3GPP TSG-RAN WG2 #113b-e R2-210xxxx

Electronic Meeting, 12th Apr – 20th Apr 2021

Agenda Item: 8.10.2.1

Source: Huawei, HiSilicon

Title: Report of [POST113-e][106][NTN] MAC aspects (Huawei)

Document for: Discussion, Decision

# 1 Introduction

This document is to collect companies’ views for the following email discussion:

* [POST113-e][106][NTN] MAC aspects (Huawei)

 Scope: Based on RAN2#113-e contributions, discuss:

* + RA type selection
	+ TA report
	+ sr-ProhibitTimer

 Intended outcome: email discussion summary

 Deadline: Long

This offline discussion is divided into two phases:

Phase I to collect companies’ views, the deadline is March 23 1100 UTC;

Phase II to finalize the proposals, the deadline is March 26 1100 UTC.

# 2 Discussion

## 2.1 RA type selection

According to TS 38.321, UE sets the *RA\_TYPE* to *2-stepRA* if one of the following conditions is fulfilled:

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| ……1> else if the BWP selected for Random Access procedure is configured with both 2-step and 4-step RA type Random Access Resources and the RSRP of the downlink pathloss reference is above *msgA-RSRP-Threshold*; or1> if the BWP selected for Random Access procedure is only configured with 2-step RA type Random Access resources (i.e. no 4-step RACH RA type resources configured); or1> if the Random Access procedure was initiated for reconfiguration with sync and if the contention-free Random Access Resources for 2-step RA type have been explicitly provided in *rach-ConfigDedicated* for the BWP selected for Random Access procedure:2> set the *RA\_TYPE* to *2-stepRA*.1> else:2> set the *RA\_TYPE* to *4-stepRA*.…… |

If both 2-step and 4-step RA type resources are configured, UE makes the final decision based on RSRP of the downlink pathloss reference, and if the RSRP is above *msgA-RSRP-Threshold* 2-step RACH is selected.

In NTN scenario, due to the unobvious near-far effect, RAN2 made the agreement in RAN2#112 to further discuss the corresponding enhancement:

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| 1. At least the following are FFS in Rel-17 NTN:

• Report UE-calculated TA in e.g. msg3/msg5/msgA• Enhancements to RSRP-based selection mechanism of 2-step vs. 4-step RACH • LCP impact caused by disabling HARQ UL retransmission |

Based on the contributions from [1] to [9], some discussion points have been extracted for further discussion as below:

1. What new criteria to be applied, e.g. the UE calculated RTT, or the distance between UE and satellite, or to separate the UEs through UE IDs, or UE’s QoS (e.g. latency) requirements, or elevation angle of the cell, or UE’s relative location to the NTN cell.

2. If new criteria is applied alone or it should work together with RSRP based selection mechanism.

3. Whether 2-step RACH can be configured for each logical channel.

4. Whether UE can be instructed to perform 2-step RACH if it is an intra-satellite handover; else the default configured 4-step RACH is to be used by UE.

5. Whether to support proactive switching from 2-step RACH to 4-step RACH based on time or number of received fallbackRAR.

6. Whether to introduce separate BI indication for 2-step and 4-step RA in NTN (when UE receives the BI for 2-step, it will select 4-step type for RA if applicable during running of 2-step BI timer).

### 2.1.1 New criteria

If both 2-step and 4-step RACH resources are configured, the selection mechanism can be enhanced in NTN scenario. Some new criteria have been proposed in companies’ contributions.

Candidate criteria include:

1. Based on the UE calculated RTT, i.e. UE specific UE-satellite RTT. If the UE specific UE-satellite RTT is lower than a threshold, UE selects 2-step RACH, otherwise UE selects 4-step RACH. [1][3][4][7][9]
2. Based on the distance from UE to satellite. If the distance from UE to satellite is lower than a threshold, UE selects 2-step RACH, otherwise UE selects 4-step RACH. [1][3]
3. Based on UE ID. Separate the UEs into two different groups by UE ID, i.e. one for 2-step RACH, the other one for 4-step RACH [1].
4. LCH based RA type selection. The latency requirement of different UL logical channels could be considered in RA type selection. [2]
5. QoS requirement based RA type selection. Service QoS requirement (e.g. delay) may be quite different from different type of NTN UEs which is up to the upper layer application requirement. [3][4]
6. Based on slice ID. [4]
7. Based on elevation angel of the cell. If UE location is near the cell center, it selects the 2-step RACH. [7]
8. Based on relative location of the NTN cell. If UE location is near the cell center, it selects the 2-step RACH. [7]

UE location information is proposed to be considered in RA type selection in NTN [2][4], since more detail have been elaborated in candidate solution 1/2/7/8, it seems unnecessary to make it an extra option.

**Question 1: which candidate criteria would you like to support?**

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| Company | Supported candidate criteria index/indices and comments |
| APT | Support option 1 and option 2 with the following change: **Based on UE calculated TA**. For option 1 and option 2, we think the concept is the same because the longer distance between UE and satellite would incur larger RTT. However, we would like to clarify the definition of UE calculated RTT. In my understanding, RAN1 merely agreed how to derive UE-calculated TA so far, i.e., based on UEs’ GNSS-acquired position and the serving satellite ephemeris. In addition, there is an agreement in RAN1#103 that says UE will not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/MsgA. Since the definition of UE calculated TA is clearer now, we prefer to support RA type selection based on UE calculated TA.

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| Agreement:* In NTN, the network may broadcast
* A common timing offset value
	+ FFS details of the common timing offset
* FFS: A common timing drift rate
* Before Msg1/MsgA transmission, the NR NTN UE in idle/inactive mode calculates its TA as follows:

$$TA= \left(N\_{TA}+N\_{TA, offset}[+X]\right)×T\_{c}[+X]$$Where:$N\_{TA} $is derived from the User specific TA self-estimation$X$ is derived at least from the common timing offset value if broadcasted by the network. The granularity of $X$ and whether $X$ is indicated as a Timing Advance or as a Timing Offset value [unit] are FFS. Upon resolving the FFS, one of the X in the equation will be removed.* $N\_{TA, offset} $depends on band and LTE/NR coexistence and is specified in TS 38.213 section 4.2.
* $T\_{c}$ is specified in TS 38.211 section 4.1.
* Note: UE will not assume that the RTT between UE and gNB is equal to the calculated TA for Msg1/Msg A.
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Moreover, whether the UE should select 2-step RA while the (1) UE calculated TA, (2) UE specific RTT, or (3) distance between UE and satellite, is lower or higher than a threshold can be further discussed. From another perspective, it is known that the transmission latency would be higher if the TA/RTT/distance between the UE and the satellite is larger. Thus, the UE with larger TA/RTT/distance (i.e., > threshold) should select 2-step RA if the RSRP can fulfill the msgA-RSRP-Threshold, to shorten the round-trip delay. For option 3 and 6, how to group the UEs by UE ID/Slice ID is a big problem. Also, this only work if UE ID, slice UD, different UEs in a cell are uniform distributed. For example, If all UEs in the cell has similar UE ID/slice ID properties, these solutions would fail. For option 4 and 5, we think both are similar because the data with different QoS requirements would be mapped to different RBs/LCHs. Although this may reflect the latency requirement, this does not work on MAC CE (e.g., BSR MAC CE), since the MAC CE is not associated with any LCH or QoS. Note that RAN2 has agreed BSR MAC CE is beneficial to be transmitted over 2-step RA. If we would like to support option 4 and 5, we should also take MAC CE into account.Option 7 and 8 need a cell centre location. This has not been agreed and it may not be feasible for earth moving cell.Furthermore, another simple way is to randomly select, with equal probability or certain probability if NW indicates this need. |
| Xiaomi | We prefer option 4. For option 1/2/7/8, it is UE to decide when to use 2-step RACH. However, gNB also knows the RTT information, gNB can simply configure UE whether to use 2-step RACH. There is no need for UE to decide. For 3, we don’t quite understand how to use UE ID to know whether to use 2-step RACH. For option 5/6, there is no need for UE to know the details of QoS requirement or slice ID, LCH based configuration is enough. |
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### 2.1.2 New criteria alone or works together with legacy mechanism

New criteria are proposed to be applied alone in NTN [1][4][9], and meanwhile some companies think new criteria should work in combination with legacy RSRP based selection mechanism [3][7].

**Question 2: Should new criteria be applied in NTN alone or work in combination with legacy RSRP threshold criteria?**

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| Company | New Criteria is applied alone? (Y or N) | New criteria works in combination with legacy RSRP threshold? (Y or N) | Comments |
| APT |  |  | It depends on which option in Q1 is accepted. This can be FFS after deciding the option of Q1. |
| Xiaomi | N | Y | New criteria works together with the legacy RSRP can help ensure the success of 2-step RACH.  |
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### 2.1.3 Enable 2-step RACH per logic channel

If LCH based RA type selection is adopted in section 2.1.1, we can further discuss whether to allow 2-step RACH configured for each logical channel [5]. The UE selects 2-step RACH only if the logical channel that triggers RACH procedure is allowed to use 2-step RACH. Otherwise, the UE selects 4-step RACH.

**Question 3: If LCH based RA type selection is adopted, whether to further allow 2-step RACH to be configured for each logical channel?**

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| Company | Whether to further allow 2-step RACH configured for each logical channel? (Y or N) | Comments |
| APT | Y | MAC CE should also be considered. We have agreed that BSR MAC CE can be transmitted over 2-step RA. Thus, if a BSR is triggered and there is no available UL-SCH resource to accommodate a BSR MAC CE, the UE should directly initiate a RA procedure and select 2-step RA type (i.e., regardless of the SR). |
| Xiaomi | Y | We can further discuss whether to have explicit indication of using “2-step RACH” for each logical channel or based on other configuration e.g. whether Disabling HARQ feedback is configured. |
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### 2.1.4 Intra-satellite handover

A RA type selection mechanism in handover scenario is proposed in [3]. The corresponding text is quoted as “in RRC\_CONNECTED mode, the intra/inter-satellite hand-over cases can be identified simply by using the NR cell ID (PCI , GCI). The source gNB can determine if the measurement reports from the UE corresponds to a cell from the same satellite or different satellite. The UE then can be instructed to perform 2-step RACH if it is an intra-satellite handover; else the default configured 4-step RACH is to be used by UE.”

The key operation is that network instructs UE to perform 2-step RACH in condition that this is an intra-satellite handover. How to determine it is an intra-satellite handover is dependent on network implementation, e.g. based on measurement report.

**Question 4: Whether to allow network to instruct UE to perform 2-step RACH in** **intra-satellite handover scenario?**

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| Company | Whether to allow network to instruct UE to perform 2-step RACH in intra-satellite handover scenario? (Y or N) | Comments |
| APT  | Y | This already supported by Rel-16. The NW can explicitly configure CFRA resource for 2-step RA type for handover in *rach-ConfigDedicated* in handover command. If the UE receives this kind of handover command, the UE should perform 2-step RACH. \*Note that in Rel16, the NW cannot configure CFRA resources (for HO) for 4-step and 2-step RA types at the same time for a BWP. |
| Xiaomi | Y | it is network implementation to decide whether 2-STEP rach resource is configured for intra-satellite HO, we do not see any spec impact. |
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### 2.1.5 RA type switch

The RA type switch procedure is also mentioned in [4] and [6]. A proactive switching from 2-step RACH to 4-step RACH is proposed in [4], i.e. based on time or number of received fallbackRAR, other than current maximum number of MSGA transmissions (*msgA-TransMax*). In [6] it is proposed to introduce separate BI indication for 2step and 4step RA, the reasoning is that “In case 2step RA load is very high, NW can use include BI indication in subsequent RA response, and for UE receive the BI for 2step, it will select 4step type for RA if applicable during running of 2step BI timer or vise versa”.

**Question 5: Whether to support additional RA type switching mechanism other than current threshold of MSGA transmissions (*msgA-TransMax*)?**

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| Company | Whether to support proactive RA type switching, e.g. based on time or number of received fallbackRAR? (Y or N) | Whether to support separate BI indication for 2step and 4step RA? (Y or N) | Comments |
| APT | N | N | If 2 step RA load is very high, NW can configure *msgA-Trans-Max* with lower value. |
| Xiaomi | N | N | For switching based on time, it is actually the same as msgA-TransMax; For switching based on number of received fallbackRAR, in this case, if network will anyway indicate fallback, then UE will perform 4-STEP RA, it doesn’t matter if RA is performed through 2-STEP RA fallback or 4-step RA directly. So, there is no need to switch to 4-STEP RA.For the support of separate BI indication for 2 step and 4 step RACH, congestion may not be the main factor to decide whether to use 2 step or 4 step but rather the QoS requirement. If we introduce congestion based dynamic switch between 2-step and 4 step, it may degrade QoS. Besides, current mechanism can already support 2 step RACH switch due to congestion based on msgA-TransMax, there is no need for additional more dynamic control. Furthermore, currently there is only one reserved bit left in BI, we should be careful when use the last reserved bit. |
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## 2.2 TA report

In NTN scenario, in order to assist uplink scheduling, RAN2 made the agreement in RAN2#112 to further discuss about reporting UE-calculated TA in e.g. msg3/msg5/msgA:

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| 1. At least the following are FFS in Rel-17 NTN:

• Report UE-calculated TA in e.g. msg3/msg5/msgA• Enhancements to RSRP-based selection mechanism of 2-step vs. 4-step RACH • LCP impact caused by disabling HARQ UL retransmission |

Regarding TA report, the following issues need to be addressed according to companies’ contributions:

1. The content of this TA report, e.g. UE specific TA or coarse value range.
2. When to report, e.g. msg1/3/5/A.
3. Which signalling format is applied, e.g. MAC CE or RRC signalling.
4. If TA report can be requested by network?
5. If TA reporting can be done periodically?

In the remaining part of this section, we discuss the details one by one.

### 2.2.1 Basic design

All relevant contributions mention that UE specific TA or UE specific RTT should be reported to gNB [1][5][6][8]. But with respect to exact value, companies have different views as below:

1. Reporting fine value. UE specific RTT or User specific TA (NTA as defined by RAN1 for MsgA/Msg1 transmission), and the exact information (e.g. size) depends on RAN1 outcome [1][6][8].
2. Reporting coarse value range. This UE-calculated TA value range can be represented by MSG1/MSGA PRACH resource [5].

**Question 6: What is the content of TA report, i.e. User specific TA as defined by RAN1 or coarse UE-calculated TA value range represented by MSG1/MSGA PRACH resource?**

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| Company | User specific TA as defined by RAN1? (Y or N) | Coarse UE-calculated TA value range represented by MSG1/MSGA PRACH resource? (Y or N) | Comments |
| APT | Y | N | The intention for a TA report is to ensure NW has an absolute TA value. Without the absolute TA value, NW may not know the UE-gNB RTT and thus may have difficultly to schedule DRX or UL transmission. Coarse value may work but if it is based on the selected RACH resource, then it is like having a TA report with 1-bit or 2-bit quality. This might not be helpful to NW. |
| Xiaomi | Y | N | PRACH resource set based indication of TA is too coarse to be useful. And it limits the use of PRACH resource for UE and may result in RA collision or waste of PRACH resource. |
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**Question 7: If the exact User specific TA as defined by RAN1 is included in TA report, if companies agree to adopt the following principles for TA report delivery [1][8]:**

* **For 4-step RA, the UE-calculated TA report can be multiplexed in Msg3 if the size of the Msg3 is enough. Otherwise, the UE-calculated TA reported should be transmitted via Msg5.**
* **For 2-step RA, the UE-calculated TA report can be multiplexed in MsgA PUSCH if the size of the MsgA PUSCH is enough. Otherwise, the UE-calculated TA reported should be transmitted via an UL-SCH resource scheduled by MsgB.**

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| Company | Whether the principle above for TA report delivery is agreeable? (Y or N) | Comments |
| APT | Y | Agree in this principle. The intention is to let NW know the absolute TA as soon as possible to improve the scheduling efficiency.  |
| Xiaomi | Yes | RAN1 need to decide if allocating larger resources for msg3 is possible and it is impact to the UL coverage. Similar argument for MsgB. |
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**Question 8: If the User specific TA as defined by RAN1 is reported in MSG3/MSG5 in 4-step RACH or an UL-SCH resource scheduled by MsgB in 2-step RACH, whether the value should be adjusted by the TA Command? It means the reported UE-calculated TA is (NTA + timing adjustment in RAR/MSGB) [1].**

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| Company | Whether the adjusted UE-calculated TA is reported? (Y or N) | Comments |
| APT | N | The intention is to let NW know the absolution TA. During the initial access, the only missing information for NW is the UE-calculated TA. TA adjust in RAR/MsgB is known by NW. |
| Xiaomi | Y | It has been agreed by RAN1 |
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In [8] it is proposed that UE-calculated TA can be reported by MAC CE, and the other candidate is RRC signalling obviously.

**Question 9: If the exact User specific TA as defined by RAN1 is included in TA report, which signalling format is used, i.e. MAC CE or RRC signalling?**

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| Company | UE-calculated TA is reported by MAC CE? (Y or N) | UE-calculated TA is reported by RRC signalling? (Y or N) | Comments |
| APT | Y | N | No strong preference. Both formats shall fit the requirement to deliver the UE-calculated TA. However, using MAC CE will align with the current TA mechanism, which might be more understandable than using RRC. |
| Xiaomi | Y | N | Considering that UE may need to update TA very frequently in low orbit case(e.g. 600Km), MAC CE is more dynamic than RRC signalling, and consumes less signalling. |
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### 2.2.2 Supplementary procedure

In [8] the following enhancements are proposed:

Proposal 5: The UE-calculated TA report can be requested by gNB.

Proposal 6: The UE-calculated TA can be reported periodically.

**Question 10: if the following enhancements can be agreeable:**

* **The UE-calculated TA report can be requested by gNB.**
* **The UE-calculated TA can be reported periodically.**

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| Company | The UE-calculated TA report can be requested by gNB. Is it agreeable? (Y or N) | The UE-calculated TA can be reported periodically. Is it agreebale? (Y or N) | Comments |
| APT | Y | Y | In RRC\_CONECTED, RAN1 has agreed to support UE-calculated TA to maintain UL timing. NW may loss the absolute TA if there is no TA report either triggered by gNB or provided periodically from UE.

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| **Agreement** in RAN1#113-eFor TA update in RRC\_CONNECTED state, combination of both open (i.e. UE autonomous TA estimation, and common TA estimation) and closed (i.e., received TA commands) control loops shall be supported for NTN. FFS: Details of the combination of open and closed loop TA control. |

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| Xiaomi | Y | Y | Both should be supported |
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## 2.3 sr-ProhibitTimer

Two different handling of sr-ProhibitTimer are proposed, i.e. Extend the value range of *sr-ProhibitTimer* [10][12] or introduce an offset for *sr-ProhibitTimer* [11]. Regarding the extension of sr-ProhibitTimer, two ways are mentioned in [11], i.e. “adding the UE specific RTD or a multiple of it to one of the values of the already existing set of configurable values”. And one reason for not delaying the start of sr-ProhibitTimer is that “the UE behaviour during the offset is the same as that when *sr-ProhibitTimer* is running, i.e. the UE should not resend a SR during the offset.” [10].

**Question 11: how to handle sr-ProhibitTimer? Three options for consideration:**

**Option 1: Extend the timer length of *sr-ProhibitTimer* by adding the UE specific RTD to the configured *sr-ProhibitTimer* length. [10][12]**

**Option 2: Extend the timer length of *sr-ProhibitTimer* by adding a multiple of UE specific RTD to the configured *sr-ProhibitTimer* length. [12]**

**Option 3: UE starts *sr-ProhibitTimer* *K\_offset* after the UE transmits SR on one valid PUCCH resource. *K\_offset* is defined by RAN1 for uplink scheduling. [11]**

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| Company | Which option can be adopted? (option1/2/3) | Comments |
| APT | 1 | The *sr-ProhibitTimer* should be extended to keep running in the time period that the UE does not have a chance to receive the NW scheduling in response to receive the SR from UE. For option 2, we are not sure why multiple UE RTTs are needed.Option 3 is not clear since we never define the UE behavior while *sr-ProhibitTimer K\_offset* is running. |
| Xiaomi | option 1 | In IOT NTN option 1 is agreed. To align with IOT NTN, we should adopt option 1. |
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# 3 Conclusion

Based on the discussion in the previous section we propose the following:

# 4 Reference

1. R2-2100998 Remaining issues on RACH in NTN Huawei, HiSilicon
2. R2-2100158 Discussion on RACH in NTN OPPO
3. R2-2101048 Discussion on 2-Step RACH adaptation in NTN Nokia, Nokia Shanghai Bell
4. R2-2101125 Considerations on RA type selection and switching in NTN Lenovo, Motorola Mobility
5. R2-2101582 Discussion on random access aspects LG Electronics Inc.
6. R2-2101584 Considerations on Random Access in NTN ZTE Corporation, Sanechips
7. R2-2101790 NTN 2-step RACH selection enhancements Convida Wireless
8. R2-2101823 UE calculated TA report Asia Pacific Telecom, FGI
9. R2-2101833 Enhancements on RACH in NTN Asia Pacific Telecom, FGI
10. R2-2100159 Discussion on MAC timers in NTN OPPO
11. R2-2100416 Considerations on MAC timers in NTN CAICT
12. R2-2101297 Enhancements for NTN on MAC Layer THALES

# Annex

In order to ease possible offline discussions, all delegates having provided input in this document are requested to fill the following table.

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| Company | Name | Email Address |
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