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

Maastricht, NL, August 19th–23rd, 2024

**Title : Summary for Reply LS on UL synchronization for contention based Msg3 transmission without Msg1/Msg2**

**Source : Moderator (ZTE)**

**Agenda item : 9.11**

**Document for : Discussion and Decision**

# Introduction

At RAN1#118, RAN1 received an LS from RAN2 on UL synchronization for contention based Msg3 transmission without Msg1/Msg2 [1]. In the LS, RAN2 inform RAN1 the agreements on contention based Msg3 transmission without Msg1/Msg2 and ask RAN1 whether an RRC Idle UE with a pre-compensated TA can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.

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| **1. Overall Description:**In RAN2#126 meeting, the following agreements related to Msg3 transmission for uplink capacity enhancement for R19 IoT NTN have been achieved:

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| **Agreements:**=> RAN2 focusses the study on contention-based Msg3 transmission to complete an EDT-like transaction (FFS on the details of Msg3. FFS on the procedural steps, e.g. how much we reuse of EDT and PUR procedures. FFS on allocation of resources).=> If an IoT NTN UE in IDLE state is to use the new R19 contention-based procedure, the UE needs to verify/update the uplink synchronization (e.g. get GNSS fix, acquire TA) just before sending msg3. |

Based on the above agreements, RAN2 kindly asks RAN4 and RAN1:Q1: Whether an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2? Q2: If the answer for Q1 is no, from RAN4 and RAN1 perspective, how the required timing accuracy for Msg3 transmission can be satisfied in this case? **2. Actions:****To RAN4 and RAN1:****ACTION:** RAN2 respectfully requests RAN4 and RAN1 to take above RAN2 progress into account and provide feedback. |

In this summary, the questions raised by RAN2 are discussed.

# **First question**

##  **Company views**

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| Q1: Whether an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2? Q2: If the answer for Q1 is no, from RAN4 and RAN1 perspective, how the required timing accuracy for Msg3 transmission can be satisfied in this case? |

Regarding Q1, 11 companies provide views in contributions, which are summarized as following:

* [ZTE, vivo, OPPO, Apple, Huawei, HiSilicon, Qualcomm] propose that the required timing accuracy for Msg3 transmission without Msg1/Msg2 can be satisfied. The detailed analysis is listed as following:
	+ [ZTE, vivo, Huawei, HiSilicon, Qualcomm] propose that RAN4 has defined same timing requirement for NPUSCH and NPRACH, i.e., 97\*Ts as defined in section 7.20A in TS 36.133. Moreover, [Qualcomm] propose that RAN4 also define same timing requirement for eMTC as defined in section 7.24A in TS 36.133. Therefore, an RRC Idle UE with a pre-compensated TA should be able to satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.
	+ [OPPO] proposes that Msg3 transmission without Msg1/Msg2 is similar to RACH-less handover in NR-NTN. Therefore, an RRC Idle UE can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2 with following notes, which are similar to that captured in the reply LS on RACH-less handover:
		- Note 1: RAN1 assumes that the RAN4 UL synchronization requirement specified in Table 7.20A.2-1 of TS36.133 applies to the first UL transmission in the target cell.
		- Note 2: eNB is expected to provide valid assistance information of the target cell to UE.
	+ [Apple] proposes that for contention based Msg3 transmission without Msg1/Msg2, if no further requirement is to be defined by RAN4, the existing Te\_NTN requirements with NTA=0 could apply for the Msg3 transmission, which can be achieved by UE pre-compensation with the assistance information. If UL synchronization error is larger than CP, eNB implementation-based solution can be considered to detect Msg3 PUSCH.
* [CMCC, CATT, Nokia, Nokia Shanghai Bell, NEC] propose that the required timing accuracy for Msg3 transmission without Msg1/Msg2 may not be satisfied. The detailed analysis is listed as following:
	+ [CMCC] proposes that the N\_TA in Msg2 contains not only the propagation delay but also delays due to the implementation from eNB side. With only a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN), the UE may not satisfy the required timing accuracy for Msg 3 transmission.
	+ [CATT] proposes that in the Msg3 transmission without Msg1 and Msg2, tolerable TA offset should be comparable with the length of PRACH CP. Existing requirement of PUSCH transmission may not satisfy the timing accuracy.
	+ [Nokia, Nokia Shanghai Bell] propose that RAN4 transmit timing requirements assume the UE has received a network-controlled timing advance prior to NPUSCH transmission, which cannot be satisfied for Msg3 transmission without Msg1/Msg2. And the NPUSCH CP may not able to cover the transmit timing error requirement 97\*Ts. Therefore, it is not possible to initiate a NPUSCH transmission that satisfies the transmit timing requirements without a preceding Msg2/RAR reception including network-controlled timing advance.
	+ [NEC] proposes that a valid N\_TA is necessary at the time of sending Msg3 to satisfy Msg3 transmission timing requirement.
* [Ericsson] propose that the required timing accuracy for Msg3 transmission without Msg1/Msg2 can be satisfied for partial scenarios. More specifically, the required timing accuracy can be satisfied for LTE-MTC CE mode A and NB-IoT with 3.75 kHz SCS, but cannot be satisfied for LTE-MTC CE mode B and NB-IoT with 15 kHz SCS since the CP cannot handle the allowed transmission timing error.

Regarding Q2, the companies’ views are summarized as following:

* [ZTE, vivo, OPPO, Huawei, HiSilicon, Qualcomm] propose that the required timing accuracy for Msg3 transmission can be satisfied and therefore no need to reply Q2 or just reply that the required timing accuracy can be satisfied.
* [Apple] proposes that the required timing accuracy for Msg3 transmission can be satisfied and proposes to additionally reply in Q2 that eNB implementation-based solution can be considered if synchronization error is larger than CP.
* [CMCC] proposes that an assumed NTA should be defined or provided for Msg3 transmission without Msg1/Msg2 and the accuracy of the pre-compensated TA should be guaranteed.
* [CATT] proposes that whether timing accuracy can be satisfied is up to RAN4 evaluation. WID modification can be considered if Msg3 transmission without Msg1/Msg2 is really not workable.
* [Nokia, Nokia Shanghai Bell] proposes that only legacy PUR enabled direct NPUSCH which is conditioned on already received network controlled TA can work but a direct Msg3 without Msg1/2 cannot work in IoT NTN.
* [NEC] proposes that a valid NTA is necessary for Msg3 transmission to satisfy timing requirement. RAN1 need further investigation for enhancements on NTA for Msg3 transmission. And RAN1 inquire whether RAN2 is considering an RRC Idle UE sending contention-based msg3 via a different cell.
* [Ericsson] proposes that RAN1 should discuss whether any solution within RAN1 scope is possible satisfy the required timing accuracy also for NB-IoT with 15 kHz SCS and for LTE-MTC CE mode B.

From moderator’s perspective, the reply to Q2 depends on the discussion of Q1. If the working group agrees that the required timing accuracy can be satisfied, no need to reply to Q2. Therefore, Q1 can be discussed first.

According to above analysis, companies have different views on the relationship between CP and timing error limit Te. In current RAN4 specification, the timing error limit for IoT-NTN is relaxed to 97\*Ts, which is larger than CP/2 of NPUSCH with 15kHz SCS. [ZTE, vivo, OPPO, Apple, Huawei, HiSilicon, Qualcomm] think that the timing accuracy requirement is considered satisfied if the RAN4 defined timing error limit is satisfied. However, [Ericsson, Nokia, Nokia Shanghai Bell] think the timing accuracy requirement cannot be thought satisfied if the transmission timing error is larger than CP/2 even if it is smaller than the timing error limit. From moderator perspective, how to define the timing requirement is up to RAN4. RAN1’s responsibility is to judge whether the RAN4 requirement can be satisfied. The issue of whether CP can handle the allowed transmission timing error is out of RAN1 scope and should be up to RAN4. Therefore, the moderator recommends to reply RAN2 that the timing accuracy requirement is considered satisfied with note that RAN1 assumes RAN4 defined timing error limit applies to Msg3 transmission without Msg1/Msg2.

Additionally, [CMCC, Nokia, Nokia Shanghai Bell, NEC] think a valid NTA is necessary for Msg3 transmission. [Nokia, Nokia Shanghai Bell] further proposes that RAN4 requirement for NPUSCH assumes NTA to be determined by latest received TA command. From moderator’s perspective, for Msg3 transmission without Msg1/Msg2, NTA =0 should be applied as proposed by [Apple], which is same as NPRACH. Then, same timing accuracy as NPRACH can be achieved for Msg3 transmission without Msg1/Msg2. That is, the timing requirement for Msg3 NPUSCH, which is same as NPRACH, can be satisfied. According to above analysis, RAN1 may just reply RAN2 the timing accuracy requirement can be satisfied with the assumption of NTA =0. The detailed discussion on spec impact can be up to RAN2 and RAN4.

Regarding accuracy of pre-compensation, RAN2 has agreed that UE needs to verify/update the uplink synchronization (e.g. get GNSS fix, acquire TA) just before sending msg3, which can ensure the UE has valid assistance information and able to perform pre-compensation. Therefore, no need to additionally discuss whether the UE has valid assistance information or can perform accurate pre-compensation in RAN1.

Then, the following proposals are provided:

### ***Proposal 1-1-1:***

*Capture the following in the reply LS to RAN2*

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| *RAN1’s response to Q1:**From RAN1 perspective, an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.**Note 1: RAN1 assumes NTA=0 for Msg3 transmission without Msg1/Msg2**Note 2:* *RAN1 assumes that the RAN4 UL synchronization requirements specified in Table 7.20A.2-1 and Table 7.24A.2-1 of TS 36.133 apply to the Msg3 transmission without Msg1/Msg2 in NB-IoT over NTN and eMTC over NTN, respectively.* |

Companies are encouraged to share your views.

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| Companies | Comments and Views |
| LGE | In our understanding, the overall UE TX timing error needs to be smaller than the half of CP length. Otherwise, inter-symbol interference will happen among UL transmission with the timing error of T\_e and UL transmission with the timing error of -T\_e. According to TS36.133, for NB-IoT for satellite access, the UE TX timing error limit is 97\*T\_s, which is already larger than the half of 144\*T\_s that is CP length for 15kHz SCS. On the other hand, for 3.75kHz SCS, the UE TX timing error is smaller than the half of the CP length (256\*T\_s/2). In general, TA command will make the overall timing error is smaller than the half of the CP length even for 15kHz SCS. However, the TA command cannot help the target Msg3 without Msg1/Msg2. In this point of view, to satisfy the required timing accuracy without TA command, Msg3 without Msg1/Msg2 needs to use 3.75kHz SCS.  |
| Qualcomm | Just for completeness, please note that we updated our contribution with additional evaluation results for NB-IoT 15kHz single tone to show that the performance degradation is minimal even for the case where the error is larger than CP/2. The updated tdoc is R1-2407221.From our point of view we would be OK with agreeing to the FL proposal. If that is not acceptable to companies for the cases where the error is larger than CP/2, RAN1 could reply as follows:*From RAN1 perspective, an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2 at least in the following cases:** *NB-IoT with 3.75kHz SCS.*
* *eMTC CE mode A.*

*Note 1: RAN1 assumes NTA=0 for Msg3 transmission without Msg1/Msg2**Note 2:* *RAN1 assumes that the RAN4 UL synchronization requirements specified in Table 7.20A.2-1 and Table 7.24A.2-1 of TS 36.133 apply to the Msg3 transmission without Msg1/Msg2 in NB-IoT over NTN and eMTC over NTN, respectively.**Note 3: RAN1 will further investigate the cases of NB-IoT with 15kHz SCS and eMTC CE mode B.* |
| Ericsson | To answer Q1, RAN1 needs to evaluate the timing error in relation to CP/2, taking into account also e.g. channel time dispersion. Our analysis in [R1-2406122](http://10.10.10.10/ftp/RAN/RAN1/Docs/R1-2406122.zip) shows that the required timing accuracy can be satisfied for NB-IoT with 3.75kHz SCS and LTE-MTC CE mode B. RAN1 should further investigate the other cases. Therefore, we support the modified reply proposed by Qualcomm but not the original reply proposed in Proposal 1-1-1. |
| CATT | There are two issues that should be addressed.1. The timing requirement can’t be larger than 1/2 CP.
2. The timing requirement of PRACH should not be same as that of PUSCH, since RAR of msg2 will help UE to reduce the timing error.

But Msg3 transmission without Msg1/Msg2 is problematic because no RAR signaling is used to fix the timing error.So, we think an RRC Idle UE with a pre-compensated TA can not satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2. |
| CMCC | Our understanding is that the CP of 3.75kHz can cover the timing error. But the CP of 15kHz cannot. For the eMTC case, different company has different calculation methodology. For E///’s calculation, if the max TA adjustment error is not considered, then both LTE-MTC mode A and B have no problem to cope with the timing error. As mentioned in our contribution, the Nta values should be assumed and aligned between different UEs of contention based Msg3.The proposal can be updated as below,*From RAN1 perspective, an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during random access for IoT NTN) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2****, only if note 1 and note 2 are satisfied.****Note 1:* ***NTA should be assumed and aligned*** for *Msg3 transmission without Msg1/Msg2**Note 2:* *RAN1 assumes that the RAN4 UL synchronization requirements specified in Table 7.20A.2-1 and Table 7.24A.2-1 of TS 36.133 apply to the Msg3 transmission without Msg1/Msg2 in NB-IoT over NTN and eMTC over NTN, respectively.**Note 3: RAN1 will further investigate the cases of NB-IoT with 15kHz SCS* ***~~and eMTC CE mode B~~****.* |
| Lenovo | We agree with the response by FL in general.* For NBIoT, the CP length is 256Ts and 144Ts for 3.75KHz and 15KHz respectively, and the uplink timing requirement for NBIoT NTN is 97Ts, which is comparable or less than CP/2.
* For eMTC, the CP length is 144Ts, and the uplink time requirement for eMTC is 41Ts and 65Ts for CE mode A and mode B respectively, which is less than CP/2.

So we think an RRC Idle UE with a pre-compensated TA can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.By the way, based on the TU allocation for RAN1, RAN1 will not further investigate the case of NB-IoT with 15kHz SCS and eMTC CE mode B as mentioned by some companies above. |
| Nokia, NSB | Not support.1. In 36.133, NPRACH and NPUSCH has different requirement for TA although the requirement time error value are same. for the NPRACH the network controlled part is always zero, whereas for the NPUSCH transmission the value of NTA\_Ref is set by the network using the timing advance command including the Msg2/RAR, based on 36.133 “*N*TA\_Ref for NPRACH is defined as 0. $\left(N\_{TA\\_Ref}+N\_{TAoffset}+N\_{TA,common}+N\_{TA, UE-specific}\right)$ (in *Ts* units) for other channels is the difference between UE transmission timing and the Downlink timing immediately after when the last timing advance in clause 7.22A was applied.”

**Thus, NPUSCH should be only be transmitted after received network configured timing advance. i.e. Msg3 can not be transmitted before receiving TA from network by Msg2 based on Msg1.**1. Several companies have checked the Te defined in IoT NTN and **it can not be satisfied based on the NPUSCH CP for some cases, e.g. CE mode B/15kHz.**
2. The network configured TA should cover the error of all the issues including network receiver margins, GNSS error, ephemeris error, UE implementation issue, etc. **We can not allow one source of UE timing error to fully consume the entire allowed Te.**
3. For IoT NTN, NPUSCH always with repetitions, a transmission without time correction based on network controlled TA will interfere other UE for long time and can not be stopped, which will impact the system significantly and can not be allowed.

Thus, we do not agree the proposal above while propose to **For Q1, RAN1 to reply to RAN2 that it is not possible for some cases, e.g. CE mode B/15kHz, to initiate a NPUSCH transmission that satisfies the transmit timing requirements without a preceding Msg2/RAR reception including network-controlled timing advance. While, RAN4 should discuss whether it can satisfy for all case with all error source for CE mode A/3.75kHz.****For Q2, RAN1 to reply to RAN2 that only legacy PUR enabled direct NPUSCH which is conditioned on already received network controlled TA can work but a direct Msg3 without Msg1/2 can not work in IoT NTN.** |

# Proposals for discussion

To be updated

# Conclusion

# Reference

1. R1-2405837 Correction on the timing of Msg3 retransmission in NTN Huawei, HiSilicon
2. R1-2406127 Correction on timing of Msg3 retransmission in NTN ZTE Corporation, Sanechips
3. R1-2202784 Session notes for 8.4 (Maintenance on Solutions for NR to support non-terrestrial networks (NTN)) RAN1#108-e
4. R1-2202811 Feature lead summary#5 on timing relationship enhancements RAN1#108-e