**3GPP TSG-RAN WG4 Meeting # 99 R4-210XXXX**

**Electronic Meeting, 19th – 27th May, 2021**

**Agenda item:** 9.22.2

**Source:** Moderator (Nokia)

**Title:** Email discussion summary for [98-bis-e][239] NR\_IIOT\_URLLC\_enh\_RRM

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this email discussion (e.g. list of treated agenda items) and provide some guidelines for email discussion if necessary*

*The WI starts with allocated TUs in RAN4#99. However, RAN4 discussion started already in last RAN4#98bis meeting triggered by an LS from RAN1. RAN4 reached prial agreement in the questions in the Ls in RAN4#98bis, while one aspect was left open related to the RAN1 LS.*

*During this meeting RAN4 is to discuss two separate parts related to the WI:*

1. *Work plan for the WI, and*
2. *Continue the ongoing discussion related to LS and the definition of the reference point.*

Company contributions submitted and handled in this email discussion:

|  |  |  |  |
| --- | --- | --- | --- |
| R4-2110850 | Discussion on the reference point for the UE transmit timing error | MediaTek Inc. | discussion |
| R4-2109223 | Discussion on IIoT and URLLC enhancement in RRM | Intel Corporation | discussion |
| R4-2109495 | Discussion on reference point of UE transmit timing error | CMCC | discussion |
| R4-2109895 | Discussion for reply LS of UE transmit timing error | NEC |  |
| R4-2110415 | Propagation Delay Compensation Enhancements for Time Synchronization | Ericsson | discussion |
| R4-2110915 | Initial discussion on Rel-17 URLLC RRM | Huawei, HiSilicon | discussion |
| R4-2110916 | LS on the definition of Reference point for Te requirements | Huawei, HiSilicon | LS out |
| R4-2111153 | Work Plan for Enhanced IIOT and URLLC support | Nokia | Work Plan |
| R4-2111316 | LS response on UE transmit timing error | Ericsson, Nokia, Intel | LS out |

*List of candidate target of email discussion for 1st round and 2nd round*

* 1st round:
  + Initial work plan discussion
    - outcome goal: input to work plan.
  + Continue discussion related to ‘reference point’
    - outcome goal:
      * agreement on the reference point

Companies are invited to provide their views on the two aspects in Topic #1 and Topic #2 during the 1st round. Topic #2 is split into smaller specific parts in order to reach consensus on the basic foundation of the discussion.

Based on the input from the companies in 1st round, a work plan can be made drafted and potential agreement related to the reference point and Reply LS can be initiated in the 2nd round.

* 2nd round:
  + Work plan agreement
  + LS agreement
  + CR agreement

# Topic #1: Work Plan

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2110415 | Ericsson | Tdoc Title: Propagation Delay Compensation Enhancements for Time Synchronization  Proposal 1: RAN4 to pursue one set of Rel-17 enhancement to satisfy the accuracy requirement of propagation delay compensation for all use cases.  Observation 1: Work in Rel 17 should also be flexible and allow methods that can scale and target future requirements that may be more strict.  Observation 2: None of the TA-based options can satisfy the accuracy requirement range for the control-to-control use case when agreed values for the error components are used.  Observation 3: Reducing T\_e from 391ns to a substantially smaller value for the TA-based method is expected to require the UE to make use of a specialized downlink Reference Signal for clock synchronization (e.g. PRS)  Observation 4: Reducing Err\_TAG from 260ns to a substantially smaller value for the TA-based method is expected to require the gNB to make use of a specialized uplink Reference Signal (e.g. a wideband SRS).  Observation 5: The introduction of specialized reference signals for determining PD values with a substantially reduced uncertainty effectively calls for a new procedure and new signalling, to exchange information, that is distinct from the TA-based propagation delay method for determining PD.  Observation 6: None of the TA-based options can satisfy the high end of the accuracy requirement range for the control-to-control use case even if values for the two largest error components are aggressively reduced from their current values.  Observation 7: The introduction of reference signals needed to determine PD values with acceptable uncertainty within the context of a TA-based method effectively calls for a procedure, and new signalling, that is new and distinct from existing TA-based methods.  Proposal 2: RAN1 does not adopt the current TA-based method for determining propagation delay compensation since even a 75% reduction of the two largest uncertainty components (i.e. T\_e = 391 ns and Err\_TAG = 260 ns for 15 kHz SCS) does not result in a total uncertainty ±275ns or less for a single Uu interface.  Observation 8: A pessimistic estimate using worst case PRS bandwidth (24 PRB) and coarsest granularity (16 ns) show that RTT based method is better than an optimized budget for the TA based approach and certainly much better than the baseline estimate, assuming no optimizations.  Observation 9: RTT-based propagation delay estimation can satisfy the tighter Uu interface budget of ±145ns to ±275ns for control-to-control use case.  Observation 10: The RTT based approach to Propagation Delay Compensation is accurate, flexible, more readily available, hence the RTT based approach can be tuned and adapted flexible dependent actual needs and flexible to meet stricter future requirements.  Proposal 3: The WI adopts an RTT-based procedure for propagation delay compensation in Rel-17. |
| R4-2110915 | Huawei, HiSilicon | Tdoc Title: Initial discussion on Rel-17 URLLC RRM  Proposal 1: RAN4 does not need to define any requirement for PDC based on existing Rel-15/Rel-16 TA procedure and associated granularity.  Proposal 2: RAN4 to wait for RAN1 conclusions on enhanced PDC, and can consider to define requirements for the new measurements if they are introduced by RAN1. |
| R4-2111153 | Nokia, Nokia Shanghai Bell | Tdoc Title: Work Plan for Enhanced IIOT and URLLC support  Observation 1: RAN4 may need to discuss if new minimum BS demodulation performance requirements are needed for PUCCH sub-slot repetition considering all PUCCH formats and for PUCCH multi-slot repetition for the short formats (formats 0 and 2) if it is agreed from RAN1.  Observation 2: RAN4 will need to discuss the impacts on UE behavior, including possible new reporting quantities, new test cases and the corresponding UE demodulation performance requirements for the CSI feedback enhancement Case 2 and Case 1 (if bullet 1 or 2 is agreed from RAN1).  Observation 3: The TU allocation for NR\_IIOT\_URLLC\_enh-Perf at [3] does not reflect that the completion date has been postponed for three RAN plenary meetings and therefore, the TU allocation for NR\_IIOT\_URLLC\_enh-Perf should be updated and the start date can be April 2022 RAN4 #102bis.  Observation 4: RAN4 may need to investigate carrier switching delay, and any UE requirements of switching carrier for HARQ-ACK transmission. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

*In the contributions several questions have been discussed. Based on these a number of observations and proposals have been made.*

*To reduce the RAN4 discussion time it is proposed to focus on proposals which are within the RAN4 scope. Hence following proposals will not be discussed (R4-2110415):*

* *Proposal 2: RAN1 does not adopt the current TA-based method for determining propagation delay compensation since even a 75% reduction of the two largest uncertainty components (i.e. T\_e = 391 ns and Err\_TAG = 260 ns for 15 kHz SCS) does not result in a total uncertainty ±275ns or less for a single Uu interface*
* *Proposal 3: The WI adopts an RTT-based procedure for propagation delay compensation in Rel-17.*

*The proposals are seen to be targeted the RAN1 part of the WI.*

*Following 3 proposals will be discussed:*

* *Proposal 1: RAN4 to pursue one set of Rel-17 enhancement to satisfy the accuracy requirement of propagation delay compensation for all use cases.*
* *Proposal 1: RAN4 does not need to define any requirement for PDC based on existing Rel-15/Rel-16 TA procedure and associated granularity.*
* *Proposal 2: RAN4 to wait for RAN1 conclusions on enhanced PDC, and can consider to define requirements for the new measurements if they are introduced by RAN1.*

### Sub-topic 1-1

*Sub-topic description:*

# Topic #1: Reference Point

*Main technical topic overview. The structure can be done based on sub-agenda basis.*

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2110850 | MediaTek Inc. | Tdoc Title: Discussion on the reference point for the UE transmit timing error  Observation 1: Using the first detected path as reference point results in downlink frame timing detection error being not included in UE transmit timing error (i.e. Te). This contradicts the RAN4 common understanding, which is the downlink frame timing detection error is already included in UE transmit timing error.  Observation 2: Using the true arrival time at UE as the reference point for UE transmit timing error (i.e. Te) results in the DL frame timing detection error being included in the Te, which aligns with RAN4 common understating.  Observation 3: The UE is only capable of detecting the true arrival time for sufficiently high SINR, and hence the UE should follow the Te requirement for the SINR above that threshold only.  Proposal 1: Support studying and modifying the definition of the reference point in section 7.1.2 in TS 38.133 to reflect that the downlink frame timing detection error is already included in UE transmit timing error (i.e. Te).  Proposal 2: Support using the true arrival time at UE as the reference point for UE transmit timing error (i.e. Te).  Proposal 3: Support re-writing the second paragraph in section 7.1.2 in TS 38.133 as:  The UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available at the UE during the last 160 ms. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus time (N\_TA+N\_TAoffset)×T\_c. The downlink timing is defined as the true arrival time at UE of the corresponding downlink frame is received from the reference cell. NTA for PRACH is defined as 0.  Proposal 4: Support creating a side condition section in Annex B in TS 38.133 for timing requirements to clarify when the UE can detect the true arrival time. The condition is:  SSB\_RP and SSB Ês/Iot according to Annex B.x.y for a corresponding Band. |
| R4-2109223 | Intel Corporation | Tdoc Title: Discussion on IIoT and URLLC enhancement in RRM  Observation 1: Since there is no way for a UE to know the DL frame timing detection error, it has no choice but to simply use the perceived timing.  Observation 2: Test equipment verify the UE transmit timing by comparing the received timing against the transmitted DL signal timing.  Observation 3: Although there is no clear requirement specified for DL timing detection error, the UE needs to be good enough to cover detection error in Te to pass the tests.  Proposal: Further reply to RAN1 about the correct interpretation for them to take:   * Correct interpretation is that the UE takes the first detectable DL path as the reference point to apply (NTA + NTA\_offset) ×Tc * Since there is no way for the UE to know the ‘true arrival timing’, RAN4 spec specifies the correct UE behaviour |
| R4-2109495 | CMCC | Tdoc Title: Discussion on reference point of UE transmit timing error  Proposal 1: The interpretation of “the reference point” defined in section 7.1.2 in TS 38.133 for UE transmission timing is ahead of the first path (in time) of the corresponding downlink frame is received from the reference cell at the UE antenna. |
| R4-2109895 | NEC | Tdoc Title: Discussion for reply LS of UE transmit timing error  Proposal 1: “the reference point” defined in section 7.1.2 in TS 38.133 is  ahead of “first detected path (in time) of the corresponding downlink frame”. |
| R4-2110916 | Huawei, HiSilicon | Tdoc Title: LS on the definition of Reference point for Te requirements  Observation 1: The “reference point” in clause 7.1.2 of 38.133 is for “ideal UL timing” instead of “actual UL timing”. If the “reference point” is defined based on “detected path”, then the DL timing detection error is not included in Te.  Observation 2: For testing, the “ideal UL timing” is derived based on transmit timing of TE, which is effectively the arrival time of the first path.  Observation 3: The current wording for the definition of the “reference point” in 38.133 is confusing.  Proposal 1: Update the definition of the “reference point” in clause 7.1.2 of 38.133 from Rel-15:  “The downlink timing is defined as the time when the first detectable path (in time) of the corresponding downlink frame from the reference cell arrives at the UE antenna.”  Proposal 2: Send LS to inform RAN1 about the updated definition of the “reference point”. |
| R4-2111316 | Ericsson, Nokia, Intel | TDoc Title: LS response on UE transmit timing error   * Observation 1: The term first “detected path” (in time) in the definition of the reference point for timing error control requirement in section 7.1.2 in TS 38.133 is subject to misinterpretation and confusion. The power of the SSB’s first detected path in time is measured at the UE antenna. * Observation 2: The UE timing error requirement in section 7.1.2 in TS 38.133 is generic and are met for serving cell which has reasonably higher SINR e.g. ≥ -3 dB. * Proposal #1: Preferred reference point definition for timing error control requirement is as follows:   + *The interpretation of “the reference point” defined in section 7.1.2 in TS 38.133 for UE transmission timing is (NTA + NTA offset)\*Tc ahead of the time of arrival of the first detectable path at the UE antenna*. ​ * Proposal #2: If proposal # 1 is not acceptable then compromise proposal of reference point definition is:   + *The interpretation of “the reference point” defined in section 7.1.2 in TS 38.133 for UE transmission timing is   (NTA + NTA offset)\*Tc ahead of the time when the first path (in time) is received from the reference cell at the UE antenna*. |

## Open issues summary

*Before e-Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

*The discussion is related to the RAN1 LS received and discussed in RAN4#98bis. In the RAN4#98bis meeting RAN4 agreed on part of the question from RAN1:*

* *Is the downlink frame timing detection error included in UE transmit timing error (i.e. Te)?*

*RAN4 reached agreement on the issue and replied to RAN1:*

*RAN4 has the common understanding that downlink frame timing detection error is already included in UE transmit timing error (i.e. Te defined in section 7.1.2 in TS 38.133).*

*Meanwhile, it was also agreed that RAN4 will further discuss the reference point definition in the future to clarify the term. This topic is addressing the definition of the ‘reference point’ which is used currently used in 38.133, section 7.2:*

*The UE initial transmission timing error shall be less than or equal to ±Te where the timing error limit value Te is specified in Table 7.1.2-1. This requirement applies:*

*- when it is the first transmission in a DRX cycle for PUCCH, PUSCH and SRS, or it is the PRACH transmission, or it is the msgA transmission..*

*The UE shall meet the Te requirement for an initial transmission provided that at least one SSB is available at the UE during the last 160 ms. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the reference cell minus . The downlink timing is defined as the time when the first detected path (in time) of the corresponding downlink frame is received from the reference cell. NTA for PRACH is defined as 0.*

*Based on the input from the different companies there are following options proposed:*

* *use ‘true arrival time’ and define an additional condition when the UE shall be able to detect the true arrival time (MTK)*
* *use ‘first detectable DL path’ (Intel)*
* *add to current condition ‘at the UE antenna’ (CMCC)*
* *define ‘the reference point’ as ‘ ahead of “first detected path (in time) of the corresponding downlink frame”’ (NEC)*
* *use ‘The downlink timing is defined as the time when the first detectable path (in time) of the corresponding downlink frame from the reference cell arrives at the UE antenna.’ (Huawei)*
* *use: (Ericsson, Nokia, Intel)*
  + *option 1: “the reference point” defined in section 7.1.2 in TS 38.133 for UE transmission timing is (NTA + NTA offset)\*Tc ahead of the time of arrival of the first detectable path at the UE antenna.*
  + *option 2: The interpretation of “the reference point” defined in section 7.1.2 in TS 38.133 for UE transmission timing is   (NTA + NTA offset)\*Tc ahead of the time when the first path (in time) is received from the reference cell at the UE antenna.*

*From the proposals there are at least two aspect to discuss:*

1. *Which condition to use and the understanding of the condition used for the reference point/downlink timing:*
   1. *True arrival (with side conditions) at UE*
   2. *detectable by UE*
   3. *detected path by UE*
2. *Whether to additionally include the condition ‘at the UE antenna’*

*From the discussion in last meeting and from the company contributions in this meeting moderator propose to initially get an understanding that RAN4 is discussing the reception/arrival of the signal initial path at the UE, discuss the conditions when a signal can be understood as received/arrived at the UE and then (if these are agreeable) define the conditions.*

*Secondly it then needs to be discussed if the signal is received at the UE antenna connector.*

*Next sub-topics addresses each of these aspects.*

### Sub-topic 1-1

*Sub-topic description: First path arrival at the UE*

*Open issues and candidate options before e-meeting:*

*From all company proposals it seems clear that there is common understanding that RAN4 is* *discussing the reference point/downlink timing of the first path. How to define the first path will be discussed in next Sub-topic 1-2, but initially moderator propose to get common understanding that RAN4 is discussing the ‘first path’.*

**Issue 1-1:** **The reference point/downlink timing refer of the first path at the UE.**

* Proposals
  + Option 1: The reference point/downlink timing refer of the first path at the UE.
  + Option 2: Other.
* Recommended WF
  + More discussion needed.

### Sub-topic 1-2

*Sub-topic description: Define conditions and of the conditions for the reference point/downlink timing (first path)*

*Open issues and candidate options before e-meeting:*

*Based on the background and summary in section 2.2 there seem to be many companies which do prefer having a defined understanding of when the signal used as the reference point is received at the UE side. Companies use phrases ‘detected’, ‘detectable’ and ‘true arrival’ while it is not clear or agreed* *when the signal is understood to be ‘detectable’ or ‘detected’ by the UE or ‘truly arrived’ at the UE.*

*One proposed option is to use* *SSB\_RP and SSB Ês/Iot.*

**Issue 1-2: Define the conditions when is the signal is ‘detectable’ or ‘detected’ or ‘truly arrived’ at the UE.**

* Proposals
  + Option 1: Yes.
  + Option 2: No.
* Recommended WF
  + More discussion needed.

**Issue 1-3:** **The conditions when the signal is ‘detectable’ or ‘detected’ or ‘truly arrived’ at the UE.**

* Proposals
  + Option 1: When SSB\_RP and SSB Ês/Iot is better than [x]dB.
  + Option 2: Other.
* Recommended WF
  + More discussion needed.

### Sub-topic 1-3

*Sub-topic description: Signal is received/arrived at the UE antenna connector*

*Open issues and candidate options before e-meeting:*

A number of companies propose to clarify the reference point/downlink timing is defined as when the signal of the first path is received/arrives at the UE antenna.

**Issue 1-3: It should be clarified that the reference point/downlink timing refer to the signal of the first path being received/arrives at the UE antenna.**

* Proposals
  + Option 1: Yes.
  + Option 2: No.
* Recommended WF
  + More discussion needed.

## Companies views’ collection for 1st round

### Open issues

Sub topic 1-1, Issue 1-1: The reference point/downlink timing refer of the first path at the UE.

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 1-2, Issue 1-2: Define the conditions when is the signal is ‘detectable’ or ‘detected’ or ‘truly arrived’ at the UE

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 1-2, Issue 1-3: The conditions when the signal is ‘detectable’ or ‘detected’ or ‘truly arrived’ at the UE

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

Sub topic 1-3, Issue 1-4: It should be clarified that the reference point/downlink timing refer to the signal of the first path being received/arrives at the UE antenna

|  |  |
| --- | --- |
| **Company** | **Comments** |
| XXX |  |

### CRs/TPs comments collection

*For close-to-finalize WIs and maintenance work, comments collections can be arranged for TPs and CRs. For ongoing WIs, suggest to focus on open issues discussion on 1st round.*

|  |  |
| --- | --- |
| **CR/TP number** | **Comments collection** |
| R4-2111313 | CR Title: Correction to reference point defintion for UE timing in TS 38.133 (Rel-15) |
| Company A |
| Company B |
|  |

## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

|  |  |
| --- | --- |
|  | **Status summary** |
| **Sub-topic #1-1** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |
| **Sub-topic #1-2** | *Tentative agreements:*  *Candidate options:*  *Recommendations for 2nd round:* |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

*Note: The tdoc decisions shall be provided in Section 3 and this table is optional in case moderators would like to provide additional information.*

|  |  |
| --- | --- |
| **CR/TP number** | **CRs/TPs Status update recommendation** |
| XXX | *Based on 1st round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

## Discussion on 2nd round (if applicable)

# Recommendations for Tdocs

## 1st round

**New tdocs**

|  |  |  |
| --- | --- | --- |
| **Title** | **Source** | **Comments** |
| LS on … | ZZZ | To: RAN\_X; Cc: RAN\_Y |
|  |  |  |

**Existing tdocs**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics incl. existing and new tdocs.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. For new LS documents, please include information on To/Cc WGs in the comments column
4. Do not include hyper-links in the documents

## 2nd round

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Tdoc number** | **Title** | **Source** | **Recommendation** | **Comments** |
| R4-210xxxx | CR on … | XXX | Agreeable, Revised, Merged, Postponed, Not Pursued |  |
| R4-210xxxx | WF on … | YYY | Agreeable, Revised, Noted |  |
| R4-210xxxx | LS on … | ZZZ | Agreeable, Revised, Noted |  |
|  |  |  |  |  |

Notes:

1. Please include the summary of recommendations for all tdocs across all sub-topics.
2. For the Recommendation column please include one of the following:
   1. CRs/TPs: Agreeable, Revised, Merged, Postponed, Not Pursued
   2. Other documents: Agreeable, Revised, Noted
3. Do not include hyper-links in the documents