3GPP TSG-RAN WG4 Meeting # 112 R4-2411822

Maastricht, NL, 19th - 23th Aug 2024

**Agenda item:** 8.26.4

**Source:** Moderator (MediaTek inc.)

**Title:** Topic summary for [112][227] IoT\_NTN\_Ph3

**Document for:** Information

# Introduction

*Briefly introduce background, the scope of this summary (e.g. list of treated agenda items).*

This document is the topic summary for RRM requirements for R18 IoT (Internet of Things) NTN (non-terrestrial network) enhancements, including the following topics covered

* Topic#1: RRM core requirements (AI 8.26.4)

Recommended issues for online discussion:

* 1-2-1, 1-1-2

# Topic #1: RRM core requirements (AI 8.3.2)

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

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| R4-2411472 | MediaTek inc. | Proposal 1: For Q1, with the valid and applicable parameters such as ephemeris information, common TA, UE can maintain uplink synchronization by updating pre-compensated TA for the Msg3 transmission without Msg1/Msg2.Proposal 2: RAN4 to further discuss whether and how to introduce RRM requirements for the new R19 contention-based (EDT-like) procedure.*Reply LS draft* |
| R4-2411618 | Xiaomi | Proposal 1: RAN4 to wait for more progress on the OCC enhancements in RAN1 to see if there is RRM impact.Proposal 2: An RRC Idle UE with a pre-compensated TA can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2 if SIB31 is acquired before the transmission. |
| R4-2411764 | CMCC | Observation 1: For both legacy NB-IOT and NB-IOT over NTN, Te is equal to or larger than NCP/2 of NPUSCH symbols, which will cause ISI issue.Proposal 1: For NB-IOT over NTN contention-based Msg3 transmission to complete an EDT-like transaction, whether the performance degradation caused by ISI is tolerable or not should be further studied, and if not, following methods can be considered:1. For contention-based Msg3 transmission to complete an EDT-like transaction, use ECP by default
2. Define enhanced UL transmit timing requirement assuming UE can perform FFT with larger size.

Proposal 2: For eMTC over NTN contention-based Msg3 transmission to complete an EDT-like transaction, the required timing accuracy can be satisfied. |
| R4-2412207 | Huawei, HiSilicon | Proposal 1: The work scope of RRM for Rel-19 IoT NTN is to discuss whether and how to define timing requirements for Msg3 transmission without msg1/ Random Access Response (RAR).Observation 1: For PUR transmission, UE shall meet the timing transmitting timing requirements defined 7.20A using latest acquired NTA.Observation 2: RAN4 did not define RSRP-based TA validation for PUR for IoT NTN.Observation 3: Compared with PUR transmission, UE may not have pre-configured NTA for Msg3 without Msg1/RAR.Observation 4: For Msg3 without Msg1/RAR , UE determines reference point of the UL transmit timing for Msg3 without Msg1/RAR in the same manner as PUR, which is the downlink timing of the serving NB-IoT cell minus $\left(N\_{TA\\_Ref}+N\_{TAoffset}+N\_{TA,common}+N\_{TA, UE-specific}\right)×T\_{s}$. The only difference part is the value of $N\_{TA\\_Ref}$.Observation 5: UE can only assume $N\_{TA\\_Ref}$ equal to 0 NPRACH transmission if there is no further RAN1/2 procedure, and UE shall be able to meet the same timing error requirements.Proposal 2: For Msg3 transmission without Msg1/Msg2, from RAN4 perspective in terms of UE UL transmit timing error requirements, UE shall meet same timing error requirements as defined for IoT NTN, where the reference point is the downlink timing of the serving NB-IoT cell minus $\left(N\_{TA\\_Ref}+N\_{TAoffset}+N\_{TA,common}+N\_{TA, UE-specific}\right)×T\_{s}$, and $N\_{TA\\_Ref}$ is assumed as 0 if there is no further RAN1/2 agreements.*Reply LS draft* |
| R4-2412232 | Ericsson | Proposal 1: Regarding S&F, RAN4 to monitor and wait for more concrete agreements in other WGs before determining impact to RRM requirements. Proposal 2: Regarding capacity enhancements for uplink, RAN4 to monitor and wait for more concrete agreements in other WGs. |
| R4-2412233 | Ericsson | Observation 1: Taking timing adjustment error and channel dispersion into account, the existing timing requirements, for NB-IoT with 15 kHz SCS and LTE-MTC CE mode B, cannot satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.Observation 2: Not taking timing adjustment error and channel dispersion into account, the existing timing requirements, for NB-IoT with 15 kHz SCS, cannot satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.Proposal 1: Reply to Q1 as follows: * For NB-IoT with 3.75 kHz SCS and for LTE-MTC, CE mode A, the existing timing requirements (i.e., initial transmission timing error) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.
* For NB-IoT with 15 kHz SCS and for LTE-MTC CE mode B with max (245 ns) channel dispersion, the existing timing requirements (i.e., initial transmission timing error) cannot satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.
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| R4-2412602 | vivo | Proposal 1: From UE perspective, RAN4 to confirm that an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during legacy random access) can satisfy the requirement on UE transmit timing for NB-IoT for Satellite Access specified in section 7.20A in TS36.133 for Msg3 transmission without Msg1/Msg2 Proposal 2: From network perspective, the reception timing accuracy for Msg3 transmission may be different for the cases with and without Msg1/Msg2. It is expected that this timing difference should be handled by network implementation |
| R4-2412603 | vivo | *Reply LS draft* |
| R4-2412865 | Nokia | Observation 1: The maximum allowed error in NB-IoT NTN allows for transmissions timing deviations larger than the NPUSCH CP. This issue is mitigated by the large accommodation of NPRACH cyclic prefix and the network-controlled timing advance component.Proposal 1: Reply to RAN2 that it is not possible to initiate a NPUSCH transmission that satisfy timing requirements at the receiver with non-initiated network-controlled part of the timing advance. |
| R4-2413187 | Qualcomm Incorporated | Reply LS to RAN2Proposal 1: RAN4 to reply to the question from RAN2 that a UE meeting the current timing requirements in TS 36.133 should be able to successfully transmit contention-based Msg3 without Msg1/Msg2.Store&Forward satellite operationProposal 2: RAN4 to postpone the discussion on the topic of Store&Forward satellite operation until the group can get more clarity on the impact of the topic on RRM requirements.Capacity enhancements for uplinkProposal 3: RAN4 to further wait for RAN2’s progress on Msg3-solo based EDT. |

## Open issues summary

*Before f2f meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### RRM core requirements

### Sub-Topic 1-1: RRM impact

#### Issue 1-1-1: RRM impact from EDT enhancement

Proposals:

* Proposal 1a (MTK): RAN4 to further discuss whether and how to introduce RRM requirements for the new R19 contention-based (EDT-like) procedure.
* Proposal 1b (Ericsson): Regarding capacity enhancements for uplink, RAN4 to monitor and wait for more concrete agreements in other WGs.
* [Proposal 1c (Qualcomm): RAN4 to further wait for RAN2’s progress on Msg3-solo based EDT.](file:///C%3A%5CUsers%5Cmtk12330%5CDesktop%5C2402%20R4_110_Local%5C%5B203%5D%5B202%5D%5B224%5D%5B233%5D%5BNTN%20evo%5D%5C%5BM233%5D%20R18%20IoT%20NTN%20enh%20-%20Disc1ok%5CTDoc%20-%20Core%20Disc%5CR4-2402699%20Discussion%20on%20mobility%20requirements%20for%20IoT%20NTN%20enhancements.docx#_Toc159273392)

Recommended WF: Regarding the R19 EDT in capacity enhancements for uplink, RAN4 to further wait for more concrete agreements in other WGs

#### Issue 1-1-2: RRM impact from other objectives

Background: The latest WID RP-241624

* Support of Store&Forward (S&F) satellite operation with full eNB as regenerative payload, therefore:
	+ Define the necessary enhancements into E-UTRAN (network & UE) to support S&F operation for delay-tolerant services [RAN3, RAN2]
		- At least specify necessary enhancements e.g. related to S1 protocol, especially to address the feeder link switch over as needed [RAN3]

Note: Strive to minimise UE impact.

Note: Coordination with SA2 (Rel-19 SA2 led Sat-Arch ph3 SI) is needed on the detail requirements (e.g. traffic type, or QoS parameters for S&F), network architecture (e.g. whether consider (partial) core network on satellite) etc.; further coordination with CT1 might be required

* Support of Capacity enhancements for uplink

	+ Study then specify, if beneficial, enhancements to enable multiplexing of multiple UEs (e.g. up to the min of 4 and the maximum allowed by the existing UL and DL signalling) in a single 3.75 kHz or 15 kHz subcarrier via orthogonal cover codes (OCC) for NPUSCH format 1 and NPRACH [RAN1, RAN2, RAN4]
		- Multi-tone support for 15 kHz SCS should also be considered
		- Specify necessary signalling, if needed
		- Update RF requirements accordingly, if needed

Note: Impact of impairment shall be taken into account

* + Study and specify, if beneficial the following enhancements to reduce the necessary uplink and downlink signaling to complete an Early Data Transmission (EDT) transaction [RAN2]:
		- Msg3 transmission without msg1/ Random Access Response (RAR)
		- Efficient delivery (reduced overhead) of msg4 / RRCEarlyDataComplete
		- Study and specify RRM requirement, if identified [RAN4]

Proposals:

* Proposal 1 (Huawei): The work scope of RRM for Rel-19 IoT NTN is to discuss whether and how to define timing requirements for Msg3 transmission without msg1/ Random Access Response (RAR).
* [Proposal 2 (Xiaomi): RAN4 to wait for more progress on the OCC enhancements in RAN1 to see if there is RRM impact.](file:///C%3A%5C%5CUsers%5C%5Cmtk12330%5C%5CDesktop%5C%5C2402%20R4_110_Local%5C%5C%5B203%5D%5B202%5D%5B224%5D%5B233%5D%5BNTN%20evo%5D%5C%5C%5BM233%5D%20R18%20IoT%20NTN%20enh%20-%20Disc1ok%5C%5CTDoc%20-%20Core%20Disc%5C%5CR4-2402699%20Discussion%20on%20mobility%20requirements%20for%20IoT%20NTN%20enhancements.docx%22%20%5Cl%20%22_Toc159273392)
* Proposal 3a (Ericsson): Regarding S&F, RAN4 to monitor and wait for more concrete agreements in other WGs before determining impact to RRM requirements.
	+ In the contribution: *From RRM perspective, the S&F operation may define plenty of time instants for indicating starting or ending of the S&F operation, the UE may potentially update measurement behavior/limitation accordingly.*
* [Proposal 3b (Qualcom): RAN4 to postpone the discussion on the topic of Store&Forward satellite operation until the group can get more clarity on the impact of the topic on RRM requirements.](file:///C%3A%5CUsers%5Cmtk12330%5CDesktop%5C2402%20R4_110_Local%5C%5B203%5D%5B202%5D%5B224%5D%5B233%5D%5BNTN%20evo%5D%5C%5BM233%5D%20R18%20IoT%20NTN%20enh%20-%20Disc1ok%5CTDoc%20-%20Core%20Disc%5CR4-2402699%20Discussion%20on%20mobility%20requirements%20for%20IoT%20NTN%20enhancements.docx#_Toc159273392)

Moderator’s Note: According to the latest WID, RRM are not included in the objective of the support of Store&Forward (S&F) and OCC code.

Recommended WF:

* The work scope of RRM for Rel-19 IoT NTN is to discuss whether and how to define timing requirements for Msg3 transmission without msg1/ Random Access Response (RAR).
* Note: It can be revisited if the RRM impact from other objectives has been identified.

### Sub-Topic 1-2: Reply LS on Msg3 transmission

#### Issue 1-2-1: Reply LS

Background: RAN2 LS R2-2405769

**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?

Proposals:

* Proposal 1a (Xiaomi): An RRC Idle UE with a pre-compensated TA can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2 if SIB31 is acquired before the transmission.
* Proposal 1b (MTK): with the valid and applicable parameters such as ephemeris information, common TA, UE can maintain uplink synchronization by updating pre-compensated TA for the Msg3 transmission without Msg1/Msg2.
* Proposal 1c (Huawei): For Msg3 transmission without Msg1/Msg2, from RAN4 perspective in terms of UE UL transmit timing error requirements, UE shall meet same timing error requirements as defined for IoT NTN, where the reference point is the downlink timing of the serving NB-IoT cell minus $\left(N\_{TA\\_Ref}+N\_{TAoffset}+N\_{TA,common}+N\_{TA, UE-specific}\right)×T\_{s}$, and $N\_{TA\\_Ref}$ is assumed as 0 if there is no further RAN1/2 agreements.
* Proposal 1d (vivo):
	+ From UE perspective, RAN4 to confirm that an RRC Idle UE with a pre-compensated TA (i.e., the one used for Msg1 transmission during legacy random access) can satisfy the requirement on UE transmit timing for NB-IoT for Satellite Access specified in section 7.20A in TS36.133 for Msg3 transmission without Msg1/Msg2
	+ Proposal 2: From network perspective, the reception timing accuracy for Msg3 transmission may be different for the cases with and without Msg1/Msg2. It is expected that this timing difference should be handled by network implementation
* Proposal 1e (Qualcomm): RAN4 to reply to the question from RAN2 that a UE meeting the current timing requirements in TS 36.133 should be able to successfully transmit contention-based Msg3 without Msg1/Msg2.
* Proposal 2a (Ericsson): Reply to Q1 as follows:
	+ For NB-IoT with 3.75 kHz SCS and for LTE-MTC, CE mode A, the existing timing requirements (i.e., initial transmission timing error) can satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.
	+ For NB-IoT with 15 kHz SCS and for LTE-MTC CE mode B with max (245 ns) channel dispersion, the existing timing requirements (i.e., initial transmission timing error) cannot satisfy the required timing accuracy for Msg3 transmission without Msg1/Msg2.
* Proposal 2b (Nokia): Reply to RAN2 that it is not possible to initiate a NPUSCH transmission that satisfy timing requirements at the receiver with non-initiated network-controlled part of the timing advance.
* Proposal 3 (CMCC):
	+ For NB-IoT, further study the performance degradation caused by ISI is tolerable or not, and if not, following methods can be considered:
		- 1. For contention-based Msg3 transmission to complete an EDT-like transaction, use ECP by default
		- 2. Define enhanced UL transmit timing requirement assuming UE can perform FFT with larger size.
	+ For eMTC over NTN contention-based Msg3 transmission to complete an EDT-like transaction, the required timing accuracy can be satisfied.

Moderator’s Note:

* The timing accuracy requirement (as in 7.20A.2/NB-IoT, 7.24A.2/eMTC) has covered PUR/PUSCH.

7.20A.2 Requirements

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 7.20A.2-1. This requirement applies when it is the first transmission in a DRX cycle or the first transmission in a repetition period (R>1) for NPUSCH and NPRACH, the first transmission after an uplink transmission gap in a repetition period (R>1) for NPUSCH and NPRACH transmission, or it is the transmission on PUR. The reference point for the UE initial transmit timing control requirement shall be the downlink timing of the serving NB-IoT cell minus $\left(N\_{TA\\_Ref}+N\_{TAoffset}+N\_{TA,common}+N\_{TA, UE-specific}\right)×T\_{s}$.

* Note that the UE transmit timing accuracy requirement was 80\*Ts for TN NB-IoT with 15 kHz SCS (since Rel-13) and it is 97\*Ts for NTN.
* Regarding the value of $N\_{TA\\_Ref}$, it is recommended to defer the discussion to RAN1/RAN2. There seems to be no impact on the performance regarding the UE timing accuracy.

Recommended WF:

* For a IoT NTN UE that meets the existing UE transmit timing requirement in TS 36.133 should be able to maintain uplink synchronization for the Msg3 transmission without Msg1/Msg2.
* At least for NB-IoT with 3.75 kHz SCS and for LTE-MTC CE mode A.
* Further discuss the following cases during the meeting
	+ NB-IoT with 15 kHz SCS and
	+ LTE-MTC CE mode B
* The determination of the value NTA\_Ref is left for RAN1/2 discussion.