3GPP TSG-RAN WG3 Meeting #114bis-e draft R3-221071

Online, 17 – 26 January 2022

**Agenda item: 21.2**

**Source: Nokia (moderator)**

**Title: Summary of offline: Propagation delay compensation enhancements**

**Document for: Discussion and Decision**

# 1 Introduction

This paper summarizes the following email discussion:

**CB: # NRIIOT2\_PDC**

**- Continue the open issues left over NG, Xn and F1 interfaces**

**- A time distribution indication and/or a Uu time synchronization error budget are introduced over F1 interfaces?**

**- Whether the Time Synchronization Assistance Information IE needs to be included in the PATH SWITCH REQUEST ACKNOWLEDGE message of the NG?**

**- The CU can determine to enable/disable the PDC?**

**- Whether the target gNB needs to provide the UE with configuration information for RTT measurement during the handover, and discuss the RTT PDC Measurement procedure**

**- During the handover, what kinds of time synchronization assistance information should the source gNB notify the target gNB, e.g., Uncertainty, Time Information Type, TSN distribution, Periodicity, and Timestamp of last RTI…?**

**- Capture agreements and open issues**

**- TPs if agreeable**

(Nok - moderator)

Summary of offline disc [R3-221071](Inbox\R3-221071.zip)

# 2 For the Chair’s Notes

TBD

# 3 Discussion (Phase 1)

Please provide your Phase 1 views (7 questions) by **12:00 UTC Tuesday January 18th**, so that comments may be taken into account during the online discussion that day.

## 3.1 Time synchronization: F1AP open issues

At RAN3#114e, it was discussed if the IEs of *Time Synchronization Assistance Information* (i.e., *Uu Time Synchronisation Error Budget* and *Time Distribution Indication*) must be known by the gNB-DU to decide the reference time distribution to the UEs, e.g., determine the periodicity of SIB9 and/or provide appropriate reference time accuracy. The following working assumption was captured in the Chair’s Minutes:

**WA: The Uu Time Synchronisation Error Budget IE is needed over F1AP, details FFS.**

Overview of RAN3 papers:

- ZTE [1][2]: For unicast delivery, the gNB-CU can send the minimum Uu time synchronization error budget (e.g. the most rigorous budget) of multiple UEs to the gNB-DU (in REFERENCE TIME INFORMATION REPORTING CONTROL), and gNB-DU reports the reference time with the minimum budget based on the gNB-CU request. For broadcast delivery, Uu time synchronization error budget can be decided in gNB-DU by OAM.

- Nokia [5]: For broadcast delivery, the gNB-CU provides a “Cell Level Uu Time Synchronisation Error Budget” to the gNB-DU (in SYSTEM INFORMATION DELIVERY COMMAND), since the gNB-DU is responsible for determining the SIB9 periodicity. For unicast, there is no need for gNB-DU to know the error budget since the gNB-CU controls both the delivery and encoding of the DL RRC messages. Also, the need for SIB9 broadcast may change over time and thus a mechanism is needed over F1AP to enable the gNB-CU to request to stop an ongoing SIB9 broadcast.

- Samsung [10]: The time synchronization error budget should be delivered to the gNB-DU over F1AP (in REFERENCE TIME INFORMATION REPORTING CONTROL), and with the error budget, the gNB-DU can determine the periodicity of the reference time distribution by using broadcast RRC message.

- Huawei [11]: No need to introduce the Uu Time Synchronisation Error Budget in F1.

- CATT [13][14]: Use non-UE associated signalling to carry the Uu Time Synchronisation Error Budget IE in F1AP. i.e. REFERENCE TIME INFORMATION REPORTING CONTROL.

Moderator’s Summary:

There appears to be general consensus that the *Uu Time Synchronisation Error Budget* should be provided to the gNB-DU using non-UE associated signalling, implying also that it is a “cell level” error budget derived by the gNB-CU based on the error budgets of individual UEs. We note that [11] does not see the need to introduce the error budget over F1, but the analysis seems to focus on a different use case (PDC rather than RTI delivery).

However, company opinions diverge on which F1AP message to (re)use. This seems due to different understandings on the following points:

a) Is the Cell Level Uu Time Synchronisation Error Budget applicable for broadcast/SIB9 delivery (only), or unicast delivery (only), or both?

b) Does the Cell Level Uu Time Synchronisation Error Budget impact RTI delivery periodicity (only), the actual RTI content (only), or both?

Also, an issue is raised in [5] that accurate time synchronisation service can be actively enabled/disabled by the *Time Distribution Indication*, and therefore a mechanism may be needed to allow the gNB-CU to indicate to the gNB-DU that previously requested SIB9 broadcast is no longer needed.

Proposed way forward:

- WA: The gNB-CU determines a “Cell Level” Uu Time Synchronisation Error Budget value and provides it to the gNB-DU using non-UE associated signalling.

- Open Issue(s): Which F1AP message(s) to convey the Cell Level Uu Time Synchronisation Error Budget? Whether/how to enable the gNB-CU to stop ongoing broadcast/SIB9 delivery?

**Question 1: Can the following working assumption be agreed:**

WA: The gNB-CU determines a “Cell Level” Uu Time Synchronisation Error Budget value and provides it to the gNB-DU using non-UE associated signalling.

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| **Company** | **Comments** |
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| Moderator Summary:   * TBD | |

**Question 2: Please provide your views on the following open issues related to RTI delivery:**

a) Is the Cell Level Uu Time Synchronisation Error Budget applicable for broadcast/SIB9 delivery (only), or unicast delivery (only), or both?

b) Does the Cell Level Uu Time Synchronisation Error Budget affect RTI delivery periodicity (only), the actual RTI content (only), or both?

c) Which F1AP message(s)?

d) Whether/how to enable the gNB-CU to stop ongoing broadcast/SIB9 delivery?

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| **Company** | **Comments** |
| Nokia | * In our understanding, the Uu Time Synchronisation Error Budget only affects RTI delivery periodicity (no effect on any of the content of the RTI). * Since RTI delivery periodicity is determined by the DU only for the case of broadcast/SIB9 delivery, the error budget only needs to be signalled to the DU when the CU decides to initiate or modify SIB9 broadcast (therefore in the SYSTEM INFORMATION DELIVERY COMMAND). * The error budget is not needed in the REFERENCE TIME INFORMATION REPORTING CONTROL unless RAN3 determines that the DU needs the error budget also for unicast delivery (e.g. error budget affects the actual RTI content). * A mechanism is needed to enable the gNB-CU to indicate to the gNB-DU that previously requested SIB9 broadcast is no longer needed. |
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## 3.2 Time synchronization: NGAP open issues

The following agreement was previously captured in the Chair’s minutes:

**Introduce the Time Synchronisation Assistance Information IE as an optional UE-level parameter in**

**- NGAP (INITIAL CONTEXT SETUP REQUEST, UE CONTEXT MODIFICATION REQUEST, HANDOVER REQUEST, and PATH SWITCH REQUEST ACKNOWLEDGEMENT [FFS]),**

Nokia [5] and CATT [13] propose to drop the above FFS to allow the *Time Synchronisation Assistance Information* IE to be included also in the PATH SWITCH REQUEST ACKNOWLEDGEMENT.

**Question 3: Can the following be agreed (i.e. dropping FFS):**

**Introduce the Time Synchronisation Assistance Information IE as an optional UE-level parameter in PATH SWITCH REQUEST ACKNOWLEDGEMENT.**

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| **Company** | **Comments** |
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| Moderator Summary:   * TBD | |

## 3.3 Time synchronization: XnAP open issues

The following are the relevant agreements / open issues already captured in the Chair’s minutes:

**Introduce the Time Synchronisation Assistance Information IE as an optional UE-level parameter in**

**- XnAP (HANDOVER REQUEST and RETRIEVE UE CONTEXT RESPONSE)**

**It is FFS on whether assistance information (e.g., UE TSN timing reference, referenceTimeInfo delivery periodicity, timestamp) should be delivered during HO.**

This is a continuation of discussion from previous meetings, where two use cases were identified for passing additional assistance information from source to target:

**Use Case #1**: Assist the target gNB in deciding the RTI delivery configuration.

**Use Case #2**: Assist the target gNB in determining the level of urgency/reliability to deliver the first RTI following handover.

Overview of RAN3 papers:

- Ericsson [3][4]: It is beneficial for the target gNB to know the UE’s TSN time reference information used in the source gNB as early as possible during NG and Xn Handover. Therefore, the TSN Time Reference Information (Uncertainty, Time Information Type, TSN distribution, and Periodicity) should be included in the HANDOVER REQUEST message.

- Nokia [6]: To support target gNB in determining the level of urgency/reliability to deliver the first RTI following handover, source gNB provides the timestamp when, at the latest, the next RTI needs to be delivered to the UE in the HANDOVER REQUEST.

- Huawei [11][12]: The RTI configuration in the source can be used by the target gNB to determine the suitable time sync deliver mode and deliver period after the handover completion. Therefore, the source gNB sends the RTI delivery periodicity for UE to the target gNB during handover.

Moderator’s Summary:

For Use Case #1, the following information is proposed:

- Uncertainty [4]

- Time Information type [4]

- TSN distribution (i.e. broadcast or unicast) [4]

- Periodicity of RTI delivery [4][12]

For Use Case #2, the following information is proposed:

- Timestamp when, at the latest, the next RTI needs to be delivered to the UE [6]

Proposed way forward:

- RAN3 to further discuss whether use cases are acknowledged, and if so, what (if any) additional information is needed during handover.

**Question 4: Please provide your views on the following open issues:**

a) Is use case #1 acknowledged (yes/no)? If so, what additional information (if any) is needed during handover (e.g. uncertainty, time information type, TSN distribution, and/or periodicity)?

b) Is use case #2 acknowledged (yes/no)? If so, what additional information (if any) is needed during handover (e.g. timestamp)?

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| **Company** | **Comments** |
| Nokia | Use Case #1: Yes, but no additional info needed. When time synchronisation service is first initiated, the gNB determines the RTI delivery configuration based on the Time Synchronisation Assistance Information (i.e. Uu Time Synchronisation Error Budget) received from the CN over NGAP. Since RAN3 has already agreed that Time Synchronisation Assistance Information is passed from source to target during HO, the target gNB can determine the RTI delivery configuration on its own using the same information that was available at the source.  Use Case #2: Yes. The target gNB must always assume RTI must be delivered immediately and with high reliability after HO, unless source gNB provides timestamp when (at the latest) the next RTI needs to be delivered to the UE. |
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## 3.4 gNB-based PDC (network pre-compensation)

The latest progress in other groups is captured in [11] as follows (extracting the most relevant parts):

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| R1#107-e  **Conclusion:**  Leave it to RAN2 to decide whether to support UE based compensation and/or gNB based compensation for any propagation delay compensation method RAN1 may adopt for Rel-17, if applicable.  For Rel-17   * Support RTT-based PDC method * Support PDC method based on legacy TA-based mechanism   + No RAN1/RAN4 specification impact expected   For RTT-based propagation delay compensation, the Rx-Tx time difference is reported via RRC signaling. |
| R2#115e  1 RAN2 assumes that gNB can perform pre-compensation. RAN2 agrees to introduce signalling to enable/disable UE-side PDC.  R2#116e  1 The gNB can enable/disable UE-side PDC via unicast and broadcast RRC signalling.  2 A new RRC parameter can be introduced to explicitly enable/disable UE-side PDC |

Overview of RAN3 papers:

- ZTE [1]: During the handover process, the RTT measurement cannot be performed immediately because the relevant resource of the target gNB is not configured. In order to meet the handover time requirements of some services, RAN3 should consider whether the target gNB needs to provide the UE with the configuration information for RTT measurement during the handover.

- Ericsson [7]: For the case where E-CID measurements with “NR Timing Advance” have been started by the LMF, the gNB-CU can make use of the existing E-CID measurement when computing TA for PDC. However, for other cases a new F1AP procedure (e.g. “RTT PDC Measurement Initiation” procedure) is needed to enable the gNB-CU to trigger reporting of NR Timing Advance measurements.

- Samsung [8][9]: For the network pre-compensation for the PDC, the gNB should provide UE-specific time reference information because the pre-compensated time reference value would be different on UE’s time synchronization capability and location. Therefore, new UE-associated F1AP procedures (e.g. “Compensated Reference Time Information Reporting Control” and “Compensated Reference Time Information Report” procedures) are needed to enable reporting of network pre-compensated RTI.

- Huawei [11]: The gNB-CU determines to enable/disable gNB-based pre-compensation. For TA-based PDC, add a list of UEs in the REFERENCE TIME INFORMATION REPORTING CONTROL message, and then the REFERENCE TIME INFORMATION REPORT message can include the TA-based compensated reference time information for these UEs. For RTT-based PDC, the gNB-CU must request the gNB-DU to report the UL Rx-Tx time difference. Then depending on whether the pre-compensation is performed at UE or gNB, the gNB-CU sends to the UE the UL Rx-Tx time difference or the pre-compensated RTI, respectively, via unicast RRC message.

Moderator’s Summary:

Since this is the first meeting to discuss details of gNB-based PDC, the moderator would like to recommend that RAN3 first focus on F1AP impacts and postpone discussion of possible XnAP (handover) impacts to next meeting.

It is proposed in [11] that the gNB-CU determines to enable/disable gNB-based pre-compensation, which seems potentially agreeable.

Also, there seems to be consensus that new F1AP procedure(s) are needed to support network pre-compensation. However, there are different proposals for what the procedure(s) should actually do.

In case of TA-based PDC:

a) gNB-DU reports UE-specific TA value (i.e. pre-compensation is performed by the gNB-CU) using new UE-associated procedure(s) [7]

b) gNB-DU reports UE-specific pre-compensated RTI (i.e. pre-compensation is performed by the gNB-DU) using new UE-associated procedure(s) [8][9]

c) gNB-DU reports UE-specific pre-compensated RTI re-using non-UE associated Reference Time Information Reporting Control and Reference Time Information Reporting procedure(s) [11]

In case of RTT-based PDC:

d) gNB-DU reports UE-specific UL Rx-Tx time difference using new UE-associated procedure(s) [11]

Three companies propose new UE-associated procedures, while one company proposes to re-use existing non-UE associated procedures to carry UE-specific information. It seems more appropriate that UE-specific information is carried in UE-associated signalling which is also the majority view, so perhaps this can be taken as a working assumption with further details to be discussed.

Proposed way forward:

- It is the gNB-CU that decides to enable/disable gNB-based pre-compensation.

- WA: Introduce new UE-associated F1AP procedure(s) to support gNB-based pre-compensation. Details FFS.

- Open Issue(s): What information is reported by the gNB-DU to the gNB-CU?

**Question 5: Can the following be agreed:**

**It is the gNB-CU that decides to enable/disable gNB-based pre-compensation.**

**WA: Introduce new UE-associated F1AP procedure(s) to support gNB-based pre-compensation. Details FFS.**

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| **Company** | **Comments** |
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**Question 6: For TA-based PDC at the gNB, should the pre-compensation be performed by the**

**a) gNB-DU**, e.g., DU reports compensated RTI via a new UE-associated F1AP procedure; or

**b) gNB-CU**, e.g., DU reports TA value via a new UE-associated F1AP procedure, and (uncompensated) RTI via the legacy Reference Time Information Reporting procedure?

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| **Company** | **Comments** |
| Nokia | (b) has the benefit of enabling the gNB-CU to know whether TA value has changed, and whether multiple UEs have TA value in common. This could allow more accurate and efficient updating of the RTI. For example, if TA is being reported periodically and the TA value changes, it could trigger gNB-CU to provide immediate update of RTI to the UE. Or if multiple UEs have same TA value, then the broadcast RTI can be compensated by this value while unicast RTI is sent only to small number of UEs having different TA value. |
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**Question 7: For RTT-based PDC (at either the UE or gNB), do you agree that gNB-DU reports gNB Rx-Tx time difference to gNB-CU (yes/no)? Any other impacts?**

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| **Company** | **Comments** |
| Nokia | Yes. Other impacts (if any) can be discussed after further progress in RAN2 (e.g. whether RTT-based PDC is supported at gNB). |
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# 4 Discussion (Phase 2), if needed

TBD

# 5 Conclusions, Recommendations

TBD

# References

1. R3-220227, Remaining issues on Time Synchronization enhancements (ZTE)
2. R3-220228, (TP for Introduction of Enhanced IIoT support over F1) Time Synchronization enhancements (ZTE)
3. R3-220337, Discussion on Further enhanced NR-IIoT: Enhancements for support of time synchronization (Ericsson)
4. R3-220338, Enhancements for support of time synchronization (Ericsson)
5. R3-220367, (TP for NR\_IIOT\_URLLC\_enh BL CR for TS 38.473) Time synchronization open issues (Nokia, Nokia Shanghai Bell)
6. R3-220368, (TP for NR\_IIOT\_URLLC\_enh BL CR for TS 38.423) Time synchronization and handover (Nokia, Nokia Shanghai Bell)
7. R3-220616, Discussion on PDC TA based and E-CID measurement (Ericsson)
8. R3-220646, (TP for NR\_IIOT\_URLLC\_enh BL CR for TS 38.473) Discussion on supporting the network pre-compensated PDC (Samsung)
9. R3-220647, (TP for NR\_IIOT\_URLLC\_enh BL CR for TS 38.470) Supporting the network pre-compensated PDC (Samsung)
10. R3-220648, (TP for NR\_IIOT\_URLLC\_enh BL CR for TS 38.473) Discussion on the time synchronization error budget over F1AP (Samsung)
11. R3-220652, (TP for eIIOT BLCR for TS 38.473) Supporting propagation delay compensation enhancements (Huawei)
12. R3-220653, (TP for eIIOT BLCR for TS 38.423) Supporting propagation delay compensation enhancements (Huawei)
13. R3-220940, Discussion on Propagation Delay Compensation Enhancements (CATT)
14. R3-220941, TP for BLCR for 38.473 on Propagation Delay Compensation Enhancements (CATT)R3-220094, LS on updated Rel-17 LTE and NR higher-layers parameter list (RAN1)