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

Online, Feb 21st – Mar 3rd, 2022

Agenda Item: 8.5.1

Source: Ericsson

Title: Summary of [POST116bis-e][513][IIoT] CP open issues (Ericsson)

Document for: Discussion, Decision

# 1 Introduction

This contribution summarizes the following discussion:

* [POST116bis-e][513][IIoT] CP open issues (Ericsson)

Scope:

- List of critical open issues to be resolved for WI completion (including UE capabilities)

- Updated CR 38.331 for information and review

NOTE: NO contributions on these critical open issues are expected

Deadline:

- Open issues list Jan. 28th

- Company inputs Feb. 15th

Contact person(s) for each participating company:

|  |  |  |
| --- | --- | --- |
| **Company** | **Name** | **Email** |
| Ericsson | Zhenhua Zou | zhenhua.zou@ericsson.com |
| Qualcomm | Sherif ElAzzouni | selazzou@qti.qualcomm.com |
| ZTE | Ting Lu | lu.ting@zte.com.cn |
| Nokia | Ping-Heng Wallace Kuo | Ping-Heng.Kuo@nokia.com |
| vivo | Boubacar Kimba | kimba@vivo.com |
| xiaomi | Yumin Wu | wuyumin@xiaomi.com |

# 2 Discussion

## 2.1 Time sync

### 2.1.1 Issue 1: UE Rx-Tx time difference measurement report

In RAN2#116bis-e, the below is agreed.

|  |
| --- |
| 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. For RTT-based gNB side PDC, RRC measurement framework can be reused as baseline to provide UE Rx-Tx time difference report.No need to introduce additional activation for RTT measurement in UE side. |

It is rapporteur’s understanding that the UE starts to measure the Rx-Tx time difference once the relevant DL reference signals are configured by the network.

The remaining issue is how to trigger UE reporting of the Rx-Tx time difference measurement. It is rapporteur’s understanding that the baseline measurement reporting is that UE always report when there is a Rx-Tx time difference measurement. Further enhancement to trigger UE report was discussed in the email discussion [1] (see Q5a and proposal 5.1) with two alternatives that have the most support, i.e., explicit request in RRC signalling and event-based triggering. Among the companies that support event-based triggering in the email discussion [1], all are fine with the below event:

* the difference between the current UE Rx-Tx Time difference measurement value and the previous reported measurement value is larger than a configurable threshold.

There are further alternatives e.g., periodic report, L1/MAC signalling triggering, up-to UE implementation, etc. Due to the less support in the email discussion and the RAN2 agreement that the RTT-based gNB side PDC has to be a simple solution, rapporteur proposes not to explicitly re-discuss these. But companies can provide further inputs, if they believe they can change the views from the participant companies.

Rapporteur summary:

**Alt1: Explicit request in RRC signalling: an explicit indication is sent to trigger one-shot UE Rx-Tx time difference measurement report**

* Arguments for:
	+ Only gNB knows better when the reference time needs to be adjusted for the UE due to either clock drift or UE moving around.
	+ these adjustments are not expected to be often.
* Arguments against:
	+ The gNB may only be aware that the UE propagation delay compensation has changed within the cyclic prefix for data transmission. In other words, only an accuracy level corresponding to the legacy TA-based can be achieved, and not accurate enough for 100-200 ns sync target which is the motivation to introduce RTT-based method.

**Alt2: Event-based triggering: UE reports if the difference between the current measurement value and the previous reported measurement value is larger than a configurable threshold**

* Arguments for:
	+ Once the DL reference signals are configured by the gNB, 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, with event-based triggering, this can save RRC signalling overhead.
	+ Works better in the scenario where the UE is mostly stationary or moving slowly.
	+ Network can configure the triggering threshold to cater different synchronization accuracy requirement and can meet the 100-200 ns sync target on the Uu interface.
* Arguments against:
	+ Complicated event definitions.

Rapporteur has also provided two TPs for the above two alternatives in the email discussion draft folder

[https://www.3gpp.org/ftp/Email\_Discussions/RAN2/%5BRAN2%23116bis-e%5D/%5BPOST116bis-e%5D%5B513%5D%5BIIoT%5D%20CP%20open%20issues%20(Ericsson)/Pre-RAN2%23117](https://www.3gpp.org/ftp/Email_Discussions/RAN2/%5BRAN2%23116bis-e%5D/%5BPOST116bis-e%5D%5B513%5D%5BIIoT%5D%20CP%20open%20issues%20%28Ericsson%29/Pre-RAN2%23117)

**Q1a. Which alternative do you support? Please also check the TPs above for reference**

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt1 or Alt2 or ?** | **Comments** |
| Qualcomm | None | Event triggering does not work. The assumption under event triggering is that a change in UE position, i.e., a change in the UE propagation delay can be inferred by the UE. This is not true, as UE Rx-Tx time difference mostly depends on the UE RF frontend, it affects positioning only when it’s combined with the gNB Rx-Tx time difference as well, i.e., the UE can significantly change positions without the UE Rx-Tx time difference measurement changing to reflect that, thus, we do not think Alt-2 is an option. Alt-1 suffers from the same issue to some extent, as it is unclear how the gNB will know that change in position. In our view, periodic reporting is the safest and simplest option, but we are open to a periodic-aperiodic setup which can be fitted in Alt 1 if there is a majority for that.  |
| ZTE | Alt1 | We think the main issue of **Alt2** is that the UE RTT change threshold in the event definition would inevitably introduce additional error on the PDC calculation. The reason is, when the gNB needs UE side RTT to perform PDC, UE may not have reported the latest value and gNB have to use the previous reported one. The difference between the previous reported RTT and the UE current real measurement value is this error. Even this error may be small, e.g., smaller than the threshold, it’s still an error that will affect the final time accuracy. The larger the UE RTT change threshold value, the larger the error. But the smaller the threshold value, the more frequent the UE side RTT reporting to network and some of the reports may not be really needed in gNB.Therefore, we think the instantaneous report based on request from gNB would be more feasible. We also think gNB knows better when the reference time needs to be adjusted for the UE, e.g., according to whether there is need to update the time info, or UE’s service requirement (whether or not the service needs higher accuracy time and/or the time budget) or some other knowledge. |
| Nokia | None, or Alt-1 with periodic reporting  | We share the similar views as Qualcomm.Our preference is an explicit indication in RRC signaling to trigger periodical report of UE Rx-Tx time difference (option 3 in Q5a in the previous email discussion). This periodic reporting configuration can be part of the measurement configuration to follow the RAN2 agreement that for RTT-based gNB side PDC, RRC measurement framework can be reused as baseline to provide UE Rx-Tx time difference report.We see some issues with the description of Alt-2 based on the difference between measurement values at the UE side. Such UE trigger of Rx-Tx measurement 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. Moreover, it requires further specification work on definitions of threshold value ranges etc.If this event-based triggering alternative is preferred by the majority of companies, we propose to use as an event the UE detecting an CSI-RS configured for RTT-based PDC. The UE can then, after a predefined time, trigger the delivery of an Rx-Tx measurement. In this way, a Rx-Tx measurement is delivered when the gNB gives the UE the means to do an Rx-Tx measurement, and the gNB will be able to set the periodicity based on e.g., statistics of the calculated RTT. |
| vivo | Alt1 | It was discussed and agreed that UE-based trigger for TA update or RACH procedure for PDC are deprioritized for Release 17. Hence, when to trigger RACH or send TAC to UE for TA based PDC is left to gNB implementation.We see no strong motivation to define a different solution for RTT based PDC in Release 17.  |
| Xiaomi | Alt 1 | We think that the gNB by implementation should be able to handle the PDC properly, e.g. when Rx-Tx time difference measurement report is needed from the UE. Defining an event seems also requiring some inputs from RAN1/RAN4, e.g. on whether L1/L3 measurement with/without filtering is required.  |
|  |  |  |

The TPs for the two alternatives assume no layer 3 filtering for measurements. For event triggered measurement, the triggering event is that the difference between the current measurement value and the previous reported measurement value is larger than a configurable threshold. For event triggering, there is no hysteresis, no time to trigger, no report on leave, report amount after triggering is always one. Rapporteur thinks these could work. Need for further mechanisms can be discussed if there are sufficient support. Companies can provide comments below and other questions for the TPs.

**Q1b. Do you have any questions for the TP for any alternative you support/do not support?**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | TPs can be discussed once all the technical aspects in Q1a are discussed. |
| ZTE | It seems fine to use the pair of *UEInformationRequest/ UEInformationResponse* for **Alt1**. The details can be further checked. |
|  |  |
|  |  |
|  |  |
|  |  |

### 2.1.2 Issue 2, reception of both dedicated signalling and SIB9

This is to discuss the below FFS.

|  |
| --- |
| RAN2 confirm the agreement in last meeting that reference time provided in dedicated signaling takes priority. FFS UE behavior when it receives reference time info via dedicated signaling. |

RAN2 agreed in the RAN2#116 that

1. When reference time information is received in both the DLInformationTransfer message and the SIB9, the UE applies the reference time info in the DLInformationTransfer message. The UE will follow dedicated signaling if timing reference is received in both unicast and broadcast

In a deployment with both unicast delivery and broadcast delivery from the gNB, the RAN2 agreement is to indicate that the unicast delivered reference time to the UE takes priority. The rationale is that

* In Rel-17, the gNB can RRC-unicast reference time to the UE with pre-compensated PD (unlike Rel-16). The PD is UE specific. In this case, dedicated signalling should be followed.
* gNB may pre-compensate time in a broadcast message (applied for all UEs in a cell) to save signaling overhead. At the same time, gNB transmits an uncompensated time in unicast message to a specific UE together with UE-based PDC. In this case, dedicated signaling should be followed.

A similar discussion was discussed in Rel-16 IIoT WI, see question 7 in [R2-2002281](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_109_e/Docs//R2-2002281.zip). The conclusion is that

* Do not make any specifications changes to indicate which of the received reference time information takes precedence in case the UE receives reference time via both unicast and broadcast signalling.

It is rapporteur’s understanding that network pre-compensation was not agreed in Rel-16 and so there is no motivation for the gNB to differentiate broadcast and unicast message. It was okay to leave it ambiguous. This is not the case anymore in Rel-17 and so there is a need to clarify and make it clear in the agreement/specs.

One understanding is from ([R2-2200320](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200320.zip), [R2-2200952](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200952.zip)). In this alternative, as soon as a UE receives its reference time information via dedicated signalling, it ignores all further reference time information received over SIB9. The implication is that this forces gNB to transmit the reference time to the UE via dedicated signalling always. [R2-2200952](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200952.zip) proposes an indication from the gNB to the UE to fall back to receive SIB9.

Another understanding during online discussions is that if both dedicated and unicast signalling are received “at the same time”, unicast signalling takes priority. Otherwise, the latest received reference time info from either unicast or broadcast takes priority. This means that the network has to always transmit a dedicated signalling for the UE at each periodic SIB9 refresh, if the information in the dedicated signaling and the broadcast signalling is different.

Rapporteur proposes first to collect views on the understanding and the follow-up in [R2-2200952](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200952.zip) is discussed in the next question.

**Q2a. Which of the below alternative do you support? Companies are invited to further provide other alternatives that can address the above technical issue.**

* **Alt1: 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.**
* **Alt2: If both dedicated and unicast signalling are received “at the same”, the UE consider dedicated signalling takes priority. Otherwise, the UE follows latest received reference time info from either unicast or broadcast.**
* **Alt3: ??**

|  |  |  |
| --- | --- | --- |
| **Company** | **Alt1 or Alt2 ?**  | **Comments** |
| Qualcomm | Alt 1 (see comments) | Alt 1 is preferrable as long as there is no HO or RLF, which is in line with RAN2 principle of dedicated vs broadcast signaling. Alt 2 runs the risk of the UE jumping between pre-compensated and non-compensated reference timing. |
| ZTE | Alt1 | We have similar view as Qualcomm.Moreover, with the following reasons, we re-confirm our preference of dedicated signaling taking priority:* Dedicated signaling can be protected with security.
* In Rel-17, the gNB may provide RRC-unicast reference time to the UE with PDC (unlike Rel-16). So dedicated signalling should be followed.
 |
| Nokia | Alt1 | We would prefer Alt 1, as we think Alt 2 may mess up the UE timing. Imagine we have a scenario with a cell broadcasting the SIB9 every Xms, UE1 needs PDC and gNB-side RTT-based PDC is used. This UE1 will be able to read RTI in the periodic SIB9 broadcasted to the cell and additionally the DLinfoTransfer with the compensated RTI from the gNB. Then, based on the second part of Alt2, the UE will use the compensated RTI to update its time, but if an SIB9 message comes between two compensated RTIs, then the UE will also use that SIB9 RTI not compensated. The UE’s timing information will jump between compensated and not compensated RTI.  |
| vivo | Alt1 with modification | For Alt1:Alt1: As soon as a UE receives its reference time information via dedicated signaling, it ignores all further reference time information received over SIB9 before handover. gNB can only rely on dedicated signalling afterwards. It is our understanding, UE can acquire reference time information from SIB9 in the target cell. For Alt2:Agree with the rapporteur’s explain: Alt2 implies that the network has to always transmit a dedicated signalling for the UE at each periodic SIB9 refresh, if the information in the dedicated signaling and the broadcast signalling is different. Alt2 will cause a lot of signalling overhead. |
| Xiaomi | Alt 1 |  |
|  |  |  |

If Alt1 is the understanding, then the gNB is forced to transmit the reference time to the UE via dedicated signalling always. The UE location may move and so whether gNB pre-compensation is needed or not would change and so it is important that the network can de-configure the earlier provided unicasted value, or in other words that the network indicates that a previously received dedicated time information is invalid, i.e., the UE should start to read SIB9 to acquire reference time.

**Q2b. If you choose Alt1 in Q2a, do you support “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.”?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No ?**  | **Comments** |
| Qualcomm | No | We first note that the we don’t see an issue as we don’t anticipate that a good NW implementation will continuously switch reference timing between dedicated and broadcast reference timing. But in any case, if we absolutely have to enable the NW to switch back to SIB9 for a UE that has been receiving dedicated timing info, we prefer relying on a configured UE timer to solve that. When no more dedicated signaling updates arrive, the UE can wait for the timer duration then start receiving SIB9 again and adjusting the clock accordingly. |
| ZTE | Open to discuss | We think the current understanding mentioned in Q2a is completely aligned with legacy process. Now we are not sure whether there will be the case that the gNB want to “stop” the process of prioritizing the dedicated singling for all or most of the configured UEs, e.g., let these UEs back to follow time info in SIB. The main intention may be to reduce the possible dedicated signaling overhead to many UEs? If yes of the case, we are open to discuss a simple indication in SIB. |
| Nokia | No | We think it is okay for the gNB to provide the reference time to the UE by dedicated signaling always. This does not seem to be an issue from implementation point of view. |
| vivo | See comments | We agree with the motivation that gNB should be allowed to transmit the reference time to the UE via SIB9 after transmit via dedicated signalling, e.g. to reduce the possible dedicated signaling overhead to many UEs.And this can be achieved via intra-cell handover, hence we prefer to leave the issue to network implement.  |
| Xiaomi | No | We think that we think that once the gNB decided to use dedicated signaling, the gNB should always use such option. Switching from dedicated signaling to SIB would be rare. |
|  |  |  |

As this issue has not been discussed thoroughly, the rapporteur invites companies to provide further inputs if needed.

**Q2c. If you have further comments, please provide in the below.**

|  |  |
| --- | --- |
| **Company** | **Comments** |
| Qualcomm | gNB-side is not agreed yet and we still don’t see a technical necessity for it provided that UE-side already solves the problem and given the scope of the current technical discussions to support gNB-side, we don’t think convergence can happen this meeting, so we reiterate our preference of not supporting gNB-side RTT PDC. |
| ZTE | We understand Q2a and Q2b are common questions, without giving special support to gNB side RTT PDC. They can be discussed independently of issue of supporting gNB side RTT PDC. |
|  |  |
|  |  |
|  |  |
|  |  |

### 2.1.3 Issue 3, UE-side PDC, common or separate indication?

In the RAN2#116bis-e, it is agreed that

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

It is rapporteur’s assumption from this agreement that, in RRC signalling (either implicit or explicit), it is possible to configure both RTT-based PDC and TA-based PDC at the UE-side. However, there are proposals that it is already not possible from the RRC signalling to configure both. This did not receive sufficient support in the email discussion [R2-2201826](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2201826.zip) (see summary before proposal 7.1, 5 versus 11). A common indication is certainly possible, but it is an optimization to save RRC signalling overhead for a scenario that does not happen often. Rapporteur proposes to confirm with the companies since it would otherwise complicate the below discussions for issue 4 and issue 5.

**Q3. Do you support two separate activation signalling of UE-side PDC, one for TA, and another one for RTT? If not, please provide reasons and solutions.**

Note: If yes, RRC field description would restrict the network from configuring both.

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No?** | **Comments** |
| Qualcomm  | Yes | These are separate solutions and should be kept as such from signaling point of view. |
| ZTE | Yes? | We prefer separate activation schemes for UE side RTT-based PDC and UE side TA-based PDC:* As for UE side RTT-based PDC, not only measurement configuration but also gNB side RTT need to be provided to UE, these provision can act as implicit activation indication for UE side RTT-based PDC.
* For TA-based PDC, there is no any configuration from gNB. So we think an explicit activation indication specifically defined for TA-based PDC is needed and that’s enough. Such indication could be explicitly provided to the UE in unicast signalling or in SIB.

According to the email discussion in RAN2#116bise, we cannot see a clear/workable scheme of one common UE side RTT activation which can apply to activating either TA-based PDC or RTT-based PDC (even with some additional information). |
| Nokia | No | To our understanding, an explicit binary indication can be enough to indicate UE-side PDC. For UE-side TA-based PDC, as no other configuration of PDC at the UE is needed, a binary indication is needed. For UE-side RTT-based PDC, considering that the procedure will require a unicast configuration framework and unicast delivery of Rx-Tx measurement reports, implicitly the UE can determine UE-side RTT-based PDC applies. Thus, explicit indication for UE-side RTT-based PDC may be redundant.Then, we could consider the following cases for the UE to determine if TA-based PDC or RTT-based PDC applies: |
| vivo | Yes | Separate activation signalling for RTT-based PDC and TA-based PDC of UE-side PDC is simple and clear.A common activation signalling for RTT-based PDC and TA-based PDC of UE-side PDC also feasible, but it is only an optimization. Due to the limited time, we prefer to not optimize this. |
| Xiaomi | Yes | The UE may not be able to support both TA-based and RTT-based PDCs, and the UE should know which option should be preferred by the network. |

### 2.1.4 Issue 4, UE-side PDC indication for TA

The below two FFS are related with the TA-based activation. They were discussed in the email discussion R2-2201826 [1], see Q7, Q8 and proposals 7.1 and 7.2.

|  |
| --- |
| FFS an explicit indication to only activate UE side TA-based PDC is introduced in SIB or in unicast signalling and what is indicatedFFS For TA-based PDC, it’s no need to specify PD calculation related contents in RAN2. |

In RAN2#116, it is agreed that

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

Note, there are multiple questions in this section and some may argue it is already agreed as in the RAN2#116, see above. Nevertheless, there were different views, and it is worthwhile to check companies’ understanding in light of the latest RAN1 agreement that both legacy TA and RTT are supported.

The **first** question is about whether an explicit indication is needed or not.

**Q4a. Do you support an explicit indication for UE-side TA-based PDC?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No** | **Comments** |
| Qualcomm | Yes, but keep earlier agreement of RRC signaling  | Would have preferred to follow the principle of “legacy-TA” as agreed and leave the activation/deactivation to UE implementation as done in legacy Rel-16. However, given the general understanding of earlier agreement, we think RRC activation is fine. We do not think there is any reason to change that agreement and use SIB for activation. |
| ZTE | Yes | As mentioned in **Q3**, we prefer an explicit activation indication for UE side TA-based PDC (it has been agreed in either dedicated signaling or SIB). Meanwhile, we prefer implicit activation indication for UE side RTT-based PDC.We haven’t seen a workable common activation indication scheme for both TA and RTT based UE side PDC. |
| Nokia | Yes | As indicated in our comment for Q3, there is no other configuration the gNB can rely on to start/stop this method. Therefore, a binary indication for unicast activation/deactivation for UE-side TA-based PDC is preferred. If other companies see the use of a broadcast version to be supported too, an optional bit in RTI carried over SIB9 for a broadcast activation/deactivation can be considered too. The absence of the unicast UE-side PDC indication means no PDC method is configured and its backwards compatible with Rel-16 specification. |
| vivo | Yes |  |
| Xiaomi | Yes |  |

The **second** question is on what to indicate.

In the email discussion R2-2201826 [1], the proposal based on the majority view is that for TA-based PDC, there is no need to specify PD calculation in RAN2. In the LS R1-2112834, RAN1 agrees the below that there is no RAN1/RAN4 specification impact.

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

It is rapporteur’s understanding that if the PD calculation is not specified in any 3GPP specs, then there is no need to have an explicit RRC configuration to enable TA-based PDC, since it is up-to UE implementation to perform TA which is not specified. The indication to disable TA-based PDC might be useful, in case that the network pre-compensates the delivered reference time. With this understanding, this signalling option means no need to specify PD calculation at the UE.

Another option is to indicate with a Boolean “activate”/”de-activate”. The absence of this field means following Rel-16 legacy, i.e., up-to UE implementation. With this understanding, this signalling option means there is a need to specify PD calculation at the UE.

Yet another option is to indicate with a Boolean “activate”/”de-activate”, but not to specify PD calculation in RAN2 specs (however with unclear motivation).

**Q4b. Which option do you support? Please provide reasons for your preferred signalling approach.**

* **Option 1: only “de-activate”, and no need to specify PD calculation in RAN2 specs**
* **Option 2: a Boolean with “activate”/”de-activate”, and to specify PD calculation in RAN2 specs**
* **Option 3: a Boolean with “activate”/”de-activate”, and no need to specify PD calculation in RAN2 specs**
* **Option 4: ?**

|  |  |  |
| --- | --- | --- |
| **Company** |  | **Comments** |
| Qualcomm | 1 | We share the rapporteur understanding and reasoning for Option 1. If there is good reasoning for option 3 that is fine too, but specifying PD calculation is not needed. |
| ZTE | Option 3 | We see Option 1 has risk that no way to (re)activate the UE side TA-based PDC. Option 3 may be the general way.For the part of specifying PD calculation, we have no so strong view, but just have sympathy with some previous comments that we cannot only specify this in RAN2 specification.  |
| Nokia | Option 3 | Same comment as for Q4a, we think a Boolean is needed. On the other hand, we do not think there is a need to specify PD calculation, RAN2 should follow RAN1/RAN4 approach of support TA-based PDC based on legacy TA mechanism. |
| vivo | Optoin2 | Even though R16 UE can perform PDC based on legacy TA, it is not captured in the specification. Thus, R16 UE actually can adopt any other solution to calculated PD value. If nothing is specified in R17, the R17 UE behavior of TA based PDC is not clear, which is same as R16.  |
| Xiaomi | Option 3 | We think that the activation indicated for TA-based PDC is needed to differentiate the TA-based PDC from the RTT-based PDC. We have no strong view on the PD calculation, and think that once there is on testing issue, it would be ok not to include the PD calculation in RAN2 specs. |

The **third** question is on whether it can be supported on broadcast or unicast message. The details on which message and IE to include this would be part of the RRC running CR discussion. It is rapporteur’s understanding that the same signalling would be applied for both unicast and broadcast. This can allow the maximum flexibility.

**Q4c. If the answer to Q4a is yes, do you support the same option of Q4b in both SIB9 and in RRC-unicast message. If not, which option do you prefer, e.g., only in RRC-unicast, or one option in RRC-unicast and another option in SIB9?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/no** | **Comments** |
| Qualcomm | No | Only in RRC-unicast. We think given Rel-16 just followed UE implementation and Rel-17 relies on legacy-TA to some extent, this add-on can be done via RRC sufficiently whenever it’s needed. We don’t see the motivation of modifying SIB for a limited feature like that.  |
| ZTE | Yes | We already have agreement on this.  |
| Nokia | No | We prefer a unicast version of the activation indication to the UE via RRC. If a broadcast version is to be supported, it can be as an optional bit in referenceTimeInfo carried in SIB9. |
| vivo | Yes | We prefer to keep the previous agreement. |
| Xiaomi | Yes |  |

### 2.1.5 Issue 5, UE-side PDC indication for RTT

In the RAN2#116bis-e, it is agreed that

|  |
| --- |
| * For RTT-based UE side PDC, gNB Rx-Tx time difference, e.g., gNB Rx-Tx, shall be provided to UE via DLInformationTransfer signaling.
* No need to introduce additional activation for RTT measurement in UE side.
 |

The indication for UE-side RTT PDC was discussed in [R2-2201826](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2201826.zip) [1], see Q4c and proposal 4.2, with two options:

* **Option 1**: Provision of gNB Rx-Tx time difference to UE can implicitly activate RTT-based UE side PDC.
* **Option 2**: Explicit RRC signalling as RAN2 has agreed that “A new RRC parameter can be introduced to explicitly enable/disable UE-side PDC”.

It is rapporteur’s understanding that UE should measure the UE Rx-Tx time difference once the DL references are configured by the network. The question is when/whether the UE calculates the PDC after receiving the gNB Rx-Tx time difference measurement. The camps supporting option 1 believes that an implicit provision of gNB Rx-Tx time difference is sufficient, while the camps supporting option 2 mentions that an explicit RRC signalling has been agreed.

**Q5. Which option do you support for activation of UE-side RTT method? Please provide reasons.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or option 2 or?** | **Comments** |
| Qualcomm | Option 2 | We prefer a clean solution of separating activating from configuration. We think implicit activation is not preferred as it mixes the activation and configuration for very limited savings in signaling.  |
| ZTE | Option 1 | When we have the agreement “A new RRC parameter can be introduced to explicitly enable/disable UE-side PDC”, RAN2 only know the TA-based PDC would be supported and have no idea on whether RTT-based PDC can be supported. So now we should discuss the details based on the current situation. Again, as mentioned in **Q3**, we prefer implicit activation indication for UE side RTT-based PDC. The gNB Rx-Tx time difference can act as this implicit activation indication. That’s enough.Moreover, for UE side RTT-based PDC, as we prefer it can be implicitly activated by gNB RTT provided from gNB, it’s naturally an implicit activation via dedicated signaling. We see no need of indication in SIB and also no need of an explicit indication. |
| Nokia | Other | From our perspective, implicitly activating RTT-based UE side PDC based on the **provision of measurement configuration** is preferred.Option 1 may lead to strange behaviors at the UE side when the UE has already received the RTT measurement configuration, but it has not received gNB’s Rx-Tx time difference measurement yet. That is, during that period until the first gNB’s report is received at the UE, the UE does not know if it should conduct UE-side PDC or not.Option 2 may be redundant as the method already requires unicast signaling for Rx-Tx measurement configuration. |
| vivo | Option2 | Share Nokia’s understanding on option1.With option1, one UE can decide RTT-based UE side PDC is activated when gNBRx-Tx is received. On the other hand, it implies UE cannot decide whether UE side or NW side PDC is activated before gNBRx-Tx is received. Then what will happen when the network wants to activate RTT-based NW side PDC? In this case, gNBRx-Tx will never be received by UE. As a result, UE can never decide which PDC (i.e. UE side or NW side) is activated. There is a chicken-egg issue. Hence, we prefer explicit indication is used to activate the RTT-based NW or UE side PDC, which is clear and simple. |
| Xiaomi | Option 1 | The solution provided by Nokia is also acceptable to us. |

## 2.2 RAN1 agreements/conclusions

### 2.2.1 Issue 6, multi TRP

RAN1 has indicated the below conclusion in the LS [R2-2200080](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200080.zip).

|  |
| --- |
| **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
 |

If there are multiple TRPs in the PCell, then it is of vital importance that the reference signals for the propagation delay compensation and the DL reference signals for UE to derive the reference time are from the same TRP. Note that TRP is not explicitly described in RRC spec, but indirectly identified via the SSB index(es) associated with the TRP. The UE derives the reference time from the ending boundary of a system frame and the UE synchronizes to the ending boundary of a system frame using the MIB.

* If the *referenceTimeInfo* field is received in *DLInformationTransfer* message, the time field indicates the *time* at the ending boundary of the system frame indicated by *referenceSFN*.
* If the *referenceTimeInfo* field is received in *SIB9*, the *time* field indicates the time at the SFN boundary at or immediately after the ending boundary of the SI-window in which *SIB9* is transmitted.

In the paper [R2-2200952](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200952.zip), it argues that it is not clear from which SSB index (which TRP) the UE has used to derive the system frame boundary. One understanding is that it is up-to UE implementation, as in legacy for data communication. But for data communication, it is only required that DL signal from different TRPs arrive at the UE within a cyclic prefix (CP) for coherent detection. CP duration is a couple of microseconds, which is an order of magnitude too large for the tight clock synchronization needs.

Rapporteur would like to first collect companies’ view on the above understanding.

**Q6a. Do you agree there is no existing mechanism to know from which TRP (i.e., SSB index) the UE synchronizes to the ending boundary of a system frame, and thus derive the reference time information?**

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no?** | **If no, please provide further comments** |
| Qualcomm | No | There is probably no issue here. When gNB configures the DL RS resources for PDC, the UE can use the associated QCL source SSB for determining the SFN offset |
| ZTE | No | We cannot understand the issue from RAN2 point and we assume the needed mechanism is already there. |
| Nokia | No | The RAN1 conclusion is sufficient, i.e.* The UE can by implementation ensure that it selects the SFN boundary of the TRP it receives referenceTimeInfo from.
* The gNB can by implementation ensure that referenceTimeInfo is delivered via the DL beam the UE is associated to.

In a scenarios with distributed TRPs each identified with an SSB index, the UL and DL beam will be selected based on the SSB index and corresponding RACH opportunity. In this way the gNB and UE knows how to reach each other. |
| vivo | No | Agree with the above comments, no enhancement in RAN2 is needed. |
| Xiaomi | No | The gNB by implementation should send the reference time information via a proper TRP. |

If the above answer is no (i.e., there is such a mechanism), then the gNB can configure the downlink reference signals properly and no spec change is needed. Otherwise, the gNB needs to know from which TRP the UE receives the reference time information.

**Q6b. If the above answer is yes, do you support “for RTT-based PDC, network indicates to the UE the same TRP for reference time estimation and propagation delay compensation”?**

|  |  |  |
| --- | --- | --- |
| **Company** | **yes/no ?** | **comments** |
| Qualcomm | No |  |
|  |  |  |

If the above answer is yes, then RAN2 can further discuss how to implement it in the RRC spec. As all the reference signals (TRS/PRS, SRS) would most likely have spatial relation information field, which could be configured to an SSB index. The RRC impact is on where to write this explanatory field description.

## 2.3 UE capabilities

It is agreed in RAN2#116bis-e that

Agreements:

1 An optional UE capability signalling is introduced for simultaneous configuration of LCH based prioritization (capability lch-priorityBasedPrioritization-r16) and cg-RetransmissionTimer. The capability is per UE, not FDD-TDD DIFF, not FR1-FR2 DIFF.

2 An optional UE capability signalling (intraCG-Prioritization) is introduced to indicate whether UE supports the HARQ process ID selection based on LCH priority. A UE supporting this feature shall also support simultaneous configuration of LCH based prioritization and cg-RetransmissionTimer. The capability is per UE, not FDD-TDD DIFF, not FR1-FR2 DIFF.

3 An optional UE capability signalling for survival time is introduced.

 FFS A UE supporting survival time feature shall also support CA PDCP duplication (capability pdcp-DuplicationMCG-OrSCG-DRB) and configured grant type-1 (capability configuredUL-GrantType1 or configuredUL-GrantType1-v1650). The capability is per UE, not FDD-TDD DIFF, not FR1-FR2 DIFF.

 FFS on DC duplication or CG Type 1 is supported

### 2.3.1 Issue 7, UE capability for time-sync

RAN1 has agreed the following propagation delay compensation related capabilities in [R1-2112902](http://www.3gpp.org/ftp//tsg_ran/WG1_RL1/TSGR1_107-e/Docs//R1-2112902.zip):

* FG 25-19: Propagation delay compensation based on CSI-RS for tracking and SRS, per FS
* FG 25-19a: Propagation delay compensation based on DL PRS and SRS, per FS
* FG 25-20: Propagation delay compensation based on legacy TA procedure, per UE

What remains to discuss is the feature introduced by RAN2. RAN2 has agreed in the last meeting that

|  |
| --- |
| 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.  |

For UE-side PDC, the UE shall be able to receive the gNB Rx-Tx time difference measurement and calculate the PDC based on UE Rx-Tx time difference measurement. For gNB-side PDC, the UE shall be able to transmit the UE Rx-Tx time difference measurement. The support of FG 25-19/25-19a is only for propagation delay compensation and it means that the UE shall support at least UE-side PDC or gNB-side PDC. The question is then on which has conditionally mandatory support.

**Q7a. Which of the below feature(s) a UE supporting FG 25-19/25-19a shall also mandatorily support? Companies can select more than one alternative**

**Alt1: UE-side PDC for RTT-method**

**Alt2: gNB-side PDC for RTT-method, if a simple solution is adopted by Feb meeting**

**Alt3: none (i.e., UE supporting at least UE-side PDC or gNB-side PDC)**

|  |  |  |
| --- | --- | --- |
| **Company** |  | **Comments** |
| Qualcomm | Alt 1 | So far, this is the only solution that has been agreed to so it makes sense to support that capability. |
| ZTE | Alt 1 and Alt2 | If UE can support RTT measurement based on DL or UL signals, we see no reason that UE cannot receive and handle gNB RTT or report its RTT to network. So we assume Alt1 and Alt2 can also be supported for UE supporting FG 25-19/25-19a. |
| Nokia | Alt1 and Alt2 |  |
| vivo | Alt1 and Alt2 | Agree with ZTE. |
| Xiaomi | Alt 1 | Alt 2 is not a simple solution for the UE, due to the Rx-Tx time difference measurement report from the UE. |

Another is related with the issue 2 in section 2.1.2. There were comments that the below agreement differs from the Rel-16 assumption (no requirement that UE considers the dedicated signalling takes priority).

|  |
| --- |
| RAN2 confirm the agreement in last meeting that reference time provided in dedicated signaling takes priority. FFS UE behavior when it receives reference time info via dedicated signaling. |

Rapporteur proposes to collect views on whether a separate UE capability is needed.

**Q7b. Do companies support an optional UE capability for that dedicating signalling takes priority and the relevant UE behaviors (if agreed)?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes, No** | **Comments** |
| Qualcomm | No | There is no need for a new UE capability for that. This is already the normal behavior. |
| ZTE | No  | Agree with Qualcomm. |
| Nokia | No |  |
| vivo | No |  |
| Xiaomi | No |  |

### 2.3.2 Issue 8, UE capability for survival time

The below is agreed in the RAN2#116bis-e

An optional UE capability signalling for survival time is introduced. FFS A UE supporting survival time feature shall also support CA PDCP duplication (capability pdcp-DuplicationMCG-OrSCG-DRB) and configured grant type-1 (capability configuredUL-GrantType1 or configuredUL-GrantType1-v1650). The capability is per UE, not FDD-TDD DIFF, not FR1-FR2 DIFF. FFS on DC duplication or CG Type 1 is supported

PDCP duplication

RAN2 has agreed that once entering the survival time, all configured RLC entities for PDCP duplication are activated and the survival time support can only be configured for DRBs (i.e., not for SRBs). This means that some form of mandatory support for PDCP duplication is needed. DRB PDCP duplication can be either CA duplication (*pdcp-DuplicationMCG-orSCG-DRB)* or DC duplication (*pdcp-DuplicationSplitDRB*). Duplication can also be with more than two RLC entities (*pdcp-DuplicationMoreThanTwoRLC-r16)*: a UE supporting this feature shall also support CA and DC duplication for both SRB and DRBs.

Therefore, as a baseline, the UE shall support at least CA duplication or DC duplication.

**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****)*

This means that the UE can indicate support of only CA duplication or only DC duplication. The paper [R2-2200992](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200992.zip) further proposes that the UE shall always support CA duplication. During the online discussion, there were comments that the DC duplication shall also be always supported. The rapporteur proposes the below question to collect views

**Q8a. Which feature(s) shall a UE supporting survival time feature also mandatorily support? Companies can select more than one alternative.**

 **Alt1: CA duplication for DRB (*pdcp-DuplicationMCG-orSCG-DRB*)**

 **Alt2: DC duplication for DRB (*pdcp-DuplicationSplitDRB****)*

**Alt3: duplication for more than two RLC entities (*pdcp-DuplicationMoreThanTwoRLC-r16****)*

**Alt4: none (i.e., the baseline above)**

|  |  |  |
| --- | --- | --- |
| **Company** |  | **Comments** |
| Qualcomm | Alt 1 | We think in its most common form, the survival state would prompt CA duplication (DC duplication is not workable due to synchronization issues and very small survival time). Thus, we think Alt 1 is a good baseline to support the most common and simple form of the feature,  |
| ZTE | Alt1, Alt2, Alt3 | We assume the UE that supports survival time would be a UE with high reliability requirements. So we tend to think that it can also support Alt1, Alt2 and Alt3. We are also fine with only Alt1 as baseline. |
| Nokia | Alt4 | We do not see the need to mandate survival time support to any specific duplication scenario. As long as CA or DC duplication is supported by the UE, the survival time support introduced in Rel-17 can be applied. The baseline above is sufficient. |
| vivo | Alt1 | CA duplication is the most promise solution and should be mandatorily support.  |
| Xiaomi | Alt 4 | We think that the UE by implementation should indicate the support of either CA duplication or DC duplication for survival time, but none of these should be considered as mandatory for survival time. |

Configured grant

Ran2 has agreed that the baseline solution is that the survival time mode is triggered by a CG retransmission scheduling (addressed by CS-RNTI). Thus, a type of CG (either type 1 or type 2) must be supported.

* Configured grant support in licensed band: *configuredUL-GrantType1-v1650, configuredUL-GrantType2-v1650.* They are per-band signalling, and UE shall set the capability value consistently for all FDD-FR1 bands, all TDD-FR1 bands and all TDD-FR2 bands respectively. They intend to replace the legacy capability bits which is per UE (*configuredUL-GrantType1, configuredUL-GrantType2,* See[R2-2106644](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_114-e/Docs//R2-2106644.zip)).
* Configured grant support in shared channel access: *configuredUL-GrantType1-r16, configuredUL-GrantType2-r16*. Both are per-UE signalling.

Therefore, as a baseline, the UE shall support at least a configured grant (either type 1 or type 2). It is also rapporteur’s understanding that UCE support for survival time is not prioritized.

**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****)*

Similarly, the paper [R2-2200992](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_116bis-e/Docs//R2-2200992.zip) further proposes that the UE shall always support configured grant type 1. During the online discussion, there were comments that the configured grant type 2 shall also be always supported. The rapporteur proposes the below question to collect views

**Q8b. Which feature(s) shall a UE supporting survival time feature also mandatorily support? Companies can select more than one alternative.**

 **Alt1: configured grant type 1 in licensed (*configuredUL-GrantType1-v1650*)**

 **Alt2: configured grant type 2 in licensed (*configuredUL-GrantType2-v1650****)*

**Alt3: configured grant type 1 in shared access (configuredUL-GrantType1-r16)**

**Alt4: configured grant type 2 in shared access (configuredUL-GrantType2-r16)**

**Alt5: none (i.e., baseline above)**

|  |  |  |
| --- | --- | --- |
| **Company** |  | **Comments** |
| Qualcomm | Alt 5 | Although the feature makes most sense on CGs type 2, there is nothing stopping the NW from implementing the duplication part on DGs for any UE, so we do not think that the UE needs to mandatorily support any type of specific grant for a feature that concerns duplication at the PDCP.  |
| ZTE | Alt5 | We need more think about this.Now we tend to agree that it’s no need for UE to mandatorily support any type of specific grant for a feature. |
| Nokia | 1&2 | As long as CG Type 1 or Type 2 can be supported, we believe survival time mechanism could be applied. We agree with the rapporteur that unlicensed band operation is de-prioritized and there is no need to mandate. |
| vivo | Alt5 | UE can apply survival time feature with either CG Type 1 or Type 2. |
| Xiaomi | Alt 5 |  |

Per UE vs Per band:

The PDCP duplication is per-UE capability, but the support of configured grant is per-band. The rapporteur proposes to collect views on this.

**Q8c. Which of the following option do companies support?**

**Option 1: The optional UE capability for survival time is per-band**

**Option 2: The optional UE capability for survival time is per-UE**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 / Option 2?** | **Comments** |
| Qualcomm | 2 |  |
| ZTE | Option 2 |  |
| Nokia | 2 |  |
| vivo | Option2 |  |
| Xiaomi | Option 2 |  |

# 3 Conclusion

TBD

# 4 References

1. R2-2201826, Tsynch open issues – outcome of email discussion 503 ZTE
2. R2-2200003, Report of [Post116-e][513][IIoT] QoS Survival Time (Apple) Apple discussion Rel-17 NR\_IIOT\_URLLC\_enh-Core
3. R2-2200992, UE capabilities for Rel-17 IIoT / URLLC Intel Corporation discussion Rel-17 NR\_IIOT\_URLLC\_enh-Core
4. R2-2200080 LS on propagation delay compensation (R1-2112834; contact: Huawei) RAN1 LS in Rel-17 NR\_IIOT\_URLLC\_enh To:RAN2, RAN4
5. R2-2200952, Propagation delay compensation enhancements Ericsson discussion