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]
9. Based on a group which can be associated with UE type, power class, GNSS capability, time and frequency synchronization/compensation accuracy etc.

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. |
| Ericsson | First, the difference in propagation loss over a cell is small so likely the coverage of 2-step and 4-step is similar, however 4-step random access is more robust than 2-step. Therefore, the RSRP criteria will have to be fulfilled, for example to handle shadowing. Secondly, the RSRP changes slowly on average for a UE in LoS, however the RSRP for a specific UE may fluctuate in a less predictable fashion. If you look at the channel models in TR 38.811 you can see that the LoS probability changes with the elevation angle which means that the RSRP may vary rapidly. Thus, to base the selection between 4-step and 2-step on the distance or elevation is potentially detrimental to performance.Thirdly, the gNB can detect any problems on RACH and reallocate resources, for example add RACH resources for all UEs or move UEs in CONNECTED to use dedicated RACH resources (or move CONNECTED mode UEs to a different BWP).Therefore, we suggest to only use RSRP as in legacy, and any of these optimizations can be considered for future releases if 2-step/4-step selection turns out to be a problem.Note that 2-step RA fallback to 4-step does not require that 4-step RA resources are configured (the fallbackRAR is effectively as the msg2 of 4-step and it schedules msg3 where ever it want – just as in 4-step – without configuring 4-step RA resources).About the options:1. From a small area on earth, the difference in propagation loss to different cells of the same satellite will only have small variations. The interference situation may be severe if many users in this small area are connected to different cells. It is not obvious that the UE-satellite RTT would matter in this or other situations.
2. Same as for 1, it is not obvious that the UE-satellite will help.
3. This is not necessary. Load on RACH from IDLE/INACTIVE UEs can be controlled by adding more resources for RACH or by access class barring. Load on RACH from CONNECTED mode users can be controlled by using dedicated RACH resources in CONNECTED (and UEs in CONNECTED may even have separate groups that further divide the RACH resources for them) which removes the load on the RACH resources accessable from IDLE/INACTIVE.
4. It is already a possible to have separate SR resources for each LCH. This is a general enhancement and is not related to NTN. We see no need for this.
5. The network can allocate seprarate RACH resources for an important UE in legacy. If this proposal is to have LCH based RA type selection, that is a general enhancement not related to NTN which there is no need for.
6. This seems like a general enhancement and is not related to NTN. We see no need for this.
7. Same as 1, it is not obvious that elevation angle will help.

Same as 1, it is not obvious that relative location of the NTN cell will help. |
| MediaTek | We think these enhancements are unnecessary at this point of time. It is better to just continue using RSRP. Hence, we suggest to only use RSRP as in legacy systems.  |
| CATT | Option 1 UE specific UE-satellite RTT may be discussed further.In our understanding, option 1 and option 2 are the similar mechanism. The UE specific UE-satellite RTT is calculated by the distance from UE to satellite. But option1 is more specific. Like the legacy criteria, the NW can configure the threshold of UE specific UE-satellite RTT, and the UE selects 2-step RA type VS 4-step RA type based on configured threshold. |
| Nokia | We support enhancements based on Option1 and Option5. The motivation to have 2-step RACH in NTN is to reduce latency. To avoid 2-step RACH overload, it is reasonable to select 2-step for time-critical service while select 4-step RACH for delay-tolerant service. Thus, UE may need support QoS requirement differentiation (e.g. latency requirement of different UL logical channel) in RA type selection. Furthermore, considering no obvious near-far effect in NTN, UE located at cell edge can reduce latency more than UE at cell centre by using 2-step RACH if UEs have similar coverage. How to identify the cell edge UE can base on either estimated RTT or distance between UE and satellite. Since Option1 and Option2 are similar mechanism and UE will estimate RTT before RACH, it seems Option1 is better.  |
| OPPO | We think UE location information should be considered on top on RSRP to compensate the unobvious near-far effect in NTN, any of option 1/2/7/8 is ok, we just need to choose one from these options.In addition, for SR triggered RACH, the delay requirement of different UL logical channels could be considered in RA type selection in order to balance the load between 2-step RACH and 4-step RACH, and satisfy the delay requirement for some delay sensitive services, so we also prefer option 4/5. |
| Qualcomm | In our view, only choosing one over another is not sufficient. We have added a new option (9). We would need more than one criterion. At least we need “RSRP based + (1) and/or (5) and/or (9)”. 2, 7 and 8 are covered by (1). 4 and 6 are covered by (5).  |
| Sony | We prefer Option 1 and 2. If TA > Threshold, use 2-step. If RTT > Threshold, use 2-step.Ideally, if UE knows that it is on NTN, it should always use 2-step in order to minimise the impact of large RTT on the duration of the RACH procedure. |
| Lenovo | We support Option 1, 4 and 6.Option 1 is a preferred option as 2-step RA is helpful in mitigating the impact of the propagation delay which is important for UEs with time-sensitive services. And UE needs to calculate the propagation delay before initiating RA for TA pre-compensation, therefore the result can also be used for RA type selection. Option 2 is similar to Option 1 as propagation is calculated by distance.We also think Option 4 and 6 can be considered as UE with time-sensitive services needs 2-step RA the most. This could be a common case in NTN and TN but in TN reducing the latency caused by the propagation delay (e.g. 0.033ms) is not so important to a time-sensitive service as that in NTN (e.g. 25.77ms~541.46ms). For NTN it is more important to let a UE with time-sensitive service (rather than with smaller/larger propagation delay) to use 2-step RA. |
| CMCC | Option 1/2/7/8 are all variants of UE location based solution. For opt.3 and opt.6, how to assign UE ID may be difficult. For opt.4 and opt.5 are similar, distinguishing different service types.  |
| ZTE | None. To us one of the most important reason to have RSRP threshold for RA type selection is to guarantee minimum requirement for reliable MsgA transmission, at least for this reason RSRP threshold based mechanism is needed in NTN.Another usage of this RSRP threshold is to balance the RA load between 2step and 4step. In TN, multipath effect could result in variance of RSRP which naturally split UE between 4step and 2step in a random way, while for NTN the RSRP fluctuation is relatively flat therefore enhancements might be needed. For this motivation we propose to have separate BI for different RA type to balance the load between different RA type as well as mitigate the congestion situation. Though alt1/2/3/7/8 can achieve similar purpose but BI-based solution are more flexible since NW can dynamically adjust BI for different RA type based on the RA request received. Also, Alt 7/8 requires additional broadcasting on reference point, which requires further discussion. Alt 4/5 more like enhancement to SR, which can be achieved by dedicate SR/CG resources in a implementation way, no enhancement in RACH is needed. Alt6 is not an NTN specific enhancement, which can be discussed in main session. |
| LG | We prefer Option 4. For Option 1/2/7/8, it is a selection method for the 2-step RACH based on UE’s GNSS information. However, the network may know the UE’s GNSS information. Considering this, the network can distribute to use the 2-step RACH to the multiple UEs based on UE’s GNSS information. Thus, we are not sure whether the enhancement based on the GNSS information is needed to select the 2-step RACH. |
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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.  |
| Ericsson | N | N with comment | No need for the optimizations in Q1. If any new unnecessary criteria are added, then RSRP will be needed to handle for example shadowing. |
| MediaTek | N | N | No need for these optimizations, mentioned in Q1.  |
| CATT |  |  | The Q2 may be FFS when the Q1 is not confirmed. Once Q1 is confirmed, we can continue to discuss it. |
| Nokia | N | Y | UE’s channel conditions at low elevation angles might prevent the successful use of 2-step RACH even if desirable due to larger delays, which may result in higher RACH latency than 4-step RACH. So, we think new criteria works in combination with legacy RSRP threshold is reasonable. |
| OPPO | N | Y | Legacy RSRP threshold should be considered as baseline. |
| Qualcomm | N | Y | Minimum RSRP threshold may need to be defined for transmitting PUSCH in 2 step RACH.  |
| Sony | Y | N | RSRP will not vary much within a spot beam footprint. |
| Lenovo | Depends | Y | We think whether new criteria are applied alone or not should depend on that new criteria will be agreed, and how the RSRP threshold is configured. E.g. if *msgA-RSRP-Threshold* is only configured as the lower bound of ensuring successfule 2-step RA, the new criteria should be combined with msgA-RSRP-Threshold. Otherwise the new criteria may be applied alone for RA type selection. |
| CMCC | N | Y | RSRP is still helpful for RA type selection. Anyway, the final solution in Q1 should be determined first. |
| ZTE | N | N | As commented in Q1, RSRP threshold is needed for guarantee the minimum requirement for MsgA transmission, and we don’t think new criteria is useful. |
| LG | N | Y | The RSRP for selection of RACH type was introduced in order to ensure the transmission of the MsgA reliability. Considering this, a new criteria should be considered in RACH type selection on top of the RSRP. |
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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. |
| Ericsson | Disagree | This is a general improvement of the scheduling request procedure. If each LCH has its own 2-step RA resources, this will waste resources.No need for this optimization.  |
| MediaTek | N | We agree with Ericsson that there is no need for this optimization. |
| CATT | N | UE specific UE-satellite RTT is good enough to be the additional criteria. |
| Nokia | Y with comment | We don’t think each LCH should has ist own 2-step RA resource. However, we agree the intention that different LCH can trigger 2-step or 4-step RACH based on it’s QoS requirement. |
| OPPO | Y | First we need to clarify that LCH based RA type selection does not mean each LCH has its own 2-step RA resource, it means whether to allow the logical channel that triggers RACH procedure to use 2-step RACH.To allow 2-step RACH to be configured for each logical channel is the most straightforward way to implement LCH based RA type selection. |
| Qualcomm | Yes | If there is congestion, network may want to enable 2 step RACH only to high priority logical channel and share the time/frequency resource to multiple UEs. |
| Sony | N | We think this is an optimisation |
| Lenovo | N | We think this optimization is not needed. |
| CMCC | Yes | Configuration of 2-step RACH per logical channel is acceptable only when the LCH based RA type selection is agreed in RAN2. |
| ZTE | N | Share the same view as Ericsson. |
| LG | Y | How to configure 2-step RACH for each logical channel should be discussed further. |
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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. |
| Ericsson | Y | Already possible by the network identifying that a handover is performed to a cell whose cellID is associated with the same satellite and then configuring it with 2-step RA. This will also work for cells of other satellites as the UE can accurately estimate the needed TA by using the GNSS receiver.  |
| MediaTek | Y | We believe this is already supported in Rel-16. Note that 2-step RA can also be used for inter-satellite handover. |
| CATT | Y | Criteria of 2-step RA and 4-step RA in Rel-16 still will work for the handover scenario. |
| Nokia | Y | It’s NW implementation to instruct UE to perform 2-step RACH or 4-step RACH in intra-satellite handover scenario. Using 2-step RACH in intra-satellite handover results in a fast random access, while the likelihood of RACH interference is low, because the UE may reuse TA estimates from the current serving cell connection. |
| OPPO | Y | 2-step RACH in handover has been supported in Rel-16, and we don’t need to limit the use of 2-step RACH for handover in NTN. It depends on network implementation, and we see no spec impact. |
| Qualcomm |  | Network may or may not configure 2 step RACH for handover. In NTN, question is whether 2 step RACH can be used for inter-satellite handover? We can leave this to RAN1. |
| Sony | Y | It is upto Network implementation |
| Lenovo | Y | NW implementation can handle. |
| CMCC | Y |  |
| ZTE | Y, and | Legacy mechanism can be reused in this scenario. |
| LG | Y | RAN2 agreed that 2-step RACH is used for NTN.  |
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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. |
| Ericsson | N | N | gNB may configure *msgA-Trans-Max* with low value if needed. If load between 2-step and 4-step is not even, gNB may reallocate resources to even out the load. No need for further optimizations by basing the selection on the BI.This is a general optimization not specific for NTNs. |
| MediaTek | N | N | We think there is no need to introduce a new mechanism. |
| CATT | N | N | It is unnecessary to support additional RA type switching mechanism when the existing mechanism can work.  |
| Nokia | N | FFS | It is a network implementation issue on how to configure maximum number of MSGA transmissions (*msgA-TransMax*) to avoid large access delay and congestion/contention on 2-step RA resources. It seems not necessary to introduce additional proactive RA type switch mechanism.We think it is beneficial to have NW controlled mechanism on 2-step/4-step RACH type selection based on RACH load. How to use the BI indicator in RAR for 2-step/4-step load control can be FFS. |
| OPPO | N | N | The current msgA-TransMax based RA type switching is sufficient. No need to introduce other mechanism. |
| Qualcomm | N | N | We also think simply network can configure small value of msgA-TransMax. This should be sufficient to fallback to 4 step RACH. |
| Sony | N | Y | The BI indicator will allow more dynamic switch between 4-step and 2-step RACH. As large number of UEs are expected to be present in one satellite cell, congestion problem could be more acute, therefore a dynamic solution would be beneficial.  |
| Lenovo | Y | N | This could be an issue as a consequence of inappropriate RA type selection in NTN (e.g. only using *msgA-RSRP-Threshold* without further enhancement). Our concern is that if most UEs select 2-step RA, there will be frequent contention resolution failures but these UEs still need to attempt *msgA-TransMax* MSGA transmissions until it can switch to 4-step RA. In this case relying on NW implementation on configuring an appropiate *msgA-TransMax* may not be sufficient as no information can be refered from the idle/inactive UEs. |
| CMCC | N | N | The NW can adjust the configuration value of *msgA-TransMax* according to the 2-step RA load. |
| ZTE | N | Y | Timer based solution is no differentiate than counter based solution.As explained in Q1, due to flat RSRP fluctuation in NTN, it might no be feasible for NW to rely on RSRP criteria to randomly split UE between two RA type. The benefits to have separate BI for different RA type is that NW can based on the RA load on different RA type to dynamically adjust BI without additional signalling. |
| LG | N | N | We do not see the need of introducing additional RA type switching mechanism.  |
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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. |
| Ericsson | RAN1 may select to report the UE position instead. | N | There are discussions on reporting the UE position instead of the used TA. Thus, it is too early to say it will be user specific TA. Reporting the UE position instead of TA has the advantage that using the satellite ephemeris the gNB can accurately predict how the TA will change, and thus reporting frequency may be lower. Alternatively, the TA reporting may include a TA drift value that the UE predicts. Note that reported TA can be used to accurately estimate the position of the UE, only a few samples during a connection is needed, but it is easier if UE report position directly. We should not further segment the available RACH resources by having groups based on the TA range. |
| MediaTek | Y | N | The new method might have impacts on RACH capacity and there is no benefit. |
| CATT | Y | N | Reporting fine value. From gNB’s perspective, UE-gNB RTT will be applied to the configuration, e.g drx-HARQ-RTT-TimerDL. So the fine value is required.Furthermore, the value of User specific TA which indicates UE to Satellite is less than UE specific RTT (UE - gNB). So User specific TA(UE - Satellite) is better on saving signalling. |
| Nokia | FFS | N | We think the UE-calculated TA value reported to NW via MsgA/Msg3 or other PUSCH will add more overhead to PUSCH. How to encode reported TA need further study. Furthermore, whether and how to report UE position to NW can be FFS.Option2 (coarse value range represented by MSG1/MSGA PRACH resource) may increase the RACH collision if UE's TA is not even distributed. |
| OPPO | Y | N | The reported TA should be accurate enough to facilitate UL scheduling for the UE by network. TA report based on PRACH resource is too coarse, and it would cause PRACH resource split as well. |
| Qualcomm | Y | N | Resource partitioning should be avoided. |
| Sony | Y | N | Agree with Xiaomi |
| Lenovo | Y | N | A coarse TA value may not be useful to scheduling. |
| CMCC | Y | N | Since the TA is to be reported, it may be of little significance to report the coarse granularity TA. |
| ZTE | Y | N | The TA value will be used for subsequent scheduling as well as DRX configuration, it is preferred for UE to report finer values. |
| LG | Y | Y | During the RA procedure, the UE applies the TA value received in RAR during the RA procedure, which means the network should calculate the UE-calculated TA value before sending RAR. Thus, it would be good to receive the UE-calculated TA value by the network before the network sends the RAR to the UE. |
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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. |
| Ericsson | N | There are scenarios where the knowledge of TA has low value for the gNB, and therefore it shall be under network control if the UE shall report TA/position at all. The gNB do not need to know the TA/position immediately when entering CONNECTED, it is sufficient that gNB know it when it starts scheduling user data. See further Q9 about integrity and encryption. The purpose for the gNB to know the TA/position is that gNB may update the K\_offset (RAN1 agreement last meeting to support updating K\_offset after initial access) to match the TA, or adapt k0/k1/k2 such that K\_offset+k0/k1/k2 matches the TA. To have a K\_offset+k0/k1/k2 that matches the TA decreases the delay for UEs that do not experience the maximum RTT, the possible delay saving is (using values from 38.821):20.6 ms in RTT for UE at shortest RTT or 20.6/541.46 = 3.8% in GEO6.36 ms in RTT for UE at shortest RTT or 6.36/41.77 = 15.2% in 1200 km LEO6.24 ms in RTT for UE at shortest RTT or 6.24/25.77 = 24.2% in 600 km LEOWhen delays are changing for all UEs in a cell, it may be complicated to signal new Koffset values to all UEs and to know from when the new value is valid, this can be avoided by gNB adjusting the k0/k1/k2 instead.The potential delay gain will only be in the cells that are experiencing the minimum elevation angle of a satellite, and within those cells, only in a part of the coverage area. Cells close to nadir will have smaller differential delays. Thus, it may be few users in a cell that will have a gain by having Koffset+k0/k1/k2 lower than what is needed for the maximum RTT in the cell. |
| MediaTek | Yes, but | For 2-step RACH, SuccessRAR in MsgB does not include an UL grant. So MAC CE will be transmitted in the next UL grant. |
| CATT | Y | The value of UE-calculated TA is required by gNB. |
| Nokia | N | We think whether UE report UE-calculated TA to NW and in which message the report should be included should be controlled by NW. E.g. for some scenarios where the cell size is small enough to limit all UE’s differential RTT or when the UE has no time critical service, it is feasible to schedule UE with maximum TA of the cell and no TA report is needed. Furthermore, with information of UE-calculated TA value added to e.g. Msg3 or MsgA PUSCH as overhead, there is an increase the Msg3/MsgA PUSCH payload size which may impact PUSCH coverage. To balance impact to RACH successful rate and PUSCH scheduling delay, we think it's up to NW to inform UE in which message the report should be included. |
| OPPO |  | We agree with Nokia that whether UE report UE-calculated TA should be controlled by network.If TA report is requested by network, whether UE reports TA via MsgA/Msg3 or via later PUSCH transmission depends the PUSCH size allocated by network. Otherwise, UE does not report TA. |
| Qualcomm | Yes | TA is readily available data for UE from Msg1. If it is sent via MAC CE, whether to send it depends on LCP.  |
| Sony | Yes |  |
| Lenovo | Yes but | We understand the benifit but have concern on the size required for reporting. Besides we think it is better to be optional and controlled by NW. |
| CMCC | Yes with comments | Whether to introduce larger Msg3/MsgA size needs RAN1 input. |
| ZTE | Partially yes, and | The TA report in RACH will be used for subsequent Msg4/MsgB scheduling, to minimize the access delay, it is preferred that UE can always report the TA in Msg3/MsgA. Noted the ue-identity included in Msg3/MsgA consists 39 bits part of 5G-S-TMSI and 39 bits random value. Considering the ue-identity included is mostly used for contention resolution (48 bits), it shall be fine to take several bits out of the random value part for TA report, which can resolve the insufficient Msg3 space issue. For example if only service link delay is reported, then the maximum bits required in Msg3/MsgA is 9 bits assuming the worst case (e.g., maximum 270 ms in GEO). |
| LG |  | We prefer Msg1 indication for reporting TA.  |
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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 |
| Ericsson | Disagree | We think it is better to report the UE position, that avoids this issue as the main contribution to TA drift is the movement of satellites in LEO. If TA is reported, it shall be the updated TA used for the transmission. |
| MediaTek | Y | UE will report the updated TA, i.e. the actual TA that the UE is using for UL transmission. In other words this is estimated after updating the initial TA-estimate of the UE by the TA received in Msg2 during RACH. |
| CATT | Y | The reason why UE report the TA to gNB is that the value will be applied to the configuration, e.g drx-HARQ-RTT-TimerDL. The adjusted UE-calculated TA is more accurate. However we observe that TA(UE - gNB) includes the feederlink delay(Satellite - gNB) which is known by gNB. So it is better to report TA(UE - Satellite) instead of the whole TA(UE-gNB), in order to saving signalling. |
| Nokia | Y with comment | If UE report TA to NW is agreed (in Q6), we think UE should report the UE-estimated TA adjusted by TA command.  |
| OPPO |  | We think either option is ok, we just need to choose one.If UE reports the adjusted UE-calculated TA, network could derive UE’s absolute TA by adding the broadcasted common TA to the reported TA.If UE reports the UE-calculated TA, network could derive UE’s absolute TA by adding the broadcasted common TA and timing adjustment in RAR/MSGB to the reported TA. |
| Qualcomm | Y/N | Either way should work. If adjusted TA is reported, then RRC message is not best to carry it. |
| Sony | N | It should be absolute TA as calculated by UE |
| Lenovo |  | Either way can work. |
| CMCC | N | What is not clear on the NW side is only the pre-compensation part calculate by UE itself, with the consideration of the msg size limitation as well. |
| ZTE | No | As replied in Q7, UE shall always report TA in MsgA/Msg3. |
| LG | N | Agree with APT |
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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. |
| Ericsson | N | Yes, TA or position reported by RRC | The TA/position of the UE may be sensitive information – therefore it is better to have TA/position encrypted regardless of if TA or position is reported.It is important that the gNB have an accurate TA/position report, thus it is better to have the TA/position report integrity protected. Therefore, we need RRC signalling after security has been established with integrity protection and encryption which a MAC CE has not.The RRC signalling shall support the gNB requesting TA/position report (for example by a flag in RRCReconfiguration used to establish SRB2 and DRBs, and/or using a separate request message that can be sent whenever gNB needs an update).  |
| MediaTek | Y | N | MAC CE will result in faster mechanism than RRC. Also in legacy there is no issue with security of sending TA in MAC CE (in the downlink from gNB to UE). TA is a MAC function, and using MAC signalling is appropriate. |
| CATT | N | Y | No strong preference. The TA is required by gNB for UE-specific configuration, e.g. drx-HARQ-RTT-TimerDL, and it is not a control command which is carried in MAC CE. The TA value just shows the distance between UE and satellite.So RRC signalling looks good to report it. |
| Nokia | FFS | FFS | Both options are possible, and we think it’s up to the bits size requirement to report the TA report. RAN2 may need first discuss how to encode reported TA (e.g. based on a NW broadcast common delay and/or re-assign the meaning of each bit to save report bits) |
| OPPO | Y | N | For RACH triggered by MAC, it is unknow to RRC. So TA report should be via MAC CE. |
| Qualcomm | Y | N | MAC CE is also faster to process and generate report. Waiting until SMC is too late. |
| Sony | Y | Y | No strong preference and it depends on the message size |
| Lenovo | Y | FFS | We prefer MAC CE as a more dynamic option. And we need to discuss the format of TA report first and see if MAC CE is sufficient. |
| CMCC | Y | N | MAC CE is faster than RRC signalling. |
| ZTE | Y | N | There could be F1 impact if we consider RRC based solution. MAC CE is preferred which has less specs impact. |
| LG | Y | Y | Even if the Msg1 indication is used for reporting calculated TA, the MAC CE and RRC signalling can be used to report the calculated TA in CONNECTED. |
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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.

In [13], the following enhancements are proposed:

**Proposal 7**: **Whether UE report UE-calculated TA to NW and in which message the report should be included should be controlled by NW.**

**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. |

 |
| Xiaomi | Y | Y | Both should be supported |
| Ericsson | Y with comment | Y with comment | We think it is better that the UE report position than TA.The UE shall only report TA/position if gNB request it, possibly also periodic reporting of TA/position if it is under gNB control. |
| MediaTek | Y | Y | Both the options can be supported. However, we prefer periodic reporting as it reduces DL signalling from NW.Additionally, reporting can be triggered by a threshold/hysteresis in the UE (the threshold can be wrt the last reported TA + common drift rate). This would reduce the signalling overhead. |
| CATT |  |  | It can be FFS until there is clear requirement from gNB on TA value or LS from RAN1 on it. |
| Nokia | Y with comment | FFS | As proposal7 in [13], we think whether UE report UE-calculated TA to NW and in which message the report should be included should be controlled by NW. The periodically report seems not necessary if NW can request it on-demand. |
| OPPO | Y | Y | For UEs in RRC idle/inactive state, we agree with Nokia’s proposal that whether to report TA during RACH should be controlled by network.For UEs in RRC connected state, both periodic TA report and TA report requested by gNB should be supported. |
| Qualcomm | Y | Y | Network can be allowed to either request the TA or configure UE to report periodically.  |
| Sony | Y | Y |  |
| Lenovo | Y | FFS | As in Q7 we think it is better to be controlled by NW. Periodic report may not be necessary. |
| CMCC | Y | Y | Both could be considered. |
| ZTE | Y with legacy mechanism | N | Since TA will be maintained on both UE side and NW side, I am not sure why we need the periodical report.If UL Sync is lost, the NW can always trigger RACH by PDCCH order and re-establish the UL sync, if needed. So I guess the “The UE-calculated TA report can be requested by gNB” can be supported for free. |
| LG | Y | Y | Both options are feasible.  |
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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. |
| Ericsson | No option | The values to select for sr-ProhibitTimer shall include values that are shorter than the RTT, this is to support high prio bearers that send multiple SRs even before one RTT to decrease delay in case one SR is not detected by the gNB. Simplest configuration is to have a “sr-factor” times the RTT where the sr-factor can have values below and above 1 (this covers both option 1 and 2). If the RTT is a new RRC parameter, it may be reused for other timers (e.g., in MAC, RLC or RRC). The RTT may also be the UE estimated full RTT between the UE and the gNB. Probably each timer may have a separate factor times the RTT value. If using Koffset as value for sr-ProhibitTimer we cannot have values shorter than Koffset which is not acceptable as each LCH can have a separate SR configuration.  |
| MediaTek | Option 1 | We agree with Xiaomi that Option 1 will make it align with IoT NTN as well. |
| CATT | Option1 but | The range of sr-ProhibitTimer which is configured by RRC will be extended for NTN. But there is no need to specify how to extend the sr-ProhibitTimer which is up to gNB implemetation. |
| Nokia | No option | We agree with Ericsson that NW should allow UE to send multiple SRs within an RTT. We prefer to extend the value range of sr-ProhibitTimer by considering the NTN RTT together with legacy enumerated values (e.g. add more enumerated values which can cover RTT)  |
| OPPO | option 1 | Similar as drx-HARQ-RTT-TimerDL in the HARQ feedback enabled case, the sr-ProhibitTimer should be extended by an offset, which directly reflects the UE-gNB RTD. |
| Qualcomm | Option 1 | The timer extended by multiple RTD may be too long. Simply this time needs to be extended by one RTD. |
| Sony | Option 3/No option | Minimum spec impact |
| Lenovo | Option 1 | Aligns with the extension of other UP timers. |
| CMCC | 1 with comments | To align with IoT-NTN, Opt.1 is feasible. While for option2, multiple UE specific RTD may be not applicable. However, how to configure the timer should be NW implementation, which does not need spec. work. |
| ZTE | Simply add larger values for sr-ProhibitTimer | Agree with CATT that only increase the sr-ProhibitTimer is sufficient, and which value to be configured is up to NW’s implementation. |
| LG | Option 1 | We agree with Xiaomi. |
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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
13. [13] R2-2101063 On UL scheduling enhancements and UE-calculated TA report in NTN Nokia, Nokia Shanghai Bell

# 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 |
| APT | Hsin-Hsi Tsai | hsin-hsi.tsai@fginnov.com |
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