3GPP RAN WG2 Meeting #117-e R2-2203567

eMeeting February 21st – March 3rd, 2022

Agenda Item: 8.10.2.1.1

Source: InterDigital

Title: [DRAFT] Report of [AT117-e][103][NTN] MAC open issues: Third Round

Document for: Discussion, Decision

# Introduction

This document is intended address a subset of remaining MAC open issues as per the following email discussion guidelines:

**[AT117-e][NTN][103] MAC open issues (InterDigital)**

* **Updated scope:**
  + **Continue the discussion on MAC open issues**
  + **Update the MAC CR**
* **Updated 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)**
  + **Updated MAC CR**

Please note the following deadlines:

* Updated deadline (for companies' feedback): **Monday 2022-02-28 1800 UTC**
* Updated deadline (for rapporteur's summary in R2-2203567): Monday 2022-02-28 2000 UTC

Please also note the following chair guidance:

* Proposals marked "for agreement" in R2-2203567 not challenged until **Tuesday 2022-03-01 1000 UTC** will be declared as agreed via email by the session chair (for the rest the discussion will continue offline).

# Remaining User Plane issues in NTN

## TA report with no UL-SCH resources available

Over the past several meetings RAN2 has discussed whether to support sending an SR when a TA report is triggered and no UL-SCH resources are available (or RACH if SR is triggered but there are no available PUCCH resources). The main discussion points are briefly summarized as follows, however companies are encouraged to refer to past offline summaries for detailed discussion:

* Those which do not support note that this may cause all connected UEs under the satelite coverage to update TA simultaneously due to satellite movement, which may cause signalling storm and significant additional overhead. Existing procedures are sufficient to provide TA report when most needed.
* Proponents note that TA reporting is important for network to adjust K-Offset and may impact subsequent UL/DL transmission if not reported. Any excessive signalling overhead can be controlled by network implementation.

In Round 2 of [AT117][103] it was proposed to use an SR delay timer (similar to BSR) as a compromise solution. Although this particular approach received limited support, many companies seem willing to make SR triggering due to TA report configurable, however prefer a simpler “On/Off” type configuration.

Rapporteur notes that although there are still a few companies which disagree, there remains strong majority support for triggering an SR for TA reporting (e.g., in RAN2#116bis-e this was supported by 14/17, 17/19, and 12/16 companies in various phases of RACH offline). It is therefore suggested that as a compromise the following solution be adopted and left to network implementation to enable/disable triggering SR for TA report.

**Question 1) Do you support the following compromise proposal?**

***Proposal: If a TA report is triggered and there are no available UL-SCH resources, the network may optionally configure UE to trigger an SR. When SR is triggered but there are no available PUCCH resources, UE will trigger RACH.***

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| **Company** | **Agree/Disagree** | **Additional comments** |
| OPPO | Agree with comments | Maybe the last sentence (i.e. When SR is triggered but there are no available PUCCH resources, UE will trigger RACH.) can be removed, since this is legacy mechanism. But it is also fine to keep it. |
| Nokia | See comments | We think NW implementation can handle the possible outdated Koffset thus there is no need for UE to trigger SR. However, we are OK to accept the compromised proposal for the sake of progress. |
| Qualcomm | Agree |  |
| Samsung | Agree |  |
| vivo | Disagree | We still think TA MAC CE should be reported asap for network to adjust K-Offset, otherwise it will impact the subsequent UL/DL scheduling.  For the compromise proposal, if NW configures UE not to trigger an SR for TA MAC CE report, UE will follow the legacy BSR-SR procedure, which means that UE will delay the TA MAC CE report until there is UL data. If we remember correctly, this has been discussed in the pre-discussion, which is not acceptable by most of companies.  We understand the intention of the compromise proposal is to solve the possible signalling storm. But as we mentioned in the Round 2 discussion, we do not see any such issue and think NW implementation can handle it well. |
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## UE location reporting for purposes of TA report

Reporting UE location information for purposes of TA report has also been discussed over many meetings, with overall opinion split. As noted in Round 2 discussion, UE location reporting is an RRC-based procedure, however there remains support for capturing a simple mechanism which relies on exiting RRC framework. Based on previous discussion, two approaches are proposed:

**Approach 1) Notify RRC specification of a TA reporting event**

One simple approach would be, if configured, for MAC to notify RRC of a TA reporting event. This type MAC-RRC interaction is already used in legacy specification (e.g. upon *timeAlignmentTimer* expiry in section 5.2), would have minimal specificaiton impact to both MAC and RRC, and would also not interfere with the existing Timing Advance Report procedure. An exemplary MAC text proposal is provided, however can be refined in Stage 3:

RRC configures the following parameters to control the TA reporting:

- [*ReportUELocation*]

…

The MAC entity shall:

1. if the UE-specific TA reporting procedure determines that at least one UE-specific TA report has been triggered and not cancelled:

2> if a TA Report has been triggered due to [TAOffsetThreshold] and [*ReportUELocation*] with value ‘true’ is configured by upper layers:

3> notify RRC to request UE location information.

2> if UL-SCH resources are available for a new transmission and the UL-SCH resources can accommodate the UE-Specific TA MAC CE plus its subheader as a result of logical channel prioritization:`

3> instruct the Multiplexing and Assembly procedure to generate the UE-Specific TA MAC CE as defined in clause 6.1.3.XX.

**Approach 2) Modification of D1 event**

An alternative approach would be a minor enhancement to the already agreed D1 event in RRC specification. This solution is also simple, would also have minimal specification impact, and (as noted by the proposing company) may be agreed in this session considering that control plane discussions did not consider the TA aspect of UE location reporting. The following changes are proposed:

* For the new Event D1, the reported location and referenceLocation1 is the 3D location (ellipsoidPointWithAltitude).
* For the configuration of Event D1, add a flag useLastReportedLocation that set referenceLocation1 to the last successfully reported location, if available, else set referenceLocation1 equal to the centre of earth.

Rapporteur notes that the above solutions would not impact the existing TA reporting procedure, and several network vendors have indicated that this is a useful feature. Furthermore, there is already an existing agreement from RAN2#116bis-e that network can ask the UE to report it’s location information at any time subject to adequate user consent.

It is therefore suggested that, under the assumption that network has adequate user consent, one of the above procedures can be supported to enable UE location reporting. As a compromise, this would not impact existing TA reporting procedure, and would rely on existing RRC reporting framework.

**Question 2) As a compromise, can you support one (or both) of the following options to enable UE location reporting?**

* **Option 1: Notify RRC specification of a TA reporting event.**
* **Option 2: Enhance existing D1 event.**

**Note: These solutions do not impact existing Timing Advance Report procedure, and are subject to receiving user consent.**

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| **Company** | **Supported Option(s)** | **Additional comments** |
| OPPO | Option 1 | We think it is inappropriate to reuse or modify Event D1 because Event D1 involves both referenceLocation1 and referenceLocation2 and it would be complicated to disable referenceLocation2 and the corresponding threshold in the spec. We should not waste time on this. |
| Nokia | Option 1 | The UE movement distance (UE location change) doesn’t mean the TA change since the trajectory of UE movement is unknown. Even with UE location reporting for TA purpose, the event to trigger UE location report should be **TA change threshold** instead of location change itself. Hence, we think the agreed TA change offset for TA value report (via MAC CE) should be reused here.  The existing D1 event is based on UE location itself which is not suitable for TA purpose. Instead, we think RAN2 should discuss how to define the **TA change threshold** in UP discussion and then inform RRC for the signalling design.  For NW, it can predict the TA based on UE **reported** **location** and satellite ephemeris data. For UE, it can predict the TA based on UE’s **current** **location** and satellite ephermeir data. Then   * If UE is stationary, the NW can perfectly predict the actual TA which the UE will experience, hence no UE location updated is needed. * If the UE is moving, the UE should calculate *a reference TA* between UE and satellite based on the last successfully **reported location** and the satellite positions for the current time. The UE should also calculate *an actual TA* between UE and satellite based on the **current UE location** and the satellite positions for the current time. Only if the *actual TA* and the *reference TA* deviation exceed the network configured TA change threshold, the UE provides a location update.   Hence, for the UE location report for TA purpose, we propose as below:  **Proposal: If the UE detects that the TA deviation between TA estimation based on *current UE location* and the TA estimation based on last successfully *reported UE location* is larger than network configured threshold, the UE should send a location update to the NW.** |
| Qualcomm | Other | Introduce a location event Lx in RRC. |
| Samsung | See comment | Consider UE location report can serve multiple purpose if it’s available by user consent, e.g. SMTC in connected mode, TA, we wonder do we specify separate trigger event for each purpose, or do we use a unified event for different purposes. If we specify separate event for each purpose, we are fine with option 1 if majority support UE location report for TA purpose although we don’t see much gain of supporting both mechanisms for TA reporting. If we specify a unified event for UE location report for any purpose, we are open to discuss whether to reuse (enhanced) event D1. |
| vivo | None | As we mentioned in Round 2 discussion, we do not support UE location reporting for TA purpose in this release. Also, as seem from above comments from companies, there are still divergent views on the specific mechanism they want. Considering the little time left, not supporting this feature is the only realistic way-out at this moment. |
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## Additional details of ra-ContentionResolutionTimer

In [AT117e], additional details of the *ra-ContentionResolutionTimer* were discussed to enable support of blind Msg3 retransmission. Based on outcome of Round 1 discussions, the following is captured in chair notes as a possible way forward:

* *Further discuss offline to see whether it’s possible to make it configurable*

In Round 2 discussions, opinion was essentially split between regarding network configuration. However, it was noted that the alternative proposal (i.e., not base on configuration) has been discussed several times and it has been made very clear this is not acceptable.

Considering the strong concerns from at least one network vendor regarding disabling a legacy function and resulting impacts to coverage, Rapporteur hopes that companies can at least agree that blind Msg3 retransmission can be supported in NTN by configuration.

**Question 3a) As a compromise, do you agree that blind Msg3 retransmission can be supported in Rel-17 NTN by configuration?**

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| **Company** | **Agree/Disagree** | **Additional comments** |
| OPPO | Agree | Depending on different NW implementation, NW can configure different UE’s behaviours accordingly. |
| Nokia | Agree | We do think Msg3 blind retransmission is a legacy function which should be supported in NTN for coverage enhancement. To move forward, we accept the compromise to support configurable option (i.e. UE support both blind Msg3 retx enabled and disabled, it is up to NW to configure which option is to be used). |
| Qualcomm | Disagree | We are not sure of adding this complexity. There will be two different UE behaviours based on this configuration.  Prefer to define a single behavior which can be stoping the current running timer before expiry if it is scheduled to be started again in future.  Ok with (1) stop after Msg3 retransmission or (2) stop just right before expiry. |
| Samsung | Disagree with comment | We prefer the simply solution: the UE stops ra-ContentionResolutionTimer once Msg3 is retransmitted and then starts ra-ContentionResolutionTimer after the end of the Msg3 retransmission plus UE-gNB RTT. In this way, legacy operation (i.e. both blind Msg3 retransmission and HARQ feedback based Msg3 retransmission) is unchanged without introducing a new configuration. We understand the purpose of introducing a new configuration is 1) keep legacy blind Msg3 retransmission and 2) save UE power by “*stoping ra-ContentionResolutionTimer upon receiving PDCCH indicating Msg3 retransmission”*instead of “*stopping ra-ContentionResolutionTimer once Msg3 is retransmitted”*, but we think 2) is not an essential optimization and brings more complications. But for the sake of progress, we are fine if majority agree. |
| vivo | Agree |  |
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In Round 2 of [AT117e][103], Question 6b) discusses possible UE behaviours if blind Msg3 retransmission is configured. The following options have been captured based on dsicussion input, and companies are asked to indicate their preferred option.

**Question 3b) If ‘Agree’ to Q3a), when [blind Msg3 retransmission] is configured, what is the preferred UE behaviour?**

* **Option 1: If *ra-ContentionResolutionTimer* expires during the UE-gNB RTT after Msg3 retransmission, (to wait for new CR timer restart) the UE does not consider the Contention Resolution unsuccessful.**
* **Option 2: If *ra-ContentionResolutionTimer* expires and no PDCCH addressed to TC-RNTI indicating uplink grant for a MSG3 retransmission is received after the start of the *ra-ContentionResolutionTimer*, the UE considers the Contention Resolution not successful**

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| **Company** | **Preferred Option?** | **Additional comments** |
| OPPO | Option 2 | Since a common K offset is always used for Msg3 scheduling which can be conservatively configured by the NW, this may lead to larger time interval between PDCCH reception and the actual scheduled Msg3 retransmission compared with TN case. It is possible that ra-ContentionResolutionTimer expires between PDCCH reception and Msg3 retransmission. Similar as the case that ra-ContentionResolutionTimer expires during the UE-gNB RTT after Msg3 retransmission, if ra-ContentionResolutionTimer expires between PDCCH reception and Msg3 retransmission, UE should not consider the Contention Resolution unsuccessful since UE knows it would start ra-ContentionResolutionTimer later. |
| Nokia | Option 2 or Option 1 | To support blind Msg3 retransmission, we are open to discuss how to capture the intended UE behaviour.  In general, we understand the correct UE behavior is that, if there is a future CR timer which will be run by UE later, UE should not declare CR failure when it waits for the timer running to resolve the Contention Resolution.  Option 2 seems more general to cover any UL grant for Msg3 retx, which can cover the general principle above. Option1 is also OK for us. |
| vivo | Option 1 |  |
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Based on past discussion, if blind Msg3 retransmission is *not* configured, there has been significant support for UE to stop *ra-ContentionResolutionTimer* upon receiving PDCCH indicating Msg3 retransmission and then start *ra-ContentionResolutionTimer* after the end of the Msg3 retransmission plus UE-gNB RTT.

**Question 3c) Do you agree that if [blind Msg3 retransmission] is not configured, the following UE behaviour applies in NTN:**

***UE stops ra-ContentionResolutionTimer upon receiving PDCCH indicating Msg3 retransmission and then starts ra-ContentionResolutionTimer after the end of the Msg3 retransmission plus UE-gNB RTT.***

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| **Company** | **Agree/Disagree** | **Additional comments** |
| OPPO | Agree |  |
| Nokia | Agree with comment | The maximum contention resolution timer length is 64 subframes hence there is not many benefit to stop it earlier, but we accept it for compromise to move forward. |
| vivo | Agree |  |
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## UL synchronization failure

Based on outcome of Round 2 discussion, the following was agreed regarding UL synchronization failure:

*Upon validity timer expiry, UE shall suspend uplink transmission and re-acquire SI (FFS whether or not UE needs to flush HARQ buffer)*

In subsequent discussion, companies also mention that we may need to discuss whether UE additionally needs to release all resource configurations and/or perform RACH. However, Rapporteur notes that in IoT-NTN a similar issue was discussed, and it was agreed:

*“when SI used for UL synch (pre-compensation) is no longer valid, the UE autonomously tunes away and re-acquires the required SI, and then comes back.* *FFS whether anything additional is needed.”*

Regarding the FFS, so far there is no agreement anything additional is needed. Therefore, if a company supports one or more additional actions (other than suspension of UL transmission and re-acquisition of SI) they are asked to explain why this is needed specifically in NR.

**Question 4a) Upon validity timer expiry, in addition to suspending UL transmission and re-aquiring SI, are one (or more) of the following additional actions needed?**

* **A) Flush HARQ buffer**
* **B) Release all resource configurations**
* **C) trigger RACH**

**If yes, please indicate which action(s), and provide reasoning why they are needed specifically in NR.**

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| **Company** | **Supported Action(s)?** | **Additional comments** |
| OPPO | C) | Regarding A) and B), different from the case of TAT expiry, the validity timer expiry at the UE is not known to the network. That means even if the UE releases all resources autonomously, since the network will not be aware of this, these resources would not be used by other UEs. So in our view, A) and B) are not needed.  After UE re-acquires the serving satellite ephemeris data and common TA parameters from SIB, UE should trigger RACH to inform network that it has recovers UL synchronization, so that network could schedule the UE with DL/UL transmission. This is especially needed when NW has only DL data to transmit, otherwise, NW has no idea when it can start to schedule DL transmission. |
| Nokia | At least C), FFS for A) and B) | We tend to agree UE should trigger RACH. Without RACH procedure, we are not sure whether UE can send PUSCH/PUCCH correctly with an accurate TA without NW adjustment (via RAR and TAC MAC CE).  There has been some "drift" in the UE's understanding of the TA that need to be applied due to systematic errors in the system. For example, (1) the Common TA will be drifting due to poor curve fitting - we have a 2nd order polynomial to describe the feeder link behavior, (2) the UE will calculate its own service link TA based on prediction of the satellite's position into the future, (3) The UE may have an understanding of its own geo-location which is not 100% correct.  All of these will cause the eNB to have to **apply closed loop TA** to ensure that all UL receptions from many UEs are aligned.  And when UE all of a sudden (after timer expiry and re-acquire new SI) corrects Common TA and satellite's position for service link delays, there will be a jump in transmit time, where the UE is at the same time **still applying old accumulated TA commands.** So, our preference would be that if validity timer expires, UE goes through RACH procedure in order to ensure that we have a fresh reset of the accumulated TA commands (through the absolute TA command that we have available here). Please note the maximum TA adjustment in RAR can be up to 2ms while the adjustment for TAC MAC CE in RRC Connected mode is only 0.017ms. RAR is needed for quick TA adjustment.  For whether UE should flush HARQ buffer or release UL resource, it is a separate issue. We are open for the solution but slightly prefer to keep it simple to just follow TAT timer expiry handling (i.e. flush buffer and release resource) to have less specification impact. |
| Qualcomm | None | If a UE receives out-of-sync indication and temporarily looses signal and again receives “in-sync” indication, does UE perform any of the A, B C?  But if it takes long time and does not receive “in-sync” indication, then it has to declare RLF.  We prefer this issue be defined in similar way of declaring RLF. |
| Samsung | None | Upon validity timer expires, we think A and B are not needed and UE can resume operation at recovery. If UE successfully reacquires SI after validity timer expires, RACH can be triggered as legacy when there is a need for DL/UL transmission. |
| vivo | A | We think at least HARQ buffer shall be flushed. When the validity timer expires, there may be MAC PDU carrying MAC CE (e.g. TA MAC CE, BSR) in HARQ buffer. We should avoid UE reporting the outdated MAC CE to NW after the UL snyc recovers later. |
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Additionally, during reflector input to Round 2 one company would further like to make it clear that the normal behaviour is that the UE always reacquire the SIBxx before the validity duration has elapsed. This is because it is not normal to have UE randomly leave the system without the gNB knowing or having the opportunity to release the UE.

Considering this was already supported by a large majority (13/18) in Round 2 Question 10a), Rapporteur suggests that this may be captured as a formal agreement to address the above concern.

**Question 4b) Do you agree to capture the following as a RAN2 agreement?**

***“In general case, UE re-aquires SIBxx prior to validity timer expiry”***

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| **Company** | **Agree/Disagree** | **Additional comments** |
| OPPO | See comments | Since in case cases (e.g. if the UE is not configured with searchSpaceSIB1 or searchSpaceOtherSystemInformation on the active BWP), UE may not be able to re-aquires SIBxx prior to validity timer expiry, we suggest to revise the proposal as fowllowing:  ***“In general case, UE may re-aquire SIBxx prior to validity timer expiry”*** |
| Nokia | Agree | The validity timer indicates the maximum time duration in which the UE can apply the satellite ephemeris without having acquired new satellite ephemeris and Common TA related information. We think UE should attempt to re-acquire the SIB before the validity timer expirty. |
| Qualcomm | Yes |  |
| Samsung | Agree with comment | “In general case” may be unclear. We suggest to reword, e.g. ***UE should attempt to re-aquire SIBxx prior to validity timer expiry by UE implementation.*** |
| vivo | See comments | It is up to UE implementation to re-aquire SIBX prior to validity timer expiry. If anything really needs to be captured, we prefer to capture in state 2 spec.  In addition, for connected UEs, this is only allowed when the current active BWP is configured with common search space. This means that autonomous BWP switch for requiring SIBx is not allowed. This should be clarified. |
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# Conclusions

<To be generated based on company input>

# References

1. [R2-2203424](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_117-e/Docs/R2-2203424.zip) Report of [Pre117-e][103][NTN] MAC open issues (InterDigital)
2. [R2-2203160](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_117-e/Docs/R2-2203160.zip) Report of [Pre117-e][011][IoT-NTN] User plane Open Issues Input (OPPO)
3. [R2-2203532](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_117-e/Inbox/R2-2203532.zip) Report of [AT117-e][103] MAC open issues (InterDigital)
4. [R2-2203542](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_117-e/Inbox/R2-2203542.zip) Report of [AT117-e][103] MAC open issues Round 2 (InterDigital)