**3GPP TSG-RAN WG2 Meeting #119 electronic  *R2-210xxxx***

**Online, August 17th – 29th 2022**

**Agenda item: 7.2.2**

**Source: ZTE (rapporteur)**

**Title: Report of [AT119-e][104][IoT-NTN] CR timer**

**Document for: Discussion and Decision**

# Introduction

This document is the report of the following offline discussion:

***[AT119-e][104][IoT-NTN] CR timer (ZTE)***

*Initial scope: Discuss corrections related to contention resolution timer (from proposals in R2-2207056, R2-2207351, R2-2207600, R2-2207824, R2-2208563)*

*Initial intended outcome: Summary of the offline discussion with e.g.:*

*         List of proposals for agreement (if any)*

*         List of proposals that require online discussions*

*         List of proposals that should not be pursued (if any)*

*Initial deadline (for companies' feedback): Thursday 2022-08-18 0600 UTC*

*Initial deadline (for rapporteur's summary in*[*R2-22*](javascript:void(0);)*08754): Thursday 2022-08-18 1000 UTC*

# Contact Information

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| **Company** | **Name** | **Email** |
| ZTE | Lu Ting | lu.ting@zte.com.cn |
| OPPO | Haitao Li | lihaitao@oppo.com |
| MediaTek | Abhishek Roy | Abhishek.Roy@mediatek.com |
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# Discussion

In RAN2 #118e meeting, the new issues of blind Msg3 retransmission/false claiming of contention resolution failure were raised in IoT NTN for the first time. Such issues have been initially discussed in NR NTN. Some companies think it’s common for NR NTN and IoT NTN and so the issues were discussed in “*[AT118-e][048][IoT-NTN] New Issues”*[6]:

**Issue 1**, whether to support blind Msg3 retransmission: In RAN2#117e, blind Msg3 retransmission has been agreed to be supported for NR NTN, which enables NW to schedule Msg3 retransmission during the UE-gNB RTT in case NW wants to improve the coverage, without having to wait for the decoding result of the previous Msg3. Some companies suggested that IoT NTN should align with NR NTN and support blind Msg3 retransmission.

**Issue 2**, unintended declaration of contention resolution failure: this is also called the false claiming of contention resolution failure by some companies. After each Msg3 retransmission, CR timer would be restarted after the end of Msg3 retransmission plus UE-gNB RTT. But the current CR timer may expire before it is restarted, which would lead to the issue that the UE considers contention resolution as not successful, even if Msg4 would arrive later.

However, in RAN2 #118e meeting, no consensus was achieved for the above mentioned issues.

In the current RAN2 #119e meeting, several contributions [1][2][3][4][5] related to contention resolution timer issues are submitted to the User Plane aspect of IoT NTN (AI 7.2.2). In the document, based on the contributions, some initial proposals will be drafted for the online discussion.

## Whether the unintended declaration of Contention Resolution failure exist

With reference to the following observations in the contributions:

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| **Contributions** | **Related observations or opinions** |
| R2-2207056 [1] | Observation 2 Stopping mac-ContentionResolutionTimer upon receiving PDCCH indicating Msg3 retransmission could not only avoid unexpected expiry of *mac-ContentionResolutionTimer* but also be beneficial for UE power saving. |
| R2-2207351[2] | As shown in figure below, when Msg3 retransmission grant is received while the contention resolution timer is running, the contention resolution timer is not restarted immediately but after UE-eNB RTT. Therefore, it is possible the ongoing contention resolution timer expires before the scheduled contention resolution timer can be restarted. |
| R2-2207600 [3] | Company mentions that NR NTN has agreed some specification changes to support blind MSG3 retransmission and to avoid UE mistakenly declaring Contention Resolution not successful after MSG3 is retransmitted. But for IoT NTN, opinions are split and two options are discussed. |
| R2-2207824 [4] | Company mentions that even with suitable configuration, it would be very rare case that CR timer expires during RTT when Msg3 retransmission is scheduled, such rare case is still possible. That will cause unnecessary contention resolution failure. |
| R2-2208563 [5] | Observation 1: After a MSG3 retransmission, Contention Resolution timer started by previous MSG3 (re)transmission might expire before the timer is restarted after the UE-eNB RTT, which might lead to unintended declaration of Contention Resolution failure.  **Proposal 1: The false claiming of contention resolution failure is a bug in current specification which need to be fixed for IoT NTN.** |

Rapporteur understand companies have common understanding that, in IoT NTN, the issue of unintended declaration of Contention Resolution failure is indeed possible to happen and needs to be addressed.

**Draft proposal 1 (***[Easy Agreements]***): RAN2 needs to address the issue of unintended declaration of Contention Resolution failure after MSG3 is retransmitted.**

**Q1: Companies are invited to provide comments or suggestions for the Draft proposal 1.**

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| **Company** | **Comments** |
| OPPO | Yes |
| MediaTek | Yes |
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## How to address unintended declaration of Contention Resolution failure

According to the contributions, several options have been mentioned that could address the unintended declaration of Contention Resolution failure:

* Option1: Expiration of *mac-ContentionResolutionTimer* is not considered as contention resolution failure (or UE ignores expiration of *mac-ContentionResolutionTimer*) when a Msg3 retransmission is scheduled (Reuse NR NTN solution).
* Option2: UE stops *mac-ContentionResolutionTimer* upon reception of PDCCH indicating Msg3 retransmission.
* Option2a: UE stops *mac-ContentionResolutionTimer* upon starting Msg3 retransmission.
* Option3: Leave the handling of *mac-ContentionResolutionTimer* up to the UE implementation when a MSG3 retransmission is scheduled.

According to the previous discussion and contributions in this meeting, there is concern for the Option2 and Option2a, e.g., that means after Msg3 retransmission, UE doesn’t monitor PDCCH and it makes blind Msg3 retransmission impossible. Per rapporteur’s understanding, such concern may be also applied to Option 3, e.g., NW cannot schedule blind Msg3 retransmission without knowing the *mac-ContentionResolutionTimer* status in UE.

In the last RAN2 meeting, there are diverse views on whether blind Msg3 retransmission should be allowed [6]. In this meeting, some companies also give their views in details for this aspect. Therefore, rapporteur think firstly RAN2 needs to achieve common understanding on whether blind Msg3 retransmission is possible or should be allowed in IoT NTN.

### Whether blind Msg3 retransmission/early Msg4 transmission is allowed

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| **Contributions** | **Related proposals or opinions** |
| R2-2207056 [1] | “*In NR, given that the support of Msg3 repetition is an optional UE capability, blind scheduled Msg3 retransmission would be useful to improve coverage, especially for UEs not supporting Msg3 repetition. Unlike NR, Msg3 repetition was introduced in NB-IoT and eMTC in R13, which is an essential feature for NB-IoT and eMTC UEs. Therefore, we see no need to support blind scheduled Msg3 retransmission for IoT NTN on top of Msg3 repetition.*   1. *Blind Msg3 retransmission is not supported for IoT NTN.*” |
| R2-2207351 [2] | In the following figure, company has the assumption that blind Msg3 retransmission is possible in IoT NTN: |
| R2-2207600 [3] | Company mentions two possible UE behaviours during RTT:   * Option 1: There is no need to monitor PDCCH during RTT (i.e. no blind retransmission during RTT). * Option 2: There is need to monitor PDCCH during RTT (i.e. possible blind retransmission during RTT).   Company think Option 2 is not appropriate for IoT NTN as it is against the purpose of delaying the start of the timer by RTT. Option 2 may be equivalent to setting CR timer duration to the configured value plus RTT and this will cause lots of UE power consumption. Meanwhile, company also understand the concern for Option 1, e.g., the CR timer should be stopped upon scheduling of a MSG3 retransmission and then blind retransmission is not possible during RTT. |
| R2-2207824 [4] | “*Observation 1: In order to ensure a certain transmission reliability of Msg4 and the success rate of contention resolution, CR timer length setting should generally be able to satisfy a certain number of Msg4 transmissions (e.g., 1 initial transmission and 2 retransmission)..….*  *Observation 4: If NW can successfully decode the first few repetitions of Msg3 retransmission, NW can schedule the PDCCH for Msg4 earlier, e.g., no need to wait for reception all the repetitions (since the CR timer is already running). Such eNB scheduling implementation further help to avoid the possible unexpected CR timer expiration (before CR timer restart), especially in the case the maximum CR timer length for eMTC may not completely enough for eMTC over GEO.*  *After CR timer has been started, as UE would continuously monitor PDCCH, eNB would be allowed to earlier schedule Msg4 when it’s possible. Moreover, it’s also possible for NW to “blindly” schedule Msg3 retransmission earlier than completely reception of the previous Msg3 transmission.*” |
| R2-2208563 [5] | “*We understand extending the repetition for every scheduling is one implementation in NW to increase transmission robustness. However, blind retransmission is another possible implementation in NW where NW may keep the flexibility to schedule UE in multiple attempts considering the NW resource allocation status and UE’s repetition requirements. For example, Msg3 blind retransmission is quite useful at least for eMTC with small repetition number. Given the high RTT in NTN, multiple short transmissions could have benefits such as time-diversity and allow scheduling other UE in the intervals between transmissions.*  *In our understanding, both the repetition number extension and the blind retransmission are supported in legacy IoT. It is NW implementation strategy on how to schedule UE in different scenarios. It makes no sense to disable them for IoT NTN.*  ***Proposal 2: There is no need to restrict NW implementation to support repetition extension while no blind retransmission for Msg3 scheduling for IoT NTN.*”** |

Per rapporteur’s understanding on above companies’ views, more companies have the understanding that blind Msg3 retransmission is possible in IoT NTN and no need to restrict NW implementation not to perform this function. One company further mention early Msg4 transmission is also possible and should be allowed in IoT NTN. Then the following Draft proposal 2 is given:

**Draft proposal 2 (***[To be discussed]***): RAN2 confirms the understanding that blind Msg3 retransmission/early Msg4 transmission is possible (or should be allowed) in IoT NTN.**

**Q2: Companies are invited to provide comments or suggestions for the Draft proposal 2.**

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| **Company** | **Comments** |
| OPPO | Based on the companies views above, it seem three companies [2][4][5] tend to support blind Msg3 retransmission/early Msg4 transmission while other two companies [1][3] think blind Msg3 retransmission is not needed in IoT NTN. We suggest to revise the proposal as following:  **Draft proposal 2 (***[To be discussed]***): RAN2 discusses whether blind Msg3 retransmission/early Msg4 transmission is possible (or should be allowed) in IoT NTN.**  We don’t think blind Msg3 retransmission/early Msg4 transmission should be supported in IoT NTN.  In NR, as the support of Msg3 repetition is an optional UE capability, blind scheduled Msg3 retransmission would be useful to improve coverage, especially for UEs not supporting Msg3 repetition. Unlike NR*,* Msg3 repetition is an essential feature for NB-IoT and eMTC UEs. Compared with Msg3 repetition, blind scheduled Msg3 retransmission would consume more PDCCH resources, in our view blind scheduled Msg3 retransmission could be replaced by Msg3 repetition since network could dynamically determine Msg3 repetition number in UL grant indicating Msg3 (re)transmission. So we see no need to support blind scheduled Msg3 retransmission for IoT NTN on top of Msg3 repetition.  For early Msg4 transmission, it is not supported in TN (since mac-ContentionResolutionTimer is started after UE finish all the Msg3 repetition transmission), we think in NTN we should follow this principle. |
| MediaTek | The blind Msg3 retransmission/early Msg4 transmission is an optimization. Without it, the function is not broken.  The trickiest thing of blind Msg3 retransmission is network has to avoid the Msg3 retransmission scheduling (DCI N0) to overlap the first Msg3 NPUSCH transmission. To accommodate the round-trip delay, UE will transmit the Msg3 ahead of time. Due to the different location of UEs, the time in advance varies. And network does not know the exact time when the UE will transmit the Msg3. The network has to carefully evaluate the time range of UE Msg3 transmission and try to avoid overlapping the UE initial Msg3 transmission and UE receiving the Msg3 retransmission scheduling information (DCI N0). Moreover, the time duration of initial Msg3 transmission could be very long due to the repetition number. NPUSCH transmission will be interrupted by NPRACH occasion, make the NPUSCH transmission even longer. These two factors further limit the chance of network sending the Msg3 retransmission scheduling information.  In a short, for IoT NTN, it’s tricky for network to select time for msg3 retransmission. The solution is complicated and less practical.  We propose not to support blind Msg3 re-transmission at least for NB-IoT.  For the early msg4 transmission, there is no such overlapping concern, it can be easily supported. However, UE needs to keep monitoring PDCCH during the UE-eNB RTT for the possible early Msg4. The benefit of not stopping CR timer is not guaranteed while the benefit of stopping CR timer which saves power consumption is constant. |
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### Choice on the options

If RAN2 can confirm the understanding in proposal 2, only Option1 need to be agreed and the detailed text proposals for Option 1 can be further discussed. There are some support for Option 1 in contributions:

In R2-2207351[2], the company suggest that this problem can be simply resolved by not declaring it as expiry of contention resolution timer (as it is going to be restarted soon in future). The text proposal is as below:

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| - if *mac-ContentionResolutionTimer* expires:  - for BL UEs or UEs in CE or NB-IoT UEs:  - if notification of a reception of a PDCCH transmission has been received from lower layers before *mac-ContentionResolutionTimer* expired; and  - if the MAC PDU received until the subframe that contains the last repetition of the corresponding PDSCH transmission is successfully decoded; and  - if the MAC PDU contains a UE Contention Resolution Identity MAC control element; and  - if the UE Contention Resolution Identity included in the MAC control element matches the 48 first bits of the CCCH SDU transmitted in Msg3:  - consider this Contention Resolution successful and finish the disassembly and demultiplexing of the MAC PDU;  - set the C-RNTI to the value of the Temporary C-RNTI;  - discard the Temporary C-RNTI;  - consider this Random Access procedure successfully completed.  - else if notification of a reception of a PDCCH transmission addressed to Temporary C-RNTI indicating uplink grant for a Msg3 retransmission has been received before *mac-ContentionResolutionTimer* expired:  - not consider *mac-ContentionResolutionTimer* expired;  - else:  - discard the Temporary C-RNTI;  - consider this Contention Resolution not successful.  - except for BL UEs or UEs in CE or NB-IoT UEs:  - discard the Temporary C-RNTI;  - consider the Contention Resolution not successful. |

In **R2-2207824 [4],** the company gives the following proposals:

Proposal 1: According to legacy process of *mac-ContentionResolutionTimer* and also for facilitating the scheduling flexibility in NW and avoiding the missing of Msg4 scheduling, UE is not allowed to intentionally or [intermittently](https://dict.cn/intermittently) stop the CR timer by its implementation when a retransmission is scheduled.

Proposal 2: In order try to avoid the unnecessary contention resolution failure, UE can ignore such CR timer expiration when Msg3 retransmission is scheduled.

The corresponding text proposal is as below:

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| - if *mac-ContentionResolutionTimer* expires:  - for BL UEs or UEs in CE or NB-IoT UEs:  - if notification of a reception of a PDCCH transmission has been received from lower layers before *mac-ContentionResolutionTimer* expired; and  - if the MAC PDU received until the subframe that contains the last repetition of the corresponding PDSCH transmission is successfully decoded; and  - if the MAC PDU contains a UE Contention Resolution Identity MAC control element; and  - if the UE Contention Resolution Identity included in the MAC control element matches the 48 first bits of the CCCH SDU transmitted in Msg3:  consider this Contention Resolution successful and finish the disassembly and demultiplexing of the MAC PDU;  - set the C-RNTI to the value of the Temporary C-RNTI;  - discard the Temporary C-RNTI;  - consider this Random Access procedure successfully completed.  - else:  - if Msg3 is transmitted on a non-terrestrial network:  - if no PDCCH transmission addressed to its Temporary C-RNTI indicating uplink grant corresponding to a Msg3 retransmission is received before *mac-ContentionResolutionTimer* expired:  - discard the Temporary C-RNTI;  - consider this Contention Resolution not successful.  - else:  - discard the Temporary C-RNTI;  - consider this Contention Resolution not successful.  - except for BL UEs or UEs in CE or NB-IoT UEs:  - discard the Temporary C-RNTI;  - consider the Contention Resolution not successful. |

In R2-2208563 [5], the company gives the following proposals:

**Proposal 3: Reuse NR NTN solution to fix the issue of false claiming of contention resolution failure for IoT NTN.**

* **Expiry of Contention Resolution timer is not considered as contention resolution failure when there is Msg3 scheduled, which is more recent than the Msg3 that triggered the start or restart of the CR timer**

The corresponding text proposal is as below:

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| - if *mac-ContentionResolutionTimer* expires:  - for BL UEs or UEs in CE or NB-IoT UEs:  - if notification of a reception of a PDCCH transmission has been received from lower layers before *mac-ContentionResolutionTimer* expired; and  - if the MAC PDU received until the subframe that contains the last repetition of the corresponding PDSCH transmission is successfully decoded; and  - if the MAC PDU contains a UE Contention Resolution Identity MAC control element; and  - if the UE Contention Resolution Identity included in the MAC control element matches the 48 first bits of the CCCH SDU transmitted in Msg3:  - consider this Contention Resolution successful and finish the disassembly and demultiplexing of the MAC PDU;  - set the C-RNTI to the value of the Temporary C-RNTI;  - discard the Temporary C-RNTI;  - consider this Random Access procedure successfully completed.  - if Msg3 transimssion was transmitted on a non-terrestrial network  - if no PDCCH addressed to TC-RNTI indicating uplink grant for a Msg3 retransmission is received after the start of the mac-ContentionResolutionTimer:  - discard the TEMPORARY\_C-RNTI;  - consider the Contention Resolution not successful.  - else:  - discard the Temporary C-RNTI;  - consider this Contention Resolution not successful.  - except for BL UEs or UEs in CE or NB-IoT UEs:  - discard the Temporary C-RNTI;  - consider the Contention Resolution not successful. |

Then the following draft proposal is given:

**Draft proposal 3a (***[To be discussed]***): If RAN2 can confirm the understanding in proposal 2, RAN2 specify that expiration of *mac-ContentionResolutionTimer* is not considered as contention resolution failure (or UE ignores expiration of *mac-ContentionResolutionTimer*) when a Msg3 retransmission is scheduled.**

**Q3: Companies are invited to provide comments or suggestions for the Draft proposal 3a.**

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| **Company** | **Comments** |
| MediaTek | It is better to stop CR timer to save power. UE needs to keep monitoring PDCCH before CR timer expiry to try to get the possible early Msg4. The benefit of not stopping CR timer is not guaranteed while the benefit of stopping CR timer which saves power consumption is constant. |
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Per rapporteur’s understanding, for Option 1, it’s still unclear whether UE still monitors the PDCCH after UE ignores the expiration of CR timer? Companies may have different opinions. In R2-2207824 [4], company may think ignoring CR timer just keeps the UE from declaring CR failure, but UE still needs to monitor PDCCH for receiving Msg3 or Msg4 scheduling. But in R2-2208563 [5], company mentions UE only needs to monitor PDCCH when the CR timer is running. That means UE no longer needs to monitor PDCCH after it ignores the expiration of CR timer. Company think this is same as legacy PDCCH monitoring and would not increase the UE power consumption compared to TN. Therefore, RAN2 needs to clarify this ambiguity for Option 1:

**Draft proposal 3b (***[To be discussed]***): RAN2 clarify whether the UE still needs to monitor the PDCCH after UE ignores the expiration of *mac-ContentionResolutionTimer* when a Msg3 retransmission is scheduled.**

**Q4: Companies are invited to provide comments or suggestions for the Draft proposal 3b.**

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| **Company** | **Comments** |
| MeddiaTek | The early Msg4 is more likely to occur after the CR timer expiry and before the re-start of CR timer. From this point of view, UE needs to keep monitor the PDCCH during the entire UE-eNB RTT.  However, it looks wired to monitor PDCCH without a running CR timer. This is another reason that the CR timer should be stopped upon reception of PDCCH indicating Msg3 retransmission. |
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**Draft proposal 3c (***[To be discussed]***): RAN2 further discuss the text proposals in [2][4][5] for Option 1.**

**Q5: Companies are invited to provide comments or suggestions for the Draft proposal 3c.**

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| **Company** | **Comments** |
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If RAN2 cannot confirm the understanding in proposal 2, we need to make choice among Option2, Option 2a and Option 3 to address the unintended declaration of Contention Resolution failure.

In **R2-2208563 [5]**, company give some comparison for Option2 and Option2a: *For Option2 and Option2a, both options propose that UE should stop the Contention Resolution timer earlier before the expiry of the timer, to avoid false claiming of contention resolution failure by UE. The only difference is whether handle the timer expiry between the PDCCH and the beginning of PUSCH (PDCCH->PUSCH delay). Option2 can handle the case while Option2a not. In our understanding, Option2 is better than Option2a to cover more scenarios.*

In R2-2207056 [1], companies propose the Option 2 and the corresponding text proposal is given as following:

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| Once Msg3 is transmitted, the MAC entity shall:  - if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:  - if Msg3 is transmitted on a non-terrestrial network:  - if, for EDT, *edt-SmallTBS-Enabled* is set to *TRUE* for the corresponding PRACH resource:  - start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe corresponding to the last subframe of a PUSCH transmission corresponding to the largest TBS indicated by the UL grant plus UE-eNB RTT subframes.  - else:  - start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe containing the last repetition of the corresponding PUSCH transmission plus UE-eNB RTT subframes.  - if notification of a reception of a PDCCH transmission indicating Msg3 retransmission is received from lower layers:  - stop *mac-ContentionResolutionTimer*.  - else:  - if, for EDT, *edt-SmallTBS-Enabled* is set to *TRUE* for the corresponding PRACH resource:  - start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe corresponding to the last subframe of a PUSCH transmission corresponding to the largest TBS indicated by the UL grant.  - else:  - start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe containing the last repetition of the corresponding PUSCH transmission.  - else:  - start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission.  ……. |

**Draft proposal 4 (***[To be discussed]***): If RAN2 cannot confirm the understanding in proposal 2, RAN2 makes choice among the following options to address the unintended declaration of Contention Resolution failure:**

* Option2: UE stops *mac-ContentionResolutionTimer* upon reception of PDCCH indicating Msg3 retransmission.
* Option2a: UE stops *mac-ContentionResolutionTimer* upon starting Msg3 retransmission.
* Option3: Leave the handling of *mac-ContentionResolutionTimer* up to the UE implementation when a MSG3 retransmission is scheduled.

**Q6: Companies are invited to provide comments or suggestions for the Draft proposal 4.**

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| **Company** | **Comments** |
| OPPO | We prefer Option 2.  Compared with option 2a, option 2 could further save UE power.  For Option 3, we think *mac-ContentionResolutionTimer* state should be aligned between UE and NW, so that NW could schedule the UE during the running of *mac-ContentionResolutionTimer* properly. The handling of *mac-ContentionResolutionTimer* should not be up to UE implementation. |
| MediaTek | We prefer Option 1 or Option 2.  Option 3 make the network confusing if network is allowed to send the early Msg4. Ambiguity should be avoided.  For option 2a, nothing is expected from UE between the Msg3 retransmission scheduling information and Msg3 retransmission. Thus option 2 is preferred. |
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# Conclusion

*TBD*

*[Easy Agreements]*

*[To be discussed]*

# References

[1] R2-2207056 Discussion on mac-ContentionResolutionTimer in IoT NTN OPPO discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN

[2] R2-2207351 Clarification on the expiry of the contention resolution timer. Qualcomm Incorporated CR Rel-17 36.321 17.1.0 1544 - F LTE\_NBIOT\_eMTC\_NTN

[3] R2-2207600 Discussion on MSG3 retransmission Huawei, HiSilicon discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN

[4] R2-2207824 Discussion on contention resolution timer in IoT NTN ZTE Corporation, Sanechips discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN-Core

[5] R2-2208563 Issue on false claiming of contention resolution failure for IoT NTN Nokia, Nokia Shanghai Bell discussion Rel-17 LTE\_NBIOT\_eMTC\_NTN

[6] R2-2206420 Report of [AT118-e][048][IoT-NTN] New Issues (OPPO) – 1st round OPPO