3GPP TSG-RAN WG2 Meeting #117 electronic R2-2203302

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:

|  |  |  |
| --- | --- | --- |
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# 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>

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

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| --- | --- | --- |
| **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.  V07 Ericsson:  If UE significantly changes positions without the UE Rx-Tx time difference measurement changing to reflect that, then the gNB Rx-Tx time difference measurement is definitely different and so the gNB-based PDC mechanism still works. |
| 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.  V07 Ericsson:  The network can adjust the threshold value based on the needed accuracy level. In the extreme case, the network can configure a threshold of zero and the UE report for every measurement. |
| 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.  V18 Ericsson:  Even the UE-based PDC relies on that the UE can properly track the DL frame timing changes. |
| 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.  V07 Ericsson:  The TA-based PDC method targets a sync accuracy of 500 ns, while RTT-based PDC method targets a sync accuracy of 100 ns – 200 ns. |
| 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. |
| LGE | Alt1 | It would be sufficient to get the UE RTT only when needed, which can be decided by the gNB by itself. |
| OPPO | None or Alt1 with periodic reporting | We share a similar view as Qualcomm that Event triggering does not work. On the other hand, a proper event triggering requires more RAN2 discussions and also requires RAN1/RAN4 input. We understand that the gNB can control the PDC in a proper configuration by its implementation. One way may be periodic reporting and another may be one-shot reporting triggered by an explicit indication. |
| CATT | Alt1 | For its simplicity. We are not sure of the argument of limited accuracy due to cyclic prefix. gNB can accumulate the timing estimation from multiple SRS transmission instances to achieve the desired accuracy level and derive when UE should provide a fresh UE Rx-Tx time difference measurement.  V18 Ericsson:  If the gNB can accumulate the timing estimation from multiple SRS transmission instances to achieve 100 ns sync accuracy, then this is equivalent to an enhanced TA-based method which is ruled out by RAN1. |
| Intel | Alt1 | Since the compensation is performed at gNB side, gNB can explicitly request UE to send the measurement report. |
| DOCOMO | Alt2 | Event based triggering obviously has much more signaling efficiency than periodical triggering.  Regarding the argument that “UE can significantly change positions without the UE Rx-Tx time difference measurement changing to reflect that”, we admit UE side estimation alone is not accurate without combining with gNB Rx-Tx time difference measurement, but it is rare that there is no UE Rx-Tx time change while UE position changed significantly, especially for TDD deployment i.e. the propagation path of UL and DL should not be a big difference for the same frequency band.  Moreover, event based reporting is a triggering for UE Rx-Tx time difference report, gNB can decide not to respond to it if position change estimation at gNB side is small. We think the trigger of calculation of PD compensation at UE side happen only when UE receive gNB Rx-Tx time difference measurement result from gNB.  In short, the event based triggering still reduce the signaling of measurement reporting compared with periodical triggering, which is quite signaling efficient for use case e.g. the bulky IIoT devices (robot arm, machine control device) that are almost stationary. |
| Samsung | None or Alt1 with periodic reporting | We prefer the simplest solution, so it’s ok not to support RTT-based gNB compensation. |
| MediaTek | Alt1 | Agree with LGE |
| Apple | Alt2 | As already discussed during the last email discussion [1], Alt2 allows for higher accuracy. Moreover, the UE can judge necessary updates due to clock drift. |
| Huawei, HiSilicon | Alt 2 | Event driven reporting can work based on UE Rx-Tx time difference. |
| Sequans | Alt 2 | Event driven reporting allows to report whenever there is a change with the desired granularity. |
| Ericsson | Alt 2 | Please see further comments above.  For Alt1, we are not sure how the gNB is able to know that the UE Rx-Tx time difference has changed, or the propagation delay has changed down-to the target accuracy (100 ns).  If Alt1 is adopted, then the gNB has to request every time when there is a need for gNB to refresh the reference time. If a periodic refresh is planned by gNB, then it is equivalent to a periodic explicit request and Alt1 with periodic reporting might be okay. Nevertheless, if the UE is stationary always, then the periodic reporting is not optimal in the signalling overhead. |

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?**

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| **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. |
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**Summary:**

* 7 companies: Alt1, explicit request in RRC signalling: an explicit indication is sent to trigger one-shot UE Rx-Tx time difference measurement report
* 5 companies: 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
* 3 companies: None or Alt1 with periodic reporting
* 1 company: None. The same company also indicates in the comment they are fine with periodic reporting.

11 companies out of 16 companies are fine with an explicit request. There are comments that Alt2 with event-based triggering does not work. One company has replied but not sure if other companies are convinced. There are further comments on the complexity of Alt2. On the other hand, for explicit request (Alt1), the concern is mostly on the signalling overhead. Per the agreement that a simple solution must be converged in this meeting, the rapporteur proposes to adopt the explicit request.

Among the companies that support an explicit request, 7 support one-shot request, 4 support periodic report. One more company mentions that one-shot request is not efficient signalling-wise if the network intends to periodically refresh the time. From Rapporteur’s point of view, if an explicit request is agreed, then it is worthwhile to further check companies’ view on these two alternatives and rapporteur tends to think supporting both is not complicated spec-wise. Thus, rapporteur proposes to further discuss.

1. UE Rx-Tx time difference measurement report is triggered by an explicit request (11/16). RAN2 to further discuss whether it is one shot, periodic or both.
   1. Explicit request (11/16): one-shot, 7/16
   2. Explicit request (11/16): periodic, 4/16

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

This is to discuss the below FFS.

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| 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: ??**

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| **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 |  |
| LGE | Alt 1 |  |
| OPPO | Alt1 | We understand Alt1 is aligned with our intention of dedicated signaling taking priority and Alt2 has the issue of signaling overhead. |
| CATT | Alt 1 | Agree with Rapporteur’s arguments |
| Intel | Modified Alt1 | Our understanding is that Alt1 is only applicable for one serving cell, i.e. “*As soon as a UE receives its reference time information via dedicated signaling, it ignores all further reference time information received over SIB9 from the current serving cell*”. The reason is that the information regarding dedicated signaling for time information provisioning is not exchanged between source and target gNB during handover, and target gNB has the flexibility to determine whether to use SIB9 or dedicated RRC signalling. |
| DOCOMO | Alt1 | Agree with Qualcomm’s view. |
| Samsung | Alt 1 | No strong view |
| MediaTek | Alt1 | For the same reasons as Qualcomm |
| Huawei, HiSilicon | Alt 3 “other” | For Alt 1 gNB can only rely on dedicated signalling afterwards which is too restrictive. For the problem commented on “alt 2”: “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.” We think the highlighted event would be rare.  We propose the third alternative: Alt 1 when UE PDC disabled, and when UE PDC enabled/not specified: follow R16 behaviour/the latest time info applied. |
| Sequans | Alt 1 | Need also to discuss the HO case. |
| Ericsson | Alt1 |  |

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.”?**

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| **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. |
| LGE | No | We see no benefit of switching between dedicated and broadcast signaling. |
| OPPO | No | We understand that a proper gNB implementation can be relied on to avoid the continuously switch between dedicated and broadcast reference timing. If that is the case, we also think that the UE can rely on a configured timer for triggering the switch from the dedicated to the broadcast reference timing. |
| CATT | Preferably not | We acknowledge the issue and agree it can be constraining to mandate gNB to always deliver the reference time via dedicated signaling even when UE-specific reference time delivery is no longer necessary. However we would first check if that cannot be handled by NW implementation (leveraging existing procedure). |
| Intel | No | We prefer no further optimization is pursued. gNB can still use dedicated RRC signalling to provide time information when needed. |
| DOCOMO | No strong view | We are fine that once gNB sends the RTI in dedicated signaling and it provides the RTI always. So UE follows the RTI in dedicated signaling. |
| Samsung | No | Agree with Nokia |
| MediaTek | No |  |
| Huawei, HiSilicon | No | We think this is a corner case. Network would guarantee unicast time info is valid. With above our proposed alt 3, gNB can always reconfigure UE-side PDC. |
| Sequans | No | Agree with Nokia |
| Ericsson | Yes |  |

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.**

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| --- | --- |
| **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. |
| Ericsson | Agree with ZTE. @Qualcomm. TA-based gNB-side PDC is agreed. |
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**Summary:**

14 companies out of 15 companies support alt1, and the vast majority companies do not support an explicit indication to the UE to fallback to SIB9 reception.

* 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.

Some companies also mention that the Alt1 is valid only when neither HO nor RLF happens. This means that if there is a handover or RLF, then the UE can fall back to receive SIB9. This point was also mentioned by serval other companies in the question 2b. Some companies in the question 2b also mention that existing procedure can allow the UE to fallback to receiving SIB9. Rapporteur believes this is more stage-3 related details and proposes to further discuss this.

1. 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 (14/15). FFS, when the UE fallback to receiving SIB9 with the existing procedure (e.g., handover, RLF, etc.)

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

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

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| * 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.

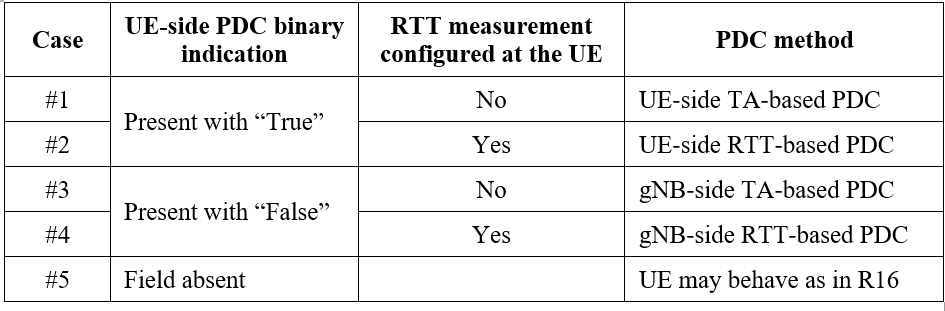
**Q3. Do you support two separate activation signalling of UE-side PDC, one for TA, and another one for RTT? If not, please provide reasons and solutions.**

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. |
| LGE | Yes | It is simple and clear to have separate signaling for activating different types of PDC. We don’t see a big need for further optimization. |
| OPPO | No | We understand that it is impossible to configure RTT-based PDC and TA-based PDC together based on the agreements. The gNB has enough time to reconfigure. If the gNB wants the RTT-based PDC, it can configure the RS parameters for RTT, otherwise, it can de-configure those parameters. Thus, common signaling is sufficient. The following can be the solution for a common mechanism.  - If the UE receives UE-side PDC enabling indication, and  • If the RS parameters needed for RTT are configured, the UE performs UE-side RTT-based PDC.  • If the RS parameters needed for RTT are not configured, the UE performs UE-side TA-based PDC.  - If the UE receives UE-side PDC disabling indication, and  • If the RS parameters needed for RTT are configured, the UE reports UE RX-TX time difference, i.e. The gNB may perform RTT-based pre-compensation.  • If the RS parameters needed for RTT are not configured, the UE does nothing.  - If the UE-side PDC enabling/disabling indication is absent,  • The UE may behave as in Rel-16. |
| CATT | Yes |  |
| Intel | Yes | The activation/deactivation of TA-based PDC and RTT-based PDC should be independent. |
| DOCOMO | No | Explicit (de)activation signaling for TA- based PDC is enough.  Activation of RTT based PDC at UE side can be triggered implicitly by receiving gNB Rx-Tx time difference measurement result. |
| Samsung | No | Simultaneous activations of more than one PDC will bring another complexity, e.g. how to prioritize when the calculated UE timing is different. From only signaling perspective, it’s ok not to optimize. But the simultaneous configurations shall be avoided.  Regarding the possible cases, we agree with Nokia. One of the five cases can be configured at the same time. |
| MediaTek | No | Agree with Nokia |
| Apple | Yes | Agree with Qualcomm |
| Huawei, HiSilicon | No | Agree with Nokia |
| Sequans | Yes | Similar view as Qualcomm. |
| Ericsson | Yes | A common indication is an optimization to save RRC signalling overhead for a scenario that does not happen often |

**Summary:**

10 companies out of 16 companies support a separate indication, while 6 companies out of 16 companies support a common indication where the below is the understanding.



The companies support a common indication only mention that a common indication is feasible but not the necessity of it. The pros/cons of the options are clear, and rapporteur proposes to follow the majority view. The below is the proposal with some wording changes and the clarification that they cannot be configured at the same time.

1. 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 (10/16).

### 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 indicated  FFS 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.  Ericsson v18:  The earlier agreement is that   * The gNB can enable/disable UE-side PDC via unicast and **broadcast** RRC signalling. |
| 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 |  |
| LGE | Yes | We also think RRC signaling is sufficient, i.e., not via SIB. |
| OPPO | Yes |  |
| CATT | Yes | Given TA-based PDC mechanism is fully left to UE implementation, it is a “black box” from NW perspective and the agreement “The gNB can enable/disable UE-side PDC via unicast and broadcast RRC signalling” requires an explicit RRC signaling to turn it on/off. |
| Intel | Yes |  |
| DOCOMO | Yes |  |
| Samsung | Yes | Agree with Nokia |
| MediaTek | Yes | Agree with Nokia |
| Apple | Yes |  |
| Huawei, HiSilicon | Yes | Agree with Nokia |
| Sequans | Yes |  |
| Ericsson | Yes |  |

**Summary:**

All companies are fine with an explicit indication for TA-based PDC at the UE side.

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. |
| LGE | Option 3 | We agree with ZTE that option 1 does not allow reactivation of TA-based UE-side PDC. |
| OPPO | Option 3 | We understand that UE needs a binary indication for deactivation and activation, i.e. a Boolean with “activate”/”de-activate”, which is better for the UE to understand the gNB preference. As the legacy TA-based PDC is to be used, we can follow the legacy mechanism and do not need to specify the PD calculation. |
| CATT | Option 1 | Presence of the field means “deactivate” absence of the field means “activate” (by default). |
| Intel | Option 1 | gNB can deactivate UE-side PDC. If UE-side PDC is not deactivated, how UE performs PDC is up to UE implementation, as in Rel-16. |
| DOCOMO | Option 3 | For option1, we wonder how to reactivate the TA-based PDC if it is deactivated once. |
| Samsung | Option 3 |  |
| MediaTek | Option 3 |  |
| Huawei, HiSilicon | Option 3 |  |
| Sequans | Option 3 |  |
| Ericsson | Option 2 | There is a need to specify this in the RAN2 specs, since Ran1/4 does not specify the UE behaviors.  For option 3, even if the network indicates the UE to activate the TA-based PDC, it is up to UE to implement which can mean that the UE does not perform PDC. From network vendor point of view, the explicit activation is not useful. |

**Summary:**

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

Option 3 has the majority support (10/15)

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 |  |
| LGE | No |  |
| OPPO | Yes | We understand that it is already agreed. |
| CATT | Yes | Assuming of course different indications could be provided in SIB9 and unicast, in which case UE should prioritize unicast, as discussed in Q2a. |
| Intel | Yes | As already agreed in RAN2#116-e meeting. |
| DOCOMO | Yes | We are fine to keep the agreement. |
| Samsung | No | Agree with Nokia |
| MediaTek | No | Only in RRC-unicast. |
| Huawei, HiSilicon | No | We prefer unicast indication, which can control individual UE more efficiently. |
| Sequans | Yes |  |
| Ericsson | Yes | We see benefits in providing this in the broadcast message. For example, the network indicates to all UEs in the cell not to compensate, if the cell size is small. Similarly, the indication to compensate could ensure a unified and guaranteed UE implementation that the PD is compensated, in contrast to Rel-16 UEs (which are up-to UE implementation).  @Nokia. Yes, it is optional and can be in the referenceTimeInfo IE. |

**Summary:**

* 9 companies: in both RRC-unicast and SIB9
* 6 companies: in RRC-unicast only

There is a majority support for both RRC-unicast and SIB9.

RAN2 has discussed the question 4b the second time and the pros/cons/implication of each option is clear, and rapporteur proposes to follow the majority view:

1. UE-side TA PDC is activated/de-activated by a Boolean. No need to specify PD calculation in RAN2 spec. (10/16)

For question 4c, still majority of the companies want to have both RRC-unicast and SIB9 support which is in align with a previous generic agreement. Moreover, there does not seem to have any concern for SIB9 indication. Rapporteur proposes to adopt this.

1. UE-side TA PDC activation/de-activation is supported in both RRC unicast and SIB9 (9/15).

### 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.  Ericsson V18: UE cannot conduct UE-side PDC without receiving gNB Rx-Tx time difference measurement. The understanding is that the UE preforms the UE Rx-Tx time difference measurement whenever the RRC configuration for the reference signals are provided. |
| 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.  Ericsson V18: Would it clearer if RAN2 clarifies that the UE performs Rx-Tx time difference measurement whenever the RRC configuration for the reference signals are provided? |
| Xiaomi | Option 1 | The solution provided by Nokia is also acceptable to us. |
| LGE | Option 2 | Explicit indication would be clearer. |
| OPPO | Option 1 | We understand that Option 1 can avoid unnecessary signaling overhead. The UE can clearly know the UE-side RTT-based PDC is enabled when receiving gNB Rx-Tx time difference, and UE-side RTT-based PDC is disabled when the gNB Rx-Tx time difference is not received. |
| CATT | Option 1 | Simple and sufficient. |
| Intel | Option 1 |  |
| DOCOMO | Option 1 | Our understanding is UE calculates the PDC after receiving the gNB Rx-Tx time difference measurement result. So activation of RTT based PDC at UE side can be triggered implicitly by receiving gNB Rx-Tx time difference measurement result. |
| Samsung | Option 1 | The solution provided by Nokia is also ok. |
| MediaTek | Option 2 | This is clearer. Nokia’s solution is also ok |
| Huawei, HiSilicon | Other | Support Nokia solution “implicitly activating RTT-based UE side PDC based on the provision of measurement configuration” |
| Sequans | Option 1 or 2 | Option 1 is the simplest, but we are also ok to have an explicit activation which seems cleaner. |
| Ericsson | Option 1 or 2 | All options are okay, but the option proposed by Nokia is more complicated and not preferred. The network may configure the measurement configuration of DL reference signals but intend to have a gNB-based PDC. Even though one can make it work, it is more complicated than the other two options. |

**Summary:**

Many companies have provided multiple choices. Here is the collection of the views. The number means the number of companies that are fine, and some companies are fine with more than one option.

* 9 companies option 1: Provision of gNB Rx-Tx time difference to UE can implicitly activate RTT-based UE side PDC
* 6 companies option 2: Explicit RRC signalling as RAN2 has agreed that “A new RRC parameter can be introduced to explicitly enable/disable UE-side PDC”.
* 5 companies option 3 (other): Provision of measurement configuration implicitly activates RTT-based UE side PDC.

From the inputs by various companies, there seem to have some different understandings. An explicit configuration is certainly possible, but there is more support to have an implicit indication. Moreover, some companies have different understanding that the provision of the measurement configuration can also indicate activation of the RTT-based UE side PDC. But, one company has replied that the configuration of the reference signals can also be for gNB-based PDC and so this might be complicated.

Rapporteur proposes the below, which is based on option 1 (majority view) with a clarification from support of option 3 (other). This option appears beneficial/clean from RRC spec point of view

1. Provision of measurement configuration indicates that UE measures the Rx-Tx time difference. Provision of gNB Rx-Tx time difference to UE implicitly activates PDC calculation at the UE side.

## 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. |
| LGE | No | Agree with above. |
| OPPO | No | We understand that the current system already supports the case of multiple TRPs. In that case, it relies on the gNB implementation to have a proper configuration and sending, and no spec text is required. |
| CATT | No | In the running CR, PRS-Resource is related to a specific TCI-state and then specific SSB. Same for SRS. |
| Intel | No | Agree with above. gNB implementation should guarantee the same TRP is used for reference time information provisioning and propagation delay compensation. |
| DOCOMO | No | Assume implementation can solve the issue as agreed in RAN1. |
| Samsung | No | RAN1 may discuss this. No RAN2 issue here. |
| MediaTek |  | Unclear what the RAN2 issue here is. |
| Apple |  | Unclear what the RAN2 issue here is. |
| Huawei, HiSilicon | No | See no issue here, can ask RAN1 if needed. |
| Ericsson | Yes | The reference time information is delivered as an RRC message (either SIB broadcast or RRC-unicast). The network cannot deliver the reference time information via a specified TRP. The UE infers the time from the reception of the DL frame. Even if the PRS-resource can indicate to a specific SSB, there does not seem to mandate the UE to synchronize the DL frame to a particular SSB. |

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.

**Summary:**

16 companies out of 17: there are already mechanisms (either in spec or by implementation) to ensure that “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. “

1. 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.” (16/17)

## 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. |
| OPPO | Alt1 and Alt2 |  |
| CATT | Alt 3 | It is not clear to us why is there a need to have some additional mandatorily supported feature along with FG 25-19/25-19a.  Ericsson V18:  RAN1 indicates only the support of reference signals used for the propagation delay compensation. Whether UE- or gNB-based is up-to RAN2.  Alt3 means that the UE has to support at least one PDC method, either UE-based or gNB-based (if agreed). |
| Intel | Alt 1 and Alt 2 |  |
| DOCOMO | Alt1 and Alt2 |  |
| Samsung | Alt 1 | UE may be implemented the only simple solution. We can allow it. |
| MediaTek | Alt 3 | Same comment as CATT  Ericsson V18: See above comment for CATT. |
| Apple | None | Per the latest RAN1 feature list in R1-2200780, FG 25-19, 25-19a and 25-20 are all optional with capability signalling. We do not see why there is a need to introduce additional capabilities and we object to making UE capabilities for PDC mandatory.  RAN2 agreed in the last meeting:   |  | | --- | | 12. RAN2 confirms to introduce separate R17 UE capabilities for RTT-based PDC and legacy TA-based PDC, as defined by RAN1 feature list. | |
| Huawei, HiSilicon | Alt 1 and Alt 2 | Not sure about the question, we assume Rel-17 PDC is based on FG 25-19/25-19a. |
| Sequans | None | Same view as Apple. |
| Ericsson | Alt1 and Alt2 |  |

**Summary:**

A UE supporting FG 25-19/25-19a shall also support:

* 3 companies support UE-side PDC
* 8 companies support both UE-side and gNB-side PDC (if agreed)
* 4 companies support at least UE-side or gNB-side PDC (if agreed)

There seems to have some misunderstandings. Rapporteur intends to sort-out the capability dependency, in light of the RAN1 introduced FG 25-19/25-19a. Some more clarification below (assuming the gNB-side PDC is agreed):

* If UE supporting of FG 25-19/25-19a also supports UE-side PDC, then there is a need for a separate optional UE capability for gNB-side PDC;
* If UE supporting of FG 25-19/25-19a supports both UE-side and gNB-side PDC, then there is no need for any more optional UE capabilities in RAN2;
* If UE supporting of FG 25-19/25-19a also at least supports UE-side PDC or gNB-side PDC, then there is a need for two separate optional UE capabilities, one for gNB-side PDC and another for UE-side PDC.

The proposal below is a majority view

1. UE supporting of FG 25-19/25-19a also supports both UE-side and gNB-side PDC (if agreed). (8/15)

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 |  |
| OPPO | No |  |
| CATT | No | We don't think there is an additional complexity justifying this capability. |
| Intel | No |  |
| DOCOMO | No |  |
| Samsung | No |  |
| MediaTek | No |  |
| Huawei, HiSilicon | No | No need, once the relevant UE behavior is clarified. |
| Sequans | No |  |
| Ericsson | Yes | There were concerns that this differs from the Rel-16. If companies agree that this is the same as Rel-16, then there is no need for an optional UE capability. |

**Summary:**

13 companies out of 14 companies think there is no need for optional UE capability.

1. RAN2 does not introduce optional capability for dedicated signalling takes priority (13/14).

### 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. |
| LGE | Alt 4 | The baseline should be sufficient. |
| OPPO | Alt1, Alt2, Alt3 | But we are also fine to have Alt1 only. |
| CATT | Alt 4 | Baseline is sufficient. |
| III | Alt 4 | It would be sufficient to use the baseline above. |
| Intel | Alt1 | Considering the very tight delay budget (as low as 0.5 ms end-to-end delay) for services requiring survival time support, we prefer that survival time support requires the support of CA duplication (capability *pdcp-DuplicationMCG-OrSCG-DRB*). |
| DOCOMO | Alt1, Alt2, Alt3 |  |
| Samsung | Alt4 | The baseline is ok. |
| MediaTek | Alt4 | We do not see the need to mandatorily associate any specific flavour of duplication with this feature. |
| Apple | Alt4 | Baseline is sufficient. |
| Huawei, HiSilicon | Alt 4 |  |
| Sequans | Alt 4 |  |
| Ericsson | Alt1 | Agree with Qualcomm. DC duplication involves inter-node coordination and may not be fast enough for the DCI triggered PDCP duplication. |

**Summary:**

Alt1: 4 companies (2 companies are also fine)

Alt1, Alt2, Alt3: 3 companies

Alt4: 10 companies

There is a slight majority for Alt4 compared to Alt1.

1. 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)

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 signaling, 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 |  |
| LGE | Alt1, 2 | Unlicensed operation is de-prioritized so should not be mandated. |
| OPPO | Alt 1 or Alt 2 | Agree with the rapporteur’s analysis. |
| CATT | Alt 5 | Baseline is sufficient |
| III | Alt 5 | It would be sufficient to use the baseline above. |
| Intel | Alt5 | Baseline above is sufficient. |
| DOCOMO | Alt2 | Survival time does not work without CG type 2. |
| Samsung | Alt5 |  |
| MediaTek | Alt5 | We do not see the need to mandatorily associate any specific flavour of UL grant with this feature. |
| Apple | Alt5 |  |
| Huawei, HiSilicon | Alt 5 |  |
| Sequans | Alt 5 |  |
| Ericsson | Alt 5 |  |

**Summary:**

Alt1&2: 2 companies

Alt1, or alt 2: 1 company

Alt2: 1 company

Alt5: 13 companies

One company replies “1&2”, but the comment seems to indicate that they are also fine with Alt5. There are split views among companies that do no support Alt5. Rapporteur believes that it would be difficult to converge to an alternative except Alt5. Thus, we propose that

1. 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). (13/17)

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 |  |
| LGE | Option 2 |  |
| OPPO | Option 2 |  |
| CATT | Option 2 |  |
| III | Option 2 |  |
| Intel | Option 2 | Survival time support is applicable to the bands UE supports configured grant, and per UE capability is sufficient. |
| DOCOMO | Option2 |  |
| Samsung | Option 2 |  |
| MediaTek | Option 2 |  |
| Apple | Option 2 | Similar view as Intel, it would be good to capture this in the capability CR. |
| Huawei, HiSilicon | Option 1 | Shall follow the finer granularity and we understand that R17 new UE capability signaling shall be per band. |
| Sequans | Option 2 |  |
| Ericsson | Option 2 | Agree with Intel’s interpretation. |

**Summary:**

Option 1: 1 company

Option 2: 16 companies. As one company points out, this means that the survival time support is applicable to the bands UE supports configured grant

1. The optional UE capability for survival time is per-UE. (16/17)

# 3 Conclusion

Based on the discussion in the previous sections we propose the following:

[Proposal 1 UE Rx-Tx time difference measurement report is triggered by an explicit request (11/16). RAN2 to further discuss whether it is one shot, periodic or both.](#_Toc96010172)

[a. Explicit request (11/16): one-shot, 7/16](#_Toc96010173)

[b. Explicit request (11/16): periodic, 4/16](#_Toc96010174)

[Proposal 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 (14/15). FFS, when the UE fallback to receiving SIB9 with the existing procedure (e.g., handover, RLF, etc.)](#_Toc96010175)

[Proposal 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 (10/16).](#_Toc96010176)

[Proposal 4 UE-side TA PDC is activated/de-activated by a Boolean. No need to specify PD calculation in RAN2 spec. (10/16)](#_Toc96010177)

[Proposal 5 UE-side TA PDC activation/de-activation is supported in both RRC unicast and SIB9 (9/15).](#_Toc96010178)

[Proposal 6 Provision of measurement configuration indicates that UE measures the Rx-Tx time difference. Provision of gNB Rx-Tx time difference to UE implicitly activates PDC calculation at the UE side.](#_Toc96010179)

[Proposal 7 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.” (16/17)](#_Toc96010180)

[Proposal 8 UE supporting of FG 25-19/25-19a also supports both UE-side and gNB-side PDC (if agreed). (8/15)](#_Toc96010181)

[Proposal 9 RAN2 does not introduce optional capability for dedicated signalling takes priority (13/14).](#_Toc96010182)

[Proposal 10 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)](#_Toc96010183)

[Proposal 11 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). (13/17)](#_Toc96010184)

[Proposal 12 The optional UE capability for survival time is per-UE. (16/17)](#_Toc96010185)

# 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