3GPP TSG-RAN WG3 Meeting #113-e R3-214186

Online, 16 – 26 Aug 2021

**Agenda item: 21.2**

**Source: ZTE (moderator)**

**Title: Summary of offline: NRIIOT2-PDC**

**Document for: Discussion and Decision**

# 1 Introduction

This paper summarizes the following email discussion:

**CB: # NRIIOT2\_PDC**

**- During the handover, what kinds of time synchronization assistance information should the source gNB notify the target gNB, e.g., the time synchronization accuracy budget; the estimated time synchronization accuracy of the UE or the referenceTimeInfo periodicity; the timestamp associated with the latest RTI sent to the UE; the reference time synchronization requirements for one-way transmission, the Time synchronization error budget…?**

**- For enhancements for support of time synchronization, the UE mobility does not impact the RAN3 specification?**

**- The time synchronization assistance information IE is introduced over NG, Xn and F1 interfaces?**

**- The details for the time synchronization assistance information should be discussed after further progress in SA2?**

**- Capture agreements and open issues**

**- TPs if agreeable**

(ZTE - moderator)

Summary of offline disc in [R3-214186](file:///D%3A%5C3GPPmeeting%5C202108%20RAN3%20113e%5CCB%5CInbox%5CR3-214186.zip)

# 2 For the Chairman’s Notes

Propose to capture the following:

1. The time synchronization error budget needs to be delivered over NG and Xn, it is FFS over F1.
2. For the time synchronization error budget, it is FFS for which level (e.g., UE level, PDU session level, or QoS flow level) and for its details (e.g., parameter name, parameter meaning, and value range)
3. The *referenceTimeInfoPreference* delivery is already supported in XnAP and F1AP.
4. The referenceTimeInfoPreference could be delivered during HO in RRC container when it is available.
5. It is FFS on whether assistance information (e.g., UE TSN timing reference, referenceTimeInfo delivery periodicity, timestamp) should be delivered during HO.
6. No TP is needed in this meeting.

# 3 Discussion (Phase 1)

At RAN3#112e, the following open issue for PDC was captured in the Chair’s Minutes:

**Wait for RAN2/SA2 decision on Time Synchronization assistance parameters before further discussing in RAN3.**

**Further discuss assistance information that may be useful for the target gNB to maintain timing accuracy required by the UE following handover, focusing on RAN3 aspects if any issue identified.**

In this meeting, papers are provided further to discuss the assistance information for PDC.

Overview of papers:

The papers mainly discuss the assistance information for PDC in the following two aspects:

**For time synchronization error budget information**

- ZTE [1]: In the UE mobile scenario, in view of the different synchronization budgets and reference time synchronization requirements of the two scenarios, the source gNB indicates to the target gNB the reference time synchronization requirements (control-to-control or smart grid) for one-way transmission through the Handover request. The target gNB adopts different configuration strategies based on different time synchronization budgets to achieve the goal of energy saving.

- Nokia [5] thinks that a time synchronization accuracy budget is provided by the CN and can be passed from the source gNB to the target gNB.

- Huawei [6] thinks that RAN3 can further discuss whether this assistance information can be UE level, PDU session level or QoS flow level upon confirmation from other groups.

- CATT [9] thinks that the time synchronization error budget needs to be included in the QoS flow parameters.

- Samsung [8]: RAN2 has discussed and concluded that RAN2 sees some benefits to having this information. However, SA2 hasn’t made consensus or agreed CR for the time synchronization assistance information yet. So, the time synchronization assistance information IE is introduced over NG, Xn and F1 interfaces. The details for the time synchronization assistance information should be discussed after further progress in SA2.

Moderator’s Summary and Proposal:

Some of the related contributions propose to deliver the time synchronization budget information over NG, Xn, F1 interface, and other contributions discuss the time synchronization budget information delivery level (e.g. UE level, PDU session level, or QoS flow level). But all contributions do not provide the details about the the time synchronization budget information (e.g. parameter name, parameter meaning, and value range), and there is not RAN2/SA2 decision yet on Time Synchronization assistance parameters.

**Question 1: Do companies confirm that the time synchronization error budget needs to be delivered over NG, Xn and** **F1 interface?**

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| **Company** | **Yes/No** | **Comments** |
| ZTE | Yes | We think that the core network needs to send the time synchronization error budget to the gNB over NG interface so that gNB can adopt different configuration strategies for RTI according to different time synchronization error budget.With the same reason as that in NG interface, the source gNB needs to deliver the time synchronization error budget to the target gNB during HO (e.g. over NG or Xn interface).Since the RTI information is set in DU, with the same reason as that in NG interface, the time synchronization error budget should also be delivered from gNB-CU to gNB-DU over F1 interface. |
| Nokia | Yes | RAN2 has concluded that there are benefits to have time synchronization error budget signaled from CN to RAN, therefore we anticipate that this will be agreed by SA2. However, details such as granularity of the information are still pending RAN2/SA2. |
| Huawei | Yes | We agree the NG/Xn impact. And for F1 impact, this may be dependent on which nodes performs PDC, and which PDC solution is agreed, which is being discussed in other groups. About the granularity of the synchronization error budget, we agree with Nokia that this should be pending RAN2/SA2.  |
| Samsung | Yes | RAN2 sees some benefits to having the time synchronization error budget information from 5GC. However, the details for the time synchronization assistance information should be discussed after further progress in RAN2/SA2. |
| CATT | Yes | If RAN2 decide to use it. RAN3 should include this parameter in the QoS flow. The detail will be pending on SA2 |
| Ericsson |  | This can wait for further progress by SA2/RAN2. |

**Summary:**

6 companies provided inputs to this question.

5 companies confirm that the time synchronization error budget needs to be delivered over NG and Xn.

1 companies think that whether the time synchronization error budget needs to be delivered over F1 depends on which nodes performs PDC, and which PDC solution is agreed

4 companies confirm that the details should be pending on SA2.

1 company suggest to wait for further progress by SA2/RAN2.

**Proposal 1: The time synchronization error budget needs to be delivered over NG and Xn, the details is FFS. It is FFS over F1.**

**Question 2: What level do companies prefer to deliver** **the time synchronization error budget, if necessary?**

**Option 1: UE level**

**Option 2: PDU session level**

**Option 3: QoS flow level**

**Option 4: others**

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| **Company** | **Option** | **Comments** |
| ZTE | Option3 | Since the time synchronization error budget is used for RTI decision, and the RTI is mainly for TSC service, the time synchronization error budget should be delivered with the same level as that for *TSC Traffic Characteristics*.Considering that the *TSC Traffic Characteristics* is delivered with QoS flow level, the time synchronization error budget should also be delivered with QoS flow level. |
| Nokia |  | At last RAN3 meeting, it was agreed to “wait for RAN2/SA2 decision on Time Synchronization assistance parameters before further discussing in RAN3”. Therefore, it seems premature to discuss further details of the CN to RAN signaling at this meeting.However, we would like to point out that SA2 has not linked time synchronization information to TSC service. Although the information is certainly useful for TSC service, there is no need to preclude usage of time synchronization information by other (non-TSC) services. |
| Huawei | Decided by other groups | This should be determined by other groups. Currently we think option 1 is sufficient.  |
| Samsung |  | We also think RAN3 should wait for further progress in RAN2/SA2.  |
| CATT | Option 3 | QoS flow is reasonable. Agree with above, we may wait the detail coming from other team.  |
| Ericsson |  | This can wait for further progress by SA2/RAN2. |

**Summary:**

6 companies provided inputs to this question.

2 companies prefer to wait for further progress in RAN2/SA2.

**Proposal 2:** **Wait for further progress in RAN2/SA2 for the time synchronization error budget delivery level.**

**Question 3: For the details about the the time synchronization budget information (e.g. parameter name, parameter meaning, and value range), do companies agree to further wait the RAN2/SA2 conclusion?**

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| **Company** | **Yes/No** | **Comments** |
| ZTE | Yes  | Wait for RAN2 and SA2 decision. |
| Nokia | Yes | This was already captured as an agreement at RAN3#112. |
| Huawei | Yes |  |
| Samsung | Yes |  |
| CATT | Yes |  |
| Ericsson |  | This can wait for further progress by SA2/RAN2. |

**Summary:**

6 companies provided inputs to this question and all companies agree to wait the RAN2/SA2 conclusion.

**Proposal 3: For the time synchronization error budget, it is FFS for its details (e.g., parameter name, parameter meaning, and value range).**

**For the referenceTimeInfo(RTI) related information delivery during HO**

Two companies think that UE mobility does not impacts RAN3 specification on RTI related information delivery:

- ZTE [1] thinks that there is no RAN3 impact due to UE mobility, with the assumption that any information need to be exchanged between source and target can be carried within RRC containers.

- CATT [9] thinks that there is no optimization needed for the time synchronization during handover based on the following RAN2 assumptions:

**Assumptions:**

- There is no UE clock drift issue to be addressed

- The source and target gNB are tightly synchronized to the same master clock within the budget and there is no need to optimize anything for HO.

**Agreements**

- gPTP message interruption during mobility is not considered in the Rel-17 IIoT WI (i.e. no further specification impact are considered)

There companies think that UE mobility impacts RAN3 specification on RTI related information delivery:

- Ericsson [2]: After a successful handover, there is delay for the target NG-RAN node to deliver Reference Time Information (RTI) to the UE, not only because the propagation delay from the target to the UE is different than from the source to the UE, but also because of the time it takes for the target to prepare the information comprising the reference time. In the disaggregated deployment, the CU needs to extract the time reference information from the DU. Therefore, it is beneficial for the target NG-RAN node to know that a UE TSN timing reference (e.g. Uncertainty, Time Information Type, TSN distribution, and Periodicity) used in the source NG-RAN node as early as possible during NG [3] and Xn [4] Handover.

- Nokia [5]: After the UE establishes the connection to the target gNB, the target gNB needs to determine a Reference Time Information (RTI) configuration that will satisfy the timing accuracy required by the UE. This requires the target gNB to appropriately configure time synchronization parameters, and potentially also handover parameters that can reduce the handover interruption time. During handover, the source gNB provides the target gNB with the following assistance information: 1) the time synchronization accuracy budget; 2) the estimated time synchronization accuracy of the UE or the referenceTimeInfo periodicity; and 3) the timestamp associated with the latest RTI sent to the UE. Through the above information, the target gNB derives the current accuracy of the UE clock with the help of some formulas.

- Huawei [6]: During the inter-gNB handover procedure, the target gNB needs to know whether the UE needs the time sync and the 5G synchronisation time period needed by UE, so as to timely send the 5G sync time to UE to meet the time sync accuracy. The Reference Time Information configuration in the source gNB is useful for the synchronisation time configuration reference by the target RAN, it can help the target gNB determine the suitable time sync deliver mode (e.g. broadcast/unicast mode) and deliver period after the NG [7] and Xn [6] handover completion.

Moderator’s Summary and Proposal:

There are divergence for the RTI related information delivery and need to be further discussed, e.g. what information should be delivered, and whether RAN 3 specification will be impacted.

**Question 4: What RTI related information do companies agree to deliver during HO?**

**Information 1: UE TSN timing reference (e.g. Uncertainty, Time Information Type, TSN distribution, and Periodicity) used in the source NG-RAN node**

**Information 2: The estimated time synchronization accuracy of the UE or the referenceTimeInfo delivery periodicity.**

**Information 3: The timestamp associated with the latest RTI sent to the UE.**

**Information 4: *referenceTimeInfoPreference* from UE in *UEAssistanceInformation* message to indicate whether the UE prefers being provisioned with the timing information specified in the IE *ReferenceTimeInfo*.**

**Information 5: others.**

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| **Company** | **Information** | **Comments** |
| ZTE | **Information 4** | We think that *referenceTimeInfoPreference* is necessary for the target gNB to decide whether RTI will be send to UE.Based on the RAN2 specification, only *referenceTimeInfoPreference* is provided from UE to gNB, only the *referenceTimeInfoPreference* should be delivered to target gNB during HO. |
| Nokia | Others | We should first gain a common understanding of why it is useful to transfer assistance information during handover. In our understanding, two different use cases have been proposed which may require different assistance information:1. Assist target in determining RTI delivery configuration, e.g. according to [2][6] target gNB uses the same RTI configuration as the source gNB? (to be confirmed by proponents)
2. Assist target in determining the level of urgency/reliability to deliver the first RTI following handover [5]. Without assistance information, it seems necessary for the target to deliver the first RTI with highest level of urgency/reliability in order to satisfy the UE’s timing requirements (since target would not know how much time has elapsed since the last RTI was delivered to the UE), which leads to inefficient utilization of radio resources at the target.

In our understanding, **Periodicity (and possibly time synchronization error budget from Question 1) are the common denominators between the two use cases**, but then each use case may benefit from additional information as proposed in [2][5][6]. For example, **use case #2 would additionally benefit from the timestamp associated with the latest RTI sent to the UE**. |
| Huawei | Information 2.  | As proponent of 1 (in the above table), we think that the Reference Time Information configuration at the source node, e.g. the synchronisation time period, broadcast/unicast mode can be used as **the reference** for the synchronisation time configuration by the target node (not necessarily the same). Typically, * Synchronisation time period determined by the source already takes the UE synchronization requirements into account, e.g. based on the UE assistance information. This is beneficial for the target node to configure the period for the handover UE.
* Broadcast/unicast mode can be considered as reference by the target node to determine whether to broadcast/unicast RTI to the UE.

About information 3, it seems not very necessary since the target node can immediately send the message to the UE after the UE accesses the target node. But we are open for further discussion. Information 4 is already possible in RAN2 specification. Again, here information 2 is to be used to provide reference for the subsequent synchronization time configuration by the target node.  |
| Samsung |  | We’re not sure yet whether the RTI configuration in the source node needs to be delivered to the target node. In our understanding, the target node would decide the RTI configuration for the UE with the parameters from the CN and it’s HW capability. The RTI configuration in the source node might be able to be used in the target node only for the first RTI transmission to the UE (as in Nokia’s use case #2). We think it can be supported by implementation even though there may be small overhead for the first RTI transmission to the UE, e.g. sending a unicast RRC message including RTI to the UE immediately after handover. The enhancement only for the first RTI transmission seems not be required.If the assistance information from the UE is used for the NG-RAN to decide the RTI configuration for the UE, the assistance information may have to be delivered from the source node to the target node. But we don’t see UE’s assistance information other than the ***referenceTimeInfoPreference***. |
| CATT |  | Agree with Samsung’s analysis.  |
| Ericsson | Information 1 | As in Nokia comments, the source gNB determines and once the determination is made the selected periodicity etc. can be passed to the target gNB (at handover) to assist the target performance. In the unicast case, when the split architecture is used, latency could be reduced if the target RAN prepares by receiving the assistance information at HO preparation.Parameter details can be discussed further. |

**Summary:**

6 companies provided inputs to this question.

3 companies think *referenceTimeInfoPreference* should be delivered during HO.

1 company think the timestamp associated with the latest RTI sent to the UEshould be delivered during HO.

2 companies think the estimated time synchronization accuracy of the UE or the referenceTimeInfo delivery periodicity should be delivered during HO.

1 company think that the UE TSN timing reference (e.g. Uncertainty, Time Information Type, TSN distribution, and Periodicity) used in the source NG-RAN nodeshould be delivered during HO.

**Question 5: What RAN3 specification will be impacted to deliver the RTI related information, if any?**

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| **Company** | **Comments** |
| ZTE  | No RAN3 specification impacts during HO.Since *referenceTimeInfoPreference-r16* IE is already included in the *HandoverPreparationInformation* by RRC container, based on our answer to Question 4, there is no RAN3 specification impacts during HO to deliver the RTI related information.  |
| Nokia | XnAP and F1AP. |
| Huawei | Xn/NG specification are impacted. |
| Samsung | We don’t see RAN3 spec impact yet. |
| CATT | No RAN3 spec impacted.  |
| Ericsson | NGAP/XnAP for handover over NG or over Xn. |

**Summary:**

6 companies provided inputs to this question.

Since this question is related to question 4, the answer is also associated..

3 companies think there is no impact on the RAN3 specification.

3 companies think there is impact on the XnAP specification

1 company thinks there is impact on the F1AP specification.

2 companies think there is impact on the NGAP specification.

**Proposal 4: The *referenceTimeInfoPreference* should be delivered during HO and there is no RAN3 specification impacts, and FFS on whether other RTI related information should be delivered during HO.**

# 4 Conclusions, Recommendations

Capture the following in the Chair’s Notes:

# References

1. R3-213241 Further discussion on Propagation Delay Compensation enhancements ZTE
2. R3-213377 Discussion on Further enhanced NR-IIoT: Enhancements for support of time synchronization Ericsson
3. R3-213378 Enhancements for support of time synchronization Ericsson
4. R3-213379 Enhancements for support of time synchronization Ericsson
5. R3-213449 Impact of handover on time synchronization Nokia, Nokia Shanghai Bell
6. R3-213645 (TP for eIIoT BLCR for 38.423) Propagation delay compensation and timing accuracy during handover Huawei
7. R3-213646 (TP for eIIoT BLCR for 38.413) Propagation delay compensation and timing accuracy during handover Huawei
8. R3-213907 Discussion on supporting the time synchronization error budget Samsung
9. R3-213951 Discussion on Propagation Delay Compensation Enhancements CATT