**3GPP TSG RAN WG1 #118bis R1-24xxxxx**

**Hefei, China, October 14th – 18th, 2024**

**Source: Moderator (CMCC)**

**Title:** **Moderator’s summary on the discussion of common TA in a regenerative payload scenario**

**Agenda item: 9.11**

**Document for: Discussion & Decision**

# Introduction

RAN2 has sent a LS to RAN1 regarding the common TA in a regenerative payload scenario [1]. In RAN2 #127 meeting, the setting of common TA and Kmac for regenerative payload with full gNB on board was discussed. RAN2 brought questions on whether it would be a problem for TA common to stick to 0 as the minimum value or if there is a need to introduce negative values. The content of the LS is listed as below.

|  |
| --- |
| In RAN2#127 meeting, the setting of common TA and Kmac for regenerative payload with full gNB on board was discussed, and a question related to the value setting was raised.Related to this, RAN2 kindly asks RAN1 and RAN4:**Question:** Whether in a regenerative payload scenario it would be a problem to stick to 0 as the minimum possible value for TA-Common or whether we should e.g. introduce negative values for ta-Common. Additionally, RAN2 understands in any case legacy UEs would have to rely on existing signaling and then for legacy UEs, minimum value of Common TA is equal to 0.**Actions:****To RAN1 and RAN4:**RAN2 kindly requests RAN1 and RAN4 to provide feedback on above question. |

# Discussion

21 contributions [2-22] including both discussion papers and draft replies are submitted in this meeting. Based on the inputs, moderator has the following questions about the issues related to the question from RAN2.

**2.1 Issues of uplink reception window at gNB**

It was mentioned by companies’ contributions that there would be a performance loss due to the mismatch for the uplink transmission and the reception window at gNB. And the overestimated TA will induce an advanced reception at gNB, which seems the traditional terrestrial gNB never need to deal with.



Figure 2 Examples for the uplink reception at gNB

**Question 1:**

**Do companies think that it would impact the uplink reception performance due to the delayed or advanced arrival of uplink transmission?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No**  | **Detailed answers and other comments** |
| **OPPO** | **No** | For TA accuracy error falls in [-Te,+Te] with Te smaller than CP length, gNB implementation can avoid any performance degradation.  |
| **ETRI** | **No** | We don’t see any further specific issues for regenerative payload over the legacy transparent payload cases. |
| **Lenovo** | **No** | The case is same as TN network and there is no necessity for special handling. |
| **ZTE** | **No** | The pre-compensation in NTN is assumed to be accurate enough to satisfy the RAN4 requirements Te\_NTN and can be covered by CP. |
| **Nokia** | **No** | Agree with OPPO |
| **Huawei, HiSilicon** | **Yes** | We think this is an issue for gNB to receive Msg3 PUSCH considering Msg2 RAR can only adjust TA towards one direction. As show in Figure 2 above, if the UE over-compensates the TA, case 3 shall happen. In this case, within the FFT window used by gNB, there are samples of the next OFDM symbol falling into the FFT window.it should be noticed that moving the FFT window earlier would cause the loss of performance considering CP is also used to cover the multi-path transmission of the OFDM signal. This is especially true for FR2-NTN case.The reason it becomes an issue compared with Rel-17 comes from the following aspects:1. In Rel-17 focusing on transparent satellite, a configured common TA could be configured smaller than needed, i.e. consider the TA margin into the configured common TA value. This implementation method can resolve the UE over-compensated TA issue for transparent satellite payload. However, this is not feasible for regenerative satellite payload;
2. For FR2-NTN, the CP length is further reduced especially for the SCS of 120kHz. Similarly, this can be resolved in transparent satellite payload by configuring a smaller common TA value. However, for regenerative satellite payload, this cannot work. Therefore, we think this is an issue should be resolved for regenerative satellite payload.
 |
| **Apple** | **No** | It is assumed T\_eNTN must satisfy RAN4 requirement. This T\_eNTN is smaller than CP length, and hence, there is no issue on UL reception.  |
| **vivo** | **No** | These cases may also happen in TN. Regarding the MSG3 case mentioned by Huawei, the network can adjust the FFT window to handle this, as OPPO mentioned. The network can simply do not the last symbol of the slot before the MSG3, or puncturing the symbol, to avoid any potential interference. |
| **CATT** | **No**  | Based on RAN4 requirement, current assumption is workable without performance degradation. |
| **QC** |  | There could be impact especially for FR2. |
| **LGE** | **No** | Proper setting of the FFT window location will avoid inter-symbol interference. Moreover, due to the LOS-dominant scenario, the target delay spread would not be large compared to TN.  |

**Question 2:**

**Is there any difficulty for the gNB to deal with the advanced reception in uplink?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No**  | **Detailed answers and other comments** |
| **OPPO** | **No** | the gNB can select a FFT window starting from Te after the OFDM symbol boundary for the concerned PRACH reception (also applicable to PUSCH reception as well). With this implementation method, any random accuracy error within [-Te,+Te] won’t suffer from the degradation, as long as the Te is smaller than CP length.  |
| **ETRI** | **No** | We don’t see any further specific issues for regenerative payload over the legacy transparent payload cases. |
| **Lenovo** | **No** |  |
| **ZTE** | **No** | As respond to Q1, the pre-compensation is accurate enough and the potential advance of reception can be covered by CP. |
| **Nokia** | **No** |  |
| **Huawei, HiSilicon** | **Yes** | Just use the figure from moderator:图示  低可信度描述已自动生成The FFT window is shown like above. CP is used not only to handle this timing error of uplink transmission but also the impact of multi-path transmission of the OFDM signal. Especially when FR2-NTN is considered, the CP length is very short and gNB cannot have much space to move the FFT window earlier (otherwise, the effective CP that can be used to resolve the multi-path transmission is further reduced.).Taking OPPO’s figure also as an example, the OPPO’s figure shows that actually the gNB does not have sufficient CP to handle the multi-path transmission of the OFDM signal if all the CP duration used to handle the Te. |
| **Apple** | **No** |  |
| **vivo** | **No** |  |
| **CATT** | **No** |  |
| **QC** | **Yes** | But the impact is limited to the few first UL transmissions |
| **LGE** | **No** | Proper setting of the FFT window location will avoid inter-symbol interference. |

**2.2 Backward compatibility issues**

Some companies mentioned there would be a backward compatibility issue if negative values are introduced for the common TA. But other companies mentioned that if negative values were introduced for the common TA configuration in Rel-19 for regenerative payload, corresponding new IE would be introduced. With the consideration of that, there would be no backward compatibility issues.

**Question 3:**

**Is there any backward compatibility issue for the legacy UE if negative values were introduced for the configuration of common TA, with the consideration that new Rel-19 IEs with negative values of common TA can be introduced?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No**  | **Detailed answers and other comments** |
| **OPPO** | **not issue with backward compatibility** | The problem is that by introducing negative value for R19, it will make legacy performance worse. While, by NW implementation, both legacy performance and R19 performance can be kept un-impacted.  |
| **Nokia** | **In principle there would be no problems.**  | However, the network having to deliver two Common TA values (one for legacy and one for Rel-19 UEs potentially supporting this) would increase the overhead of SIB19 (and keep in mind that we are already struggling with DL coverage). Additionally, the gNB would potentially start seeing two “peaks” in the uplink reception window, and have to issue TAC for two different types of UE. It is strongly preferred to not have this additional signaling. |
| **Huawei, HiSilicon** | **No backward compatibility issue** | If no legacy UE in the network, there is no issue and the gNB can indicate only the negative common TA.If there exists legacy UE, the network can still configure the negative common TA for the new UE while the legacy UE uses the zero value common TA. In this case, the performance of new UE’s Msg3 PUSCH can be improved while the Msg3 PUSCH performance of legacy UE keeps the same as if the negative TA is not introduced. |
| **CATT** | **Basically no**  | But it will complicate gNB implementation, which need deal with different UEs.  |
| **LGE** | **Yes** | Since the legacy UE cannot interpret the negative value, the gNB may need to configure two common TA values for the legacy UE and the new R19 UE. Usage of two different common TA value would cause inter-symbol interference among UEs with different common TA value.  |

**2.3 Questions on the negative values**

Based on the consideration of the above two questions and the answers, it can be further discussed on the questions from RAN2. Though Q4 and Q5 are similar and may point to the same direction for the answers, it may save some efforts for drafting the content of reply LS.

**Question 4:**

**With the consideration of the above two issues, do you think negative values for ta-Common can be introduced to solve the overestimated TA issues and improve the performance of uplink receptions?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No**  | **Detailed answers and other comments** |
| **OPPO** | **No** | it is not meaningful to introduce negative value, it will make the system worse. |
| **ETRI** | **No** |  |
| DCM | NO | This issue is common b/w transparent payload and regenerative payload in our understanding. Why we need to discuss again is unclear. |
| Lenovo | No |  |
| **ZTE** | **No** | In Rel-17, the value range of common TA is determined with consideration that uplink time synchronization reference point can vary from the ground gNB to satellite. And as replied to Q1, the CP is able to cover the uncertainty of pre-compensation. Hence, we think it is not needed to introduce new negative values, which cannot be applied by legacy UEs. |
| **Nokia** | **No** | See above. |
| **Huawei, HiSilicon** | **Yes** | As analyzed in Q1~Q3, we think the msg3 PUSCH performance shall be guaranteed/improved if negative common TA is introduced for regenerative satellite payload. This is especially true for the FR2-NTN. |
| **Apple** | **No** | We do not see the necessity of introducing negative *ta-Common*  |
| **vivo** | **No** |  |
| **CATT** | **No**  |  |
| **QC** | **No** | The issue was discussed in Rel-17 and Rel-18 for FR2. The solution is to allow negative TA in Msg2. Introducing a negative value in common TA will negatively impact on RACHless HO. |
| **LGE** | **No** |  |

**Question 5:**

**Do you think it would be a problem to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common?**

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes or No**  | **Detailed answers and other comments** |
| **OPPO** | **No** | there is no issue with 0 value common TA as explained in the previous questions. |
| **ETRI** | **No** |  |
| DCM | NO | Same comment as Q4. |
| Lenovo | No |  |
| **ZTE** | **No** | Same comment as Q4. |
| **Nokia** | **No** | See above |
| **Huawei, HiSilicon** | **Yes** | The reason is similar as that for Q1. We summarize here:As show in Figure 2 above, if the UE over-compensates the TA, case 3 shall happen. In this case, within the FFT window used by gNB, there are samples of the next OFDM symbol falling into the FFT window.it should be noticed that moving the FFT window earlier would cause the loss of performance considering CP is also used to cover the multi-path transmission of the OFDM signal. This is especially true for FR2-NTN case.The reason it becomes an issue compared with Rel-17 comes from the following aspects:1. In Rel-17 focusing on transparent satellite, a configured common TA could be configured smaller than needed, i.e. consider the TA margin into the configured common TA value. This implementation method can resolve the UE over-compensated TA issue for transparent satellite payload. However, this is not feasible for regenerative satellite payload;
2. For FR2-NTN, the CP length is further reduced especially for the SCS of 120kHz. Similarly, this can be resolved in transparent satellite payload by configuring a smaller common TA value. However, for regenerative satellite payload, this cannot work. Therefore, we think this is an issue should be resolved for regenerative satellite payload.
3. Especially when FR2-NTN is considered, the CP length is very short and gNB cannot have much space to move the FFT window earlier (otherwise, the effective CP that can be used to resolve the multi-path transmission is further reduced.).
 |
| **Apple** | **No** |  |
| **vivo** | **No** |  |
| **CATT** | **No**  |  |
| **LGE** | **No** |  |

# 2nd round discussion

Based onthe inputs and comments on the questions, the content of the draft reply is as below. Still, views and comments are appreciated.

|  |
| --- |
| **Question:** Whether in a regenerative payload scenario it would be a problem to stick to 0 as the minimum possible value for TA-Common or whether we should e.g. introduce negative values for ta-Common. Additionally, RAN2 understands in any case legacy UEs would have to rely on existing signaling and then for legacy UEs, minimum value of Common TA is equal to 0. |

**Proposed reply:**

**From RAN1 perspective, it is not a problem to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Support/can live with or not** | **Comments and updates** |
| **Apple** | **Support in general** | **We may want to mention “regenerative payload scenario” in the reply.** **From RAN1 perspective, in a regenerative payload scenario, it is not a problem to stick to 0 as the minimum possible value for TA-common without introducing ~~the~~ negative values for ta-Common.** |
| **Ericsson** | **Support** | **We suggest to consistently use the parameter name of 38.331:****From RAN1 perspective, it is not a problem to stick to 0 as minimum possible value for ~~TA common~~ta-Common without introducing the negative value for ta-Common.** |
| **Xiaomi** | **Support**  | **Slightly prefer to add “regenerative payload scenario” in the reply LS.** **From RAN1 perspective, in a regenerative payload scenario, it is not a problem to stick to 0 as the minimum possible value for ~~TA common~~ta-Common without introducing the negative value for ta-Common.** |
| * Nokia
 | Support | Support the intention of the proposed response – potentially good to include the “for regenerative payload” for clarity of the response. |
| Moderator |  | Updates according to the comment above.**From RAN1 perspective, in a regenerative payload scenario, it is not a problem to stick to 0 as the minimum possible value for ta-Common without introducing the negative value for ta-Common.** |
| Huawei, HiSilicon | Cannot agree | As we explained, for regenerative satellite payload, it is not correct to simply say “**it is not a problem to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common.**”. This is especially an issue considering the CP is short for FR2-NTN, which is not sufficient to be used to handle the multi-path effect and the overcompensated TA. FR2 Te is as shown in the following Table in RAN4 specification.C:\Users\t00496347\AppData\Roaming\eSpace_Desktop\UserData\t00496347\imagefiles\1D1335CC-9ECE-42F9-B832-D6651D437049.pngThe following revision is proposed:**~~From RAN1 perspective,~~ RAN1 cannot achieve consensus on whether it is not a problem in a regenerative payload scenario to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common.*** **One potential issue raised in the discussion is the over-compensated TA by UE may cause performance degradation of Msg3 PUSCH, especially for FR2-NTN.**
 |
| FL2 |  | One company raises a point that it is possible the eOption 1:**From RAN1 perspective, in a regenerative payload scenario, there may be a problem to stick to 0 as the minimum possible value for ta-Common without introducing the negative value for ta-Common.*** **One potential issue raised in the discussion is the over-compensated TA by UE may cause performance degradation of Msg3 PUSCH, especially for FR2-NTN.**

Option 2:**RAN1 cannot achieve consensus on whether it is not a problem in a regenerative payload scenario to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common.*** **One potential issue raised in the discussion is the over-compensated TA by UE may cause performance degradation of Msg3 PUSCH, especially for FR2-NTN.**
 |

# 3rd round discussion



One company raises one point that it is possible that the overestimated TA may not be covered by the CP. And it will impact the transmission of Msg 3 with performance degradation. With the information above, two options are derived for the reply contents. Views and comments are appreciated.

**Option 1:**

**From RAN1 perspective, in a regenerative payload scenario, there may be a problem to stick to 0 as the minimum possible value for ta-Common without introducing the negative value for ta-Common.**

* **One potential issue raised in the discussion is the over-compensated TA by UE may cause performance degradation of Msg3 PUSCH, especially for FR2-NTN.**

**Option 2:**

**RAN1 cannot achieve consensus on whether it is not a problem in a regenerative payload scenario to stick to 0 as minimum possible value for TA common without introducing the negative value for ta-Common.**

* **One potential issue raised in the discussion is the over-compensated TA by UE may cause performance degradation of Msg3 PUSCH, especially for FR2-NTN.**

|  |  |  |
| --- | --- | --- |
| **Company** | **Option 1 or option 2** | **Comments and updates** |
| DCM | Neither | Why enhancement is necessary only for regenerative payload is still unclear. FR2-NTN is supported in R18 with transparent payload, where UL sync RP can be set at satellite; but no additional mechanism of common TA was introduced. |
| LGE |  | Regarding the timing error for FR2 case, in our understanding, RAN4 is still discussing whether or not to allow the case where the timing error is beyond CP length/2. That’s why there are square brackets. In this situation, we are not so sure we can make the proper conclusion based on the unfinished RAN4 specification. In our understanding, if RAN4 allows that case, the CP problem will not be limited to this issue only. If RAN4 has some solution to resolve this CP problem, we can reuse it for this issue as well.  |
| Samsung |  | Similar view with DCM. Furthermore, if it is real problem, would similar situation be happened in FR2 TN as well? |
| NEC | Neither | Based on current specification, the *ta-CommonDrift* belongs to an integer of (-257303,257303), with a granularity of 0.2 × 10-3 μs⁄s. Thus, an UE can already determine a negative $N\_{TA,adj}^{common}$ when the network configure a negative *ta-CommonDrift.* |
| Ericsson | Neither | We do not agree that the potential issue of Te\_NTN>CP/2 for 120 kHz SCS can be solved with a negative Common TA. If the spread in RX timing is too large to be covered by the CP length, it will be too large also with a negative common TA. Adjustment of the FFT window position can achieve the same as a negative Common TA but without specification impact. Therefore, sticking to 0 as the minimum value for ta-Common will not cause performance degradation of Msg3 PUSCH. |

# Conclusion

# References

1. R1-2407590, LS on common TA in a regenerative payload scenario, 3GPP TSG-RAN WG1 Meeting #118-bis
2. R1-2407691 Discussion on LS on common TA in a regenerative payload scenario Spreadtrum Communications
3. R1-2407830 Draft reply LS on common TA in a regenerative payload scenario vivo
4. R1-2407888 Discussion on the LS on common TA in a regenerative payload scenario CMCC
5. R1-2407889 Draft reply LS on common TA in a regenerative payload scenario CMCC
6. R1-2407929 Discussion on LS on common TA in a regenerative payload scenario ZTE Corporation, Sanechips
7. R1-2408003 Discussion on LS reply on common TA in a regenerative payload CATT
8. R1-2408140 Discussion on RAN2 LS about the common TA issue in regenerative payload scenario OPPO
9. R1-2408141 Draft LS reply on common TA in regenerative payload scenario OPPO
10. R1-2408170 Discussion on the reply of LS on common TA in a regenerative payload scenario Huawei, HiSilicon
11. R1-2408171 Draft reply LS on common TA in a regenerative payload scenario Huawei, HiSilicon
12. R1-2408226 Discussion on RAN2 LS on common TA in a regenerative payload scenario NEC, TCL
13. R1-2408396 Discussion on the LS on common TA in a regenerative payload scenario THALES
14. R1-2408397 Draft reply LS on common TA in a regenerative payload scenario THALES
15. R1-2408442 Discussion on RAN2 LS on Common TA in a Regenerative Payload Scenario Apple
16. R1-2408443 Draft Reply LS to RAN2 on Common TA in a Regenerative Payload Scenario Apple
17. R1-2408556 Discussion on common TA in a regenerative payload scenario ETRI
18. R1-2408612 Discussion on RAN2 LS on common TA in a regenerative payload scenario Samsung
19. R1-2408698 Discussion on reply LS on common TA in regenerative payload in NTN NR MediaTek Inc.
20. R1-2408726 Discussion on LS on common TA in a regenerative payload scenario Nokia
21. R1-2408772 Discussion on RAN2 LS of common TA for regenerative payload NTT DOCOMO, INC.
22. R1-2408906 Discussion on RAN2 LS on common TA in a regenerative payload scenario Ericsson