonder what happens if the UE releases the RRC connection on its own and connects to another cell upon re-connection |
| CATT | Yes | PCell change should also have the same “fallback” effect as HO and RLF. |
| Fujitsu | Yes, but | For now, HO and RLF are typical cases. There may be other cases to come up with later, maybe CR implementation phase. |
| vivo | Yes, but new solution may not need | In some scenarios, gNB may want to deliver RTI via SIB9 after deliver RTI via dedicated signalling, e.g. more and more UEs in one cell ask for RTI.  In this case, gNB can trigger a intra-cell handover. |
| Nokia | Maybe but | We agree there could be some other situations. But for now we think these can be further identified and fixed later on in the maintenance phase. |
| Qualcomm | No | Agree with Nokia |

**Conclusion:**

**Q1-2d Based on your answers above for Q1-2a, Q1-2b and Q1-2c, are there spec. changes needed to cover the cases when the UE switches from receiving dedicated RTI signalling to receiving timing information via SIB9? If yes, please specify what is needed.**

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| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Yes | We wonder if it would be cleaner/easier to state in the spec that:   * if the UE receives a RRC reconfiguration message that contains reconfiguration with sync, then the UE falls back to receive SIB9   “reconfiguration with sync” intends to cover handover, RRC re-connection after release/resume, recovery after RLF and etc. We are also open to other suggestions but prefer a simple spec change that covers all relevant scenarios.  “Reconfiguration with sync” means data transmission interruption and that is why we initially preferred to have an explicit indication. |
| CATT | Maybe | If there is a need for an intra-cell fallback indication, we can simply leverage the existing RTI procedure where, for example, if NW sends *DLInformationTransfer* to the UE where *referenceTimeInfo* is absent, it indicates the UE to use again SIB9. |
| Fujitsu | Yes | If possible, we also prefer to keep comprehensive text to cover e.g. HO and RLF. |
| vivo | Yes | It should be captured that UE receiving dedicated RTI switches to receiving timing information via SIB9 after a handover and RLF, if no dedicated RTI is received at the new serving cell. |
| MediaTek | Mostly not | The only case that could make sense is if a UE goes to Idle mode, it forgets its dedicated info. |
| Nokia | No strong view | Can follow majority |
| Qualcomm |  | Can follow majority |
| OPPO | No strong view | Can follow majority |

**Conclusion:**

### UE-side RTT PDC

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| **Contributions** | **Related proposals** |
| [2]R2-2202437 | **Proposal 1 In the case that the RS 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.**  **Proposal 2 A common enabling/disabling mechanism for RTT-based and TA-based PDC, i.e. a common RRC signalling to enable/disable UE-side PDC.** |
| [3]R2-2202580 | **Proposal 1: Activate UE side RTT based PDC when 1) UE receive explicitly RRC signalling to enable UE side PDC; and 2) UE receive UE measurement configuration for RTT based PDC** |
| [4] R2-2202708 | **Proposal 2: For UE-side RTT based PDC, when the UE receives *referenceTimeInfo* without Rx-Tx time difference from gNB, the UE does not apply the reference time.**  **Proposal 3: Activate UE side legacy TA based PDC when 1) UE receive explicitly RRC signalling to enable UE side PDC; and 2) RRC signalling does not include UE measurement configuration for RTT based PDC** |
| [9]R2-2203197 | **Observation 2: Explicit indication for UE-side RTT-based PDC may be redundant as the method already requires unicast signalling for Rx-Tx measurement configuration.**  **Proposal 1: UE-side PDC activation is controlled with an optional binary indication provided to the UE carried over SIB9 for a broadcast activation/deactivation or via RRC IE for a unicast activation/deactivation.**  **Proposal 2: Activation/deactivation of UE-side RTT-based PDC should be implicitly derived by the configuration framework for Rx-Tx measurements and the explicit UE-side PDC binary indication.** |
| [11] R2-2203461 | **Proposal 4: UE-side RTT PDC is explicitly activated using new dedicated unicast RRC signalling.** |

The first issue that needs to be resolved is how UE-side RTT PDC is activated. It is understood that for TA based PDC, the UE would likely need to get some form of explicit signaling to activate/deactivate. In [2][3][4][9], it is argued that the same signalling should be used to enable UE-side RTT and TA-based PDC. In rapporteur’s understanding, this is now ruled out by the following latest agreement:

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| RAN2 to introduce separate signalling procedures for UE-side PDC, one for TA, and another one for RTT. RRC field description restricts the network from configuring both |

The question of “**how to activate RTT UE-side PDC”** was further discussed in [1], with the concluded proposal below. However, since we did not get time to discuss this proposal, we can further ask companies to give feedback on whether they agree:

**Q1-3a: Do companies agree with the following slightly reworded proposal from [1]: For the separate signalling procedures for UE-side RTT PDC, provision of measurement configuration indicates that UE measures the Rx-Tx time difference, and provision of gNB Rx-Tx time difference to UE implicitly activates RTT-based PDC calculation at the UE side?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Yes |  |
| CATT | Yes |  |
| Fujitsu | Yes |  |
| vivo | Yes |  |
| MediaTek | Ok |  |
| Xiaomi | Yes |  |
| Nokia | Yes |  |
| Qualcomm |  | Prefer explicit RRC activation signalling rather than this two-step logic but fine with the proposal if majority agrees. |
| OPPO | Yes |  |

**Conclusion:**

If the previous proposal is agreed, it remains to discuss the case when measurement configuration is provisioned, indicating an RTT PDC scheme is active, but gNB does not provision the Rx-Tx time difference measurement. In this case, there are several options for the UE as it can assume the reference time to be uncompensated and not apply it (i.e. option 3 below) [4], or as proposed by many companies, take the activation signal with no gNB Rx-Tx time difference to mean it should apply UE-side TA PDC [2][3][9] (i.e. option 2 below); Rapporteur’s understanding however is that applying TA would be prohibited based on the agreement to introduce separate signalling for TA and RTT and the RAN2 #116 bise agreement:

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| Network configuration should guarantee that RTT-based PDC and TA-based PDC are not activated simultaneously for a UE. |

Furthermore, Rapporteur’s understanding is that for this situation, it is safe for the UE to assume that gNB-side RTT PDC is active and apply the (correctly pre-compensated) Reference Time (i.e., option 1 below). In [4], there is a nice summary on the possible options that can be discussed.

**Q1-3b: If the answer to the previous question is YES: For a UE that has been configured to perform RTT measurements but has not been provided with gNB Rx-Tx time difference measurement to calculate PDC, what of the following options is preferred by companies?**

* **Option 1: The UE apply the reference time, without propagation delay compensation.**
* **Option 2: The UE apply the reference time and perform PDC with TA/2, i.e., fall back to legacy TA based PDC.**
* **Option 3: The UE does not apply the reference time.**
* **Option 4: Up to UE implementation.**

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| --- | --- | --- |
| **Company** | **Option** | **Additional comment(s)** |
| Apple | Option 4 |  |
| Ericsson | Option 1 (clarify with UE-side PDC) | The gNB-side RTT PDC needs UE to report UE-side Rx-Tx time difference. This needs to be configured by the network, i.e., an explicit request. Thus, option 1 does not necessary mean that the time is pre-compensated. If UE is aware such an explicit request is configured, then it is clear that the time would be pre-compensated. Otherwise, the time is not pre-compensated. In both cases, the UE can safely assume that UE does not perform UE-side PDC. As a matter of fact, in this case, UE cannot perform RTT since it does not have gNB Rx-Tx measurement. |
| CATT | Option 1 | After the PRS/SRS pair has been configured, the UE starts performing the measurements but does NOT perform PDC. And, following this, the first reception of a gNB Rx-Tx time difference activates the PDC in the UE. Then, UE computes a PDC value and uses it on every new received *referenceTimeInfo* when performing PDC on it. And this value is refreshed whenever it receives a new gNB Rx-Tx time difference. |
| Fujitsu | Option 1 | We are ok with the rapporteur’s suggestion. |
| Vivo | Option 4 | If UE has reported UE Rx-Tx time difference before, the UE can assume that gNB-side RTT PDC is apply. Otherwise, UE can only assume PDC is not performed. It can be left to UE implement to avoid specifying the complicated situations. |
| MediaTek | Option 1 |  |
| Xiaomi | Option 1 |  |
| Nokia | Option 1 |  |
| Qualcomm | 1 | UE can assume gNB-side PDC is taking place |
| OPPO | Option 1 | We understand that configuring the parameters used for RTT is means RTT-based PDC is applied. As indicated by the Rapporteur, TA-based and RTT-based PDC will not be activated together, in the case with the parameters used for RTT, we understand that it implies gNB-side RTT-based PDC is implemented or no compensation is performed. Ericsson’s clarification looks fine to us. |

## Low Priority Issues

This section is to cover the topics that were addressed by one or two companies. The goal of this section is to present these views to other companies, and get feedback on whether those topics need further attention from RAN2.

### PRS Configuration Issues

Two of the contributions proposals that treated the issues of configuring SRS-PRS RTT measurements. Recall the RAN2 #116e agreement.

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| A single pair of TRS/PRS and SRS is configured via RRC signaling for RTT-based PDC |

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| **Contributions** | **Related proposals** |
| [10]R2-2203303 | For semi-persistent SRS and aperiodic SRS, it is observed that an unused bit in the existing “Enhanced SP/AP SRS Spatial Relation Indication” MAC CE can be leveraged to provide indication of PRS.  **Proposal 1 Adopt the TP in the Annex A to update MAC CE for SRS Spatial Relation Indication.** |
| [7]R2-2202784 | **Proposal 1: Confirm that pre-configured measurement gap does not need to be supported for the PRS used for PDC.**  **Proposal 2: Confirm that PPW does not need to be supported for the PRS used for PDC.**  **Proposal 3: Confirm that when SRS for PDC is not activated, UE may not receive PRS for PDC and estimate gNBRx –Tx. The triggering of PRS reception and associated UERx –Tx estimation can be left to UE implementation.** |
| [11]R2-2203461 | **Proposal 5: RAN2 to finalize the stage 3 details of RRC signalling needed to configure a single pair of TRS/PRS and SRS needed for RTT-based PDC.** |

In [10], a new topic is presented regarding the configuration of PRS/SRS. The issue presented is that RRC configuration works only for periodic SRS. For semi-persistent SRS and aperiodic SRS, MAC CEs have been defined for activation, deactivation, and spatial relation indication of SRS. The issue is that the existing Enhanced SP/AP SRS Spatial Relation Indication MAC CE does not allow the indication of the DL PRS as the spatial relation source RS for the SRS (that is configured for the PDC). Thus, there may be a need to update that MAC CE accordingly. The proposal is then to utilize the unused bit in the existing “Enhanced SP/AP SRS Spatial Relation Indication” MAC CE to provide indication of PRS. A proposed TP to achieve there is attached in the Annex in [10].

In [7], three further related issues are identified regarding PRS summarized as follows:

1. The preconfigured measurement gap feature introduced for positioning to reduce delay of time difference estimation may cause unneeded additional complexity if supported in the PDC framework.
2. PRS Positioning Window (PPW) is a R17 enhancement in positioning to acquire on-demand PRS whereby the PRS can have higher priority than DL channels and signals. This specific feature is not needed for the single gNB-UE simple PDC framework, and supporting may add unneeded complexity to the MAC spec.
3. When SRS for PDC is not activated, UE does not expect to receive the gNBRx –Tx estimation from gNB, and does not need to receive PRS and estimate UERx –Tx even if PRS for PDC is configured.

Since all the proposals here relate to PRS configuration, it is useful to collect company views on whether any of these specific problems, if any, identified need further discussion.

**Q2-1. Please indicate if any of the identified issues below regarding PRS configuration need further discussion or explicit agreement:**

* **Issue i: For semi-persistent SRS and aperiodic SRS, existing MAC CE (Enhanced SP/AP SRS Spatial Relation Indication MAC CE) does not allow the indication of the DL PRS as the spatial relation source RS for the SRS (that is configured for the PDC). It is proposed to utilize an unused bit in the existing “Enhanced SP/AP SRS Spatial Relation Indication” MAC CE to provide indication of PRS.**
* **Issue ii: RAN2 needs an agreement to confirm that pre-configured measurement gap does not need to be supported for the PRS used for PDC.**
* **Issue iii: RAN2 needs an agreement to confirm that PPW does not need to be supported for the PRS used for PDC.**
* **Issue iv: RAN2 needs an agreement to confirm that when SRS for PDC is not activated, UE may not receive PRS for PDC and estimate gNB Rx –Tx. The triggering of PRS reception and associated UE Rx –Tx estimation can be left to UE implementation.**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Issue i | Issue ii | Issue iii | Issue iv | Comment |
|  |  |  |  | Ericsson:  On issue i, we can wait for RAN1 to confirm the status of the working assumption.  On issue ii, iii, there is no need to further discuss at this moment. We can leave this to the maintenance phase, as it is related with enhancements introduced in another WI.  On issue iv, we don’t prefer this. This complicates the signalling, since it intertwines the activation of the UL reference signals and the DL reference signals. A sensible gNB implementation may always activate SRS/PRS at the same time. If it chooses not to activate SRS, then it means that gNB utilizes other mechanisms (implementation-specific) to have a rough estimate of gNB Rx-Tx time difference measurement, e.g., based on other UL signals. In one example, the gNB may not configure UE to transmit any SRS in the UL but could ask UE to report UE Rx-Tx time difference based on PRS. If gNB sees necessary, it can activate SRS later to have a more accurate gNB Rx-Tx time difference measurement. |
| ? | CATT | CATT | CATT | Issues ii-iv: Proponent.  For issue i we think it depends on whether RAN1 suggested RRC structure is adopted in RAN2.   |  | | --- | | **Working Assumption**  Alt.1: Add new “*spatialRelationInfo-PDC-r17*” field to *SRS-Resource* to indicate the spatial relation between a reference RS and the target SRS, with *spatialRelationInfo-PDC-r17* as below:  spatialRelationInfo-PDC-r17 ::=     SEQUENCE {      referenceSignal                     CHOICE {          ssb-Index                           SSB-Index,          csi-RS-Index                        NZP-CSI-RS-ResourceId,  dl-PRS-PDC                          nr-DL-PRS-ResourceID-r16          srs                                 SEQUENCE {              resourceId                          SRS-ResourceId,              uplinkBWP                           BWP-Id          }      }  }  Note: RAN1 does not pursue further optimization for SRS configuration with legacy usage and meanwhile with PRS as spatial relation source. | |
| Fujitsu |  |  |  | For Issue i, we also think that RAN2 can wait for RAN1.  For other Issues, we are neutral for the company’s proposal. |
|  | Nokia | Nokia | Nokia | We think issue i cannot be evaluated by RAN2 alone, and some study from MIMO may be needed as well.  For the other issues, we are fine to have agreements to confirm these. |
|  |  | OPPO |  | **Issue i** : It is for spatial relation RS of SRS. We understand that all proposals related to spatial relation RS of SRS depends on the RAN1 decision and should be held pending in RAN2.  **Issue ii:** RAN1 has already achieved the related conclusions, i.e. measurement gap should not be mandatory for a UE to process PRS for PDC purposes. This means the measurement gap restriction does not apply to PDC-PRS. It means there is no need for an explicit agreement in RAN2?  **Issue iii:** We understand there is no need to consider this enhancement made in the positioning session, and we are fine to keep PPW out of PDC.  **Issue iv:** we understand that the issue should not be discussed in RAN2, because it is about whether /how UE makes the measurement in the PHY layer |

### Can Pre-compensated RTI be carried in SIB9?

Following the earlier agreement in RAN2 #115e

1. RAN2 assumes that gNB can perform pre-compensation. RAN2 agrees to introduce signalling to enable/disable UE-side PDC.

While it is generally understood that a pre-compensated RTI can be transmitted to the UE via *DLInformationTransfer* message, an issue is raised in [2] on whether a pre-compensated RTI can also be transmitted in *SIB9* citing possible backward compatibility issues.

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| --- | --- |
| **Contributions** | **Related proposals** |
| [5]R2-2202728 | Once the UE-side PDC is disabled, one follow-up question is whether gNB-side PDC is always performed. The RTI can be delivered via SIB9 or dedicated RRC. If the RTI is sent via *DLInformationTransfer*, we understand that this RTI may be pre-compensated based on the network strategy. However, if the RTI is sent via *SIB9*, the network pre-compensation should be prohibited to avoid the backward compatibility issue, otherwise, there will be over-compensation for the legacy UEs.  **Proposal 3: In the case that referenceTimeInfo is sent via SIB9, the gNB pre-compensation should be prohibited to avoid backward compatibility issues.** |

**Q2-2: Can SIB9 be used to carry pre-compensated RTI?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Yes | As agreed, SIB9 can indicate UE not to compensate, and so it means that it may contain pre-compensated RTI.  Better not to restrict. In a controlled environment with only R17 UEs (e.g., factory automation), it would be okay to have SIB9 with pre-compensation.  Even though the agreement is that it is up-to UE implementation to compensate in Rel-16. The realistic expectation is that the Rel-16 UEs would not do that. If a UE has implemented compensation based on TA, it is beneficial for that UE to report the Rel-17 UE capability. |
| CATT | No | We acknowledge that there will be backward compatibility issues if pre-compensated RTI be carried in SIB9. |
| Fujitsu | No | As proposed, there is backward compatibility issue. |
| vivo | No | PDC is performed for individual UE. |
| MediaTek | No | Unclear how precompensated RTI can be carried in the SIB unless all UEs are located at exactly the same distance from the gNB and do not move. |
| Xiaomi | No |  |
| Nokia | No | There will be very limited scenarios where a common correction can be applied to the whole cell. Also there is a backward compatibility issue. |
| Qualcomm | No | Our understanding is that the timing field in SIB9 which is broadcast to every UE in the cell should reflect the real timing. Also backward compatibility issues. |
| OPPO | No | We understand that the backward compatibility issues may exist if a pre-compensated RTI is transmitted in SIB9. Note that the legacy UE considers no pre-compensation is done in RTI of SIB9, thus the double-compensation is introduced if the legacy UE performs PDC by its implementation. |

**Conclusion:**

### Broadcast UE-side PDC activation

In RAN2 116e, it was agreed that:

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| The gNB can enable/disable UE-side PDC via unicast and broadcast RRC signalling. |

In [1], it is further being discussed if activation can be included in SIB9. In any case, since UE can receive some broadcast activation it is useful to verify the understanding of the UE actions upon receiving broadcast activation.

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| --- | --- |
| **Contributions** | **Related proposals** |
| [2]R2-2202437 | **Proposal 4 RAN2 confirms that 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.**  **Proposal 5 If the unicast enabling/disabling signaling applies to the broadcast reference time info and if the UE receives the enabling/disabling signaling via both unicast and broadcast RRC, the UE follows the unicast enabling/disabling signal** |
| [11]R2-2203461 | **Observation 5: Legacy-TA based PDC has low accuracy due to large TA granularity, among other error sources, thus it is expected to be used for limited very large PD use cases, e.g., outdoor smart grid.**  **Observation 6: RAN2 has agreed that gNB can enable/disable UE-side PDC via unicast and broadcast RRC signaling.**  **Proposal 2: RAN2 to specify the RRC signaling needed to enable/disable UE-side TA-based PDC.**  **Proposal 3: SIB is not used to activate or deactivate UE side PDC.** |

In [2], an additional two problems were presented regarding unicast vs broadcast UE-side activation signalling. If it is agreed that both unicast and broadcast RRC/SIB9 activation is supported, [2] addresses how the UE should interpret a broadcast PDC activation/deactivation signal.

**Q2-3a: if the UE receives the PDC activation/deactivation signalling via both unicast and broadcast, do companies agree that the UE would always prioritize the activation command in the unicast activation signalling and no spec change is required?**

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| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Postpone | The other option is to restrict the network from doing so, i.e., PDC activation/deactivation signalling cannot be transmitted simultaneously via both unicast and broadcast.  The discussion might be easier if we refer to the RRC CR that captures the latest agreement. We propose to discuss case-by-case based on the CR. |
| CATT | Yes | Can also be taken in the offline discussion for CR finalization. |
| Fujitsu | Yes, but | if this case is considered in RAN2, the principle would be that dedicated signaling is over broadcast signaling. |
| vivo | Yes | Normally, unicast signalling is prioritized. |
| MediaTek | Postpone | Agree with Ericsson that this would be easier to discuss based on the CR |
| Xiaomi | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| OPPO | Yes, but | We understand that such behavior should be reflected in the spec, otherwise, the UE behavior is still unclear especially for ones who do not fully follow our discussion. |

**Conclusion:**

Also, in [2], it is important to reach a common understanding on what the UE exactly does when it receives a broadcast PDC activation signal. It is suggested to restrict broadcast activation to broadcast RTI only, however in rapporteur’s view, it is not a likely configuration that the gNB broadcasts a UE-side activation PDC signal when it intends to unicast some pre-compensated RTIs to some UEs in the cell, and thus, this does not warrant specific UE-side restrictions on interpreting broadcast RTI in the light of the RAN2 #116 bis agreement

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| No need to introduce additional activation for RTT measurement in UE side. |

**Q2-3b: Do companies agree that a broadcast UE-side PDC activation signal can be used to activate UE-side PDC for all Ues in the cell irrespective of whether RTI is unicast or broadcast, unless otherwise indicated via unicast activation/deactivation?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Additional comment(s)** |
| Ericsson | Postpone | Same as above, postpone to the RRC CR discussion. |
| CATT | Yes |  |
| Fujitsu | Yes, but | If this case is considered in RAN2, the proposal seems to be the way to specify UE behavior, but the question is if it is a likely configuration as the rapporteur is pointing out. |
| Vivo | Yes | To allow flexible network configuration. |
| MediaTek | Postpone | Agree with Ericsson that this would be easier to discuss based on the CR |
| Xiaomi | Yes |  |
| Nokia | Yes |  |
| Qualcomm | Yes |  |
| OPPO | No | We wonder what is the benefit in the case that RTIs are send via both SIB and dedicated RRC with the same value. If the value is the same, why the NW needs to send RTI via dedicated RRC? We understand that, usually, a smart gNB does not need to send such both RTIs if they are with the same value, that is why we think the broadcast indication is applied to SIB only. Only when such he both RTIs are with different values (e.g. unicast RTI is with pre-compensation), the benefit exists, but for this case, we think the activation indication via broadcast can not apply the unicast RTI. But, for this case, if the gNB will always provide unicast activation/deactivation together, we can fine with the proposal. |

**Conclusion:**

## Other issues

**Q3: Are there any other issue that should be addressed for the Timing Synchronization objective to complete this Rel-17 WI? Please provide your technical argument for the issue(s) you would like to raise.**

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| --- | --- | --- |
| **Company** | **Issue** | **Description and why it should be discussed** |
|  |  |  |
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**Conclusion:**

# Conclusion

**TBD**

# References

[1] R2- 2203302 Summary of [POST116bis-e][513][IIoT] CP open issues (Ericsson)

[2]R2-2202437 Remaining issues on time synchronization enhancement, OPPO

[3]R2-2202580 Left issues for time synchronization, Lenovo, Motorola Mobility

[4]R2-2202708 Discussion on remaining issues for accurate time synchronization, Huawei, HiSilicon

[5]R2-2202728 Remaining Issues on PDC Enhancement, CMCC

[6]R2-2202750 Remaining issues of time synchronization, ZTE Corporation, Sanechips, China Southern Power Grid Co., Ltd

[7]R2-2202784 Simplifying the PRS procedure for Remaining Issues of RTT-based PDC, CATT

[8]R2-2202894 Remaining issues for PDC, vivo

[9]R2-2203197 Propagation Delay Compensation signalling, Nokia, Nokia Shanghai Bell

[10]R2-2203303 MAC CE update for SRS Spatial Relation Indication, Ericsson

[11]R2-2203461 Propagation Delay Compensation for TSN, Qualcomm Incorporated

[12] R2-2202182 RE: LS on Time Synchronization, IEEE 1588 WG