3GPP TSG-RAN WG2 Meeting #110 Tdoc R2-2005945

Online, June 1st – 12th 2020

Agenda: 7.2.3

Source: Ericsson (Summary rapporteur)

Title: [ATT110-e][313] PUR open issues – Phase 3

Document for: Discussion, Decision

# 1 Introduction

This document provides the summary of the following email discussion:

* [AT110-e][313][NBIOT/eMTC] PUR open issues (Ericsson)

 Scope: Finalise PUR open issues based on [R2-2005726](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2005726.zip)

 Intended outcome: Report in [R2-2005936](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2005936.zip), Phase 2 report in [R2-2005942](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2005942.zip), Phase 3 report in R2-2005945

 Deadline: phase 1 – June 2 16:00 UTC. Phase 2 – Friday 1000 UTC, Phase 3 – Wednesday 8th 1000 UTC

The document covers phase 3 of the PUR open issues discussion, including remaining aspects of CP-PUR configuration and MAC/RRC details.

# 2 Discussion

## 2.1 CP configuration

During RAN2#110-e the following have been agreed on CP-PUR configuration:

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| * It is up to eNB implementation how UE and PUR configuration are linked according to the configured PUR resources.
* **For CP-PUR, RAN2 intends to address the case of reconfiguration/release and 'm' counting.**
	+ **FFS: which mechanism is adopted**
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The following was captured in chairman's notes on specific mechanism:

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| **CP configuration****Rapporteur proposal Q7: It is up to eNB implementation how UE and PUR configuration are linked according to the configured PUR resources.****Rapporteur proposal Q8a: For CP-PUR, RAN2 intends to address the case of reconfiguration/release and 'm' counting so that PUR works properly.****Rapporteur proposal Q8b: Discuss further which mechanism is adopted to address the issues mentioned in Proposal Q8a.*** ZTE thinks a short identifier doesn’t work, so a new identifier seems safer. Ericsson thinks that sounds like the UP solution so don’t prefer this approach. QC thinks this solution would also work but would be good to avoid sending the same information twice. Nokia thinks a PUR RNTI could be part of the identifier + some additional bits. Ericsson thinks we don’t need an identifier but a the limitation could be fine
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The discussion on which mechanism to adopt to address the issues brought in e.g. [9] for the CP-PUR configuration is not concluded yet. The earlier offline discussion can be found in the Appendix for reference.

The following lists the solutions which have been brought up for discussion during RAN2#110-e, companies are asked to provide further input on the options to conclude the discussion.

**Companies are asked to provide their view on pros and cons of each of the solutions, and what would be the impact on signalling (i.e. RRC messages) or on procedures or on other aspects.**

* Store *pur-Config* in a container in MME. The UE identifier is S-TMSI which is provided in Msg3 (to MME). After receiving the initial UE message MME provides the PUR configuration, if it exists, to eNB over S1 signaling. (cf. Appendix / HW reply for further details)

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| Company | Pros and cons? Impact on signalling / procedures / other? |
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* Solution discussed in [9] where information on PUR grant/resources would be provided from UE to eNB. UE identifier in this case would be the information provided to eNB and it would be provided in Msg5, after which eNB can link UE to its PUR configuration. (cf. Appendix / ZTE replies for further details)

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| Company | Pros and cons? Impact on signalling / procedures / other? |
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* Solution in [1] where UE would be able to request change to or release of PUR configuration only when it establishes RRC connection using the configured PUR resources. UEs do not count 'm' when UE is in RRC\_CONNECTED only when PUR resources were used to establish the connection. No additional UE identifier needs to be specified. (cf. Appendix / Ericsson replies for further details)

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| Company | Pros and cons? Impact on signalling / procedures / other? |
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* Specify a new identifier for CP-PUR. One option is to include PUR-RNTI in the identifier, additionally including information/bits to differentiate between UEs which have been configured with the same PUR-RNTI. The identifier would be provided in PUR request message, after which eNB would be able to update/release the PUR configuration. (cf. Appendix / QC replies, also online discussion)

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| Company | Pros and cons? Impact on signalling / procedures / other? |
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**Which of the above solutions is your preference, or would you prefer some other solution?**

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| Company | Preferred solution | Comments  |
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## 2.2 Remaining issues on MAC-RRC interaction

The following have been agreed on MAC-RRC related questions during RAN2#110-e:

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| Corrections / clarifications on MAC/RRC:* RRC layer calculates the exact PUR timing and provides the information to MAC in the form of UL grant. Details of the timing of providing this information to MAC layer is up to UE implementation.
* *pur-ResponseWindowSize* is provided to MAC when lower layers are configured to use PUR.
* If *pur-Config* is not present in RRC release, *pur-TimeAlignmentTimer* is kept running.
	+ **FFS whether clarification is needed in RRC for the case *pur-Config* is present but does not contain PUR TA timer configuration.**
* Clarify that PUR configuration is excluded in clause 5.3.12 in TS 36.331 when releasing the radio resource configuration.
* **FFS check in MAC that *pur-TimeAlignmentTimer* is running when transmitting HARQ feedback for PUR response message.**
* **FFS whether clarifications are needed for s**p**ecification text when "configuring lower layers to use PUR" regarding PUR-RNTI and TA timer configuration.**
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The earlier comments related to issues listed as FFS in the agreements can be found in the Appendix.

**Do you think a further clarification is needed in RRC for the case *pur-Config* is present but does not contain PUR TA timer configuration (in *RRCConnectionRelease* message)?**

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| Company | View  | Comments |
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Most companies have had the view that it should be checked whether *pur-TimeAlignmentTimer* is running before transmitting uplink HARQ feedback to PUR response message.

During earlier discussion ZTE brought up the case that if PUR TA timer has been expired, what would happen to the HARQ feedback, i.e. would it be generated at all? Rapporteur also wonders what would happen in such case, would the UE then just omit the HARQ ACK, or would it need to do a RA to transmit it?

**Please clarify what kind of check should be added in MAC regarding *pur-TimeAlignmentTimer* and transmitting HARQ feedback:**

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| Company | View  | Comments |
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For discussion what should be provided to lower layers after RRC triggers PUR transmission, two different specific aspects have been brought up: Should the PUR-RNTI be explicitly mentioned in RRC when configuration is provided and whether a clarification should be added so that PUR TA timer value is not provided when lower layers are configured for PUR.

**Please provide your view on 1) should PUR-RNTI be explicitly mentioned in RRC procedure when configuring lower layers and 2) is it clear PUR TA timer is configured only when *pur-Config* is received or should it be clarified further it should be not provided when triggering PUR transmission:**

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| Company | View on 1) | View on 2)  | Comments |
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# 3 Summary

The following is the summary and rapporteur proposals for the Phase 3 of the discussion:

**TBD**

# 4 References

1. [R2-2004632](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2004632.zip), [E906, E907] Remaining open issues in PUR, Ericsson, RAN2#110, June 2020

1. [R2-2004633](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2004633.zip), Draft LS reply on PUR open issues and working assumption, Ericsson, RAN2#110, Unknown, June 2020

1. [R2-2004817](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2004817.zip), Remaining issue on NB-IoT Preconfigured resources, ITL, RAN2#110, June 2020

1. [R2-2005019](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005019.zip), Discussion on start offset and requested TBS for PUR, Huawei, HiSilicon, RAN2#110, Unknown, June 2020

1. [R2-2005020](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005020.zip), RRC-MAC interactions for PUR, Huawei, HiSilicon, RAN2#110, June 2020

1. [R2-2005021](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005021.zip), Discussion on RAN1 LSs for PUR, Huawei, HiSilicon, RAN2#110, June 2020

1. [R2-2005022](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005022.zip), [Draft] Reply LS on PUR working assumption for NB-IoT and eMTC, Huawei, RAN2#110, Unknown, June 2020

1. [R2-2005023](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005023.zip), [Draft] Reply LS on open PUR issues for NB-IoT and eMTC, Huawei, RAN2#110, Unknown, June 2020

1. [R2-2005035](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005035.zip), Remaining FFSs for PUR, ZTE Corporation, Sanechips, RAN2#110, June 2020

1. [R2-2005206](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005206.zip), [H810] [H840] [H854] PUR start time offset, Qualcomm Incorporated, RAN2#110, June 2020

1. [R2-2005569](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005569.zip), Remaining issue of D-PUR TA timer in RRC, ASUSTeK, RAN2#110, June 2020

1. [R2-2005570](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005570.zip), PUR configuration maintenance during RRC state transition, ASUSTeK, RAN2#110, June 2020

1. [R2-2005571](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs//R2-2005571.zip), HARQ feedback in RRC\_IDLE, ASUSTeK, RAN2#110, June 2020

# Appendix

Q8: Should RAN2 address the cases mentioned above (in [1], [9]) and in P12? If yes, what is the preferred mechanism?

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| Company | Yes / no | Comments (e.g. preference and details of mechanism) |
| Thales | Yes | We would prefer mechanism outlined in [9] for CP-PUR, i.e. enable the eNB to link the UE and its PUR configuration properly so that reconfiguration and m count works accordingly/as agreed.  |
| Huawei, HiSilicon | Yes | Proposal in [1] adds restriction to the reconfiguration/release scenarios.Porposal in [9] will cause very big signaling overhead for the UE as the UE needs to send PUR configuration (more than 100 bits in NB-IoT, even larger in eMTC) to the eNB everytime it establishes RRC connection.If this issue needs to be addressed, we would like to suggest our previous proposal in R2-2000640 as an Option 3, i.e. storing pur-Config in a container in the MME. Upon receiving the Initial UE message including S-TMSI, the MME forwards the container with the PUR configuration, if any, to the eNB in the S1 DL NAS TRANSPORT message or S1 CONNECTION ESTABLISHMENT INDICATION message.In this case, the issue can be addressed without adding restriction to the reconfiguration/release scenarios and additional signaling overhead to the UE. |
| ZTE | Yes | If RAN2 would not address the cases mentioned above, it may cause misalignment between UE and eNB or even no response from eNB to UE's request.We think the proposed way in [1] would be too restricted for eNB or UE’s implementation. So we still prefer the proposed way in [9]. |
| LG | Yes | We support the solution in [1] to avoid complexity.  |
| Ericsson | Yes | As proposed in [1]: UE using CP PUR should request configuration change only when it has initiated the connection establishment using PUR resources.Change 'm' counting rules for RRC\_CONNECTED and for CP PUR so that 'm' is not counted only when UE established RRC connection using PUR resources. |
| Qualcomm | Yes | Proposal in [1] restricts the possibility to send PUR request when in CONNECTED mode and allows in only certain conditions which is not consistent with what has been agreed before. E.g. if the UE has a large UL data now, wants to go to connected and also ask for PUR release/reconfig which would otherwise be after 12 hours, that would be undue restriction to not allow to ask for release/reconfig now.Proposal in [9] Providing the Grant info back does not always solve the problem (e.g. shared grant). It needs further discussion on what parts need to be provided, e.g. maybe MCS does not make sense but time/frequency information need to be clear.Even from the principle point of view, better way is to send back the “identifier(s)” instead of “grant”. So, we think the following would solve the issue:* PUR-RNTI is mandatory in PUR-Config for configuration (can be delta signalled for reconfig).
* eNB can tag the PUR config with PUR-RNTI by implementation, given that sTMSI is not currently assumed to be stored by eNB, and that sTMSI might change from the time the UE first went to CONNECTED (regardless of with or without already having PUR Config) before the time PUR config is provided (which is done at the end of CONNECTED session with a release message).
* If network wants to share PUR-RNTI across different UEs, add another identifier, e.g. RNTI resolution identifer in the PUR-Config which can be a couple of bits depending on maximum how may UEs would share a same RNTI.
* UE includes PUR-RNTI (and the resolution ID if provided in config) in the PUR request message (for both config or release request). It is already clear the request message is always/only sent in CONNECTED.
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| Nokia |  | Agree with QC “UE should not be restricted to use only the messages sent over PUR resource for reconfiguration or release.Complete information of grant is not needed for the network to know the resource. Identifier with some additional information to uniquely identify the PUR is sufficient. |
| ZTE2 |  | Agree with above concerns for proposal in [1].Some clarification for proposal in [9]:* As PUR-RNTI share same RNTI space with other RNTIs, we assume not much PUR-RNTI can be allocated. The rate of PUR-RNTI being multiplexed by UEs may be high. Based on such consideration, if go for the QC’s suggestion, we think length for the additional new RNTI resolution identifer need to be long in order to differentiate more UEs. Moreover, this also looks like to introduce a “new PUR resource” dimension. Such “new PUR resource” also need to be (additionally) provided to the UE in the PUR configuration that will cause unnecessary signalling overhead.
* Per our understanding for physical layer spec, for the sake of uplink demodulation, the combination of time domain/frequency domain/code domain resources need to be unique for the UEs. So we believe it’s already feasible and more reliable to only use (part) of existing PUR resources as “identifier” to uniquely identify a UE. Then why new resource is needed?
* We disagree with HW’s concern on large number bits for such PUR resources “identifier”. The following is our assumption for NB-IoT and eMTC:

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| PUR resources “identifier” for NB-IoT (~total 63bits) |
| pur-StartTime-r16 (~at most 30 bits, can be smaller for shorter periodicity)ul-CarrierFreq-r16 (~25bits)npusch-SubCarrierSetIndex-r16 (~7bits)npusch-CyclicShift-r16 (~1bits) |

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| PUR resources “identifier” for eMTC (~total 43bits) |
| pur-StartTime-r16 (~at most 30 bits, can be smaller for shorter periodicity)pur-FreqInfo-r16 CHOICE { ce-ModeA SEQUENCE { prb-AllocationInfo-r16 BIT STRING (SIZE(10)) }, ce-ModeB SEQUENCE { prb-AllocationInfo-r16 BIT STRING (SIZE(8)), locationCE-ModeB-r16 INTEGER (0..5) } }  (~12 bits)pusch-CyclicShift-r16 (~1 bits) |

* One thing need to be clarify is that the definition for *pur-StartTime* in PUR resources “identifier” is similar as that *pur-StartTime* in *PUR-Config-r16*, but not totally same. The reference H-SFN for *pur-StartTime* in PUR resources “identifier” would be the H-SFN corresponding to the last subframe of the first transmission of Msg5.
* Moreover, we disagree with QC that such “identifier” can be provided via the PUR request message as this cannot handle the “m” counting issue.
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| Ericsson2 |  | Regarding use of PUR-RNTI as the identifier, we have similar concerns as in ZTE2 reply.Also, we don't support specifying a new identifier (e.g. as in Nokia reply) for the CP solution. To us the intention should be to make it work without such, otherwise we would be almost replicating the UP solution.Additionally, we don't support HW proposal on MME involvement.To us the method we propose in [1] is not a big restriction as the UE functionality is not restricted when it comes to sending data outside of PUR occasion. The restriction only applies to when the UE wants to request change in PUR configuration. In practice we don't think this will be a serious restriction considering a likely PUR use case would be for UEs which most of the time would only use the allocated PUR resources. If PUR configuration would need frequent updates/releases any power consumption savings would be mostly negated thus PUR should not be used for such use cases to start with. |
| Qualcomm2 |  | Regarding ZTE’s comment on overhead:Let’s say 4 additional bits are added for resolving RNTI collision. That is total 20 bits because RNTI is 16 bits. That is enough to address roughly a million UEs. That has generally been the upper bound on number of UEs in any MTC system design.ZTE clarified that the PUR resource “identifier” in their proposal is about just ~43bits! Then complaining that 20 bits is “unnecessary signaling overhead” is contradictory. (For downlink, that would add ~4 bits, ok, may be big deal in some cases, but not here, because RAN2 discussed in the last online session and decided that adding a “couple of bytes” for the sake of moving one field to other IE without any difference in UE behavior and any technical reason whatsoever was ok even when we were opposing and explaining!)And, apologies but we didn’t understand this comment “Moreover, we disagree with QC that such “identifier” can be provided via the PUR request message as this cannot handle the “m” counting issue.” Wondering, in ZTE’s proposal, which message is used to send the “grant information” (~43 bits) for identification at the eNB. Our understanding so far was, that is also proposed to be sent with PUR request message. Please confirm if the proposal is otherwise.Regarding proposals in [1] and [9], we already commented above and do not want to repeat. |
| Nokia2 |  | Identification the PUR resource using PUR-RNTI comes from the possibility of reuse of PUR-RNTI across UE. The reuse is possible only across allocations having sufficient gap between PUR occasions for reception of PDCCH including retransmission. For simple case, GNB may implement unique PUR-RNTI for each of the UE having PUR without need to take care of collision of PDCCH monitoring. In case if not sufficient additional identifier can be included. Or the reuse based on PUR occasion can be considered only if PUR-RNTI space is already exhausted.Even in case of reuse of PUR-RNTI, with additional index the UE resource sharing the PUR-RNTI can be identifier. In our view, additional bits to identify the UE sharing same PUR-RNTI will be sufficient instead of sending complete PUR configuration for this purpose.Otherwise, only time domain location is sufficient rather than the complete PUR grant information.As way forward network can decide on whether PUR-RNTI+additional-bits or complete resource information is needed for the identification. |

Discuss the following remaining details of MAC-RRC interaction:

a) Should PUR-RNTI be explicitly provided when configuring lower layers to use PUR (after RRC triggers PUR transmission)?

Q10: Views on Proposal 15 a) – e)

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| Company | View on a) | Comments |
| Huawei, HiSilicon | Agree with the intention | But we think the current wording in RRC has covered PUR-RNTI, i.e. configures the lower layers to use PUR. With this sentence, MAC can get all configuration which is needed, similarly to RA/EDT. |
| LG | Yes |  |
| Ericsson | Yes | We think it would be clearer to have it explicitly visible in RRC specification when the PUR-RNTI is provided from RRC to MAC. Note that in current MAC PUR-RNTI is explicitly deleted after PUR transmission. In RA/EDT there is no RNTI allocation from RRC to MAC, but configuration of specific resources (e.g. PRACH etc.).  |
| Qualcomm | Yes | Except for PUR TA timer, everything else can be provided each time „configuring lower layers to use PUR“. So, in our mind, as also commented in the ASN.1 RIL, the main question is whether any further clarification is needed that PUR TA timer is not provided to MAC again for each PUR occasion. I.e., whther it is clear based on current RRC and MAC CRs that MAC needs to update TA timer only when RRC recieves PUR config in release message. |
| ASUSTeK | Yes |  |
| ZTE2 | Yes | Generally agree with the QC’s understanding that except for PUR TA timer, everything else can be provided each time “configuring lower layers to use PUR“. |

c) How to address restarting *pur-TimeAlignmentTimer* in MAC if *pur-Config* is not present in RRC release?

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| Company | View on c) | Comments |
| Huawei, HiSilicon | NULL | The timer will keep running unless it is released explictly. The timer should not be restarted upon reception of RRC release message regardless pur-Config is present or not.5.8        MAC reconfigurationWhen a reconfiguration of the MAC entity is requested by upper layers, the MAC entity shall:-    upon addition of an SCell, initialize the corresponding HARQ entity;-    upon removal of an SCell, remove the corresponding HARQ entity;-    for timers apply the new value when the timer is (re)started;-    when counters are initialized apply the new maximum parameter value;-    for other parameters, apply immediately the configurations received from upper layers. |
| LG | NULL | PUR timer should not be restarted if pur-config is not included in RRCConnectionRelease. |
| Ericsson | TBD | We should clarify what is the intention when UE is released without *pur-Config*, e.g. wouldn't the UE have valid TA during connected? But on the other hand, as the timer also indicates the validity time for PUR configuration, it could be kept running if not explicitly restarted.  |
| ASUSTeK | Adopt the text proposal in [11]. | If PUR TA timer is not restarted upon entering IDLE, it may expire too early (although this may be a rare case). |
| ZTE2 | NULL | We disagree with the Observation in [11]. Anyway It’s possible that TA command MAC CE can be sent along with RRC release message, then *pur-TimeAlignmentTimer* would be restarted. So no need of additional process.We are not clear about HW’s comment why this is related to MAC reconfiguration? |
| Ericsson2 |  | Agree with HW, LG, ZTE that no change is needed. |
| Qualcomm2 |  | Disagree with Huawei’s explanation. If the PUR-Config is included/setup, but the timer is not, it is indeed “explicitly released” because of Need OR. The timer is indeed restarted with the value if PUR TA timer is included in release message (which is only included if PUR-config is included) or with infinite value (i.e, not applicable) if PUR-config is present/setup but TA timer is absent.Therefore, in RRC, 5.3.8.3, following update is needed:3> configure MAC in accordance with the *pur-TimeAlignmentTimer*;should be updated to the effect of *if present, configure the timer; if absent, do not use TAT (or consider infinity)*. Recall that *if not configured, TAT based validation is not used* was previously captured in the field description, but based on company comments that it would be clarified in the procedural text, that was deleted. |

e) Should additional check if *pur-TimerAlignmentTimer* is running be added to MAC when transmitting HARQ feedback for PUR response message?

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| Company | View on e) | Comments |
| Huawei, HiSilicon | Yes | But we are not sure the wording in the TP is fully correct:- if both the *timeAlignmentTimer* and *pur-TimeAlignmentTimer*, associated with the TAG containing the serving cell on which the HARQ feedback is to be transmitted, are stopped or expired:- do not indicate the generated positive or negative acknowledgement to the physical layer.In RRC\_Connected, is that possible the legacy TA timer is stopped but the PUR TA timer is still running? If yes, the proposed wording seems not correct as the UE can still send HARQ feedback in this case. |
| Ericsson | Don't think this is needed |  |
| ASUSTeK | Yes | We agree with Huawei’s view that it is possible that the legacy TA timer is stopped but the PUR TA timer is still running in connected. Exact change to TS 36.321 could be discussed later if this issue is confirmed. |
| ZTE2 | Yes | Firstly, as we think it’s rare case that *pur-TimeAlignmentTimer* expires during PUR transmission, we don’t think the process to *pur-TimeAlignmentTimer* similar as that *timeAlignmentTimer* expires is needed. Moreover, we agree with HW’s comments that the proposed change is incorrect.Secondly, we agree there has another issue that the existing description about HARQ/ACK cannot be sent when *timeAlignmentTimer* is stopped or expired may have impacts on PUR transmission in RRC\_IDLE. E.g., such condition “*timeAlignmentTimer* is stopped or expired” can be considered also to be fulfilled in the PUR transmission case, therefore, it may cause that HARQ/ACK for PUR transmission cannot be generated.Our suggestion is just to exclude the PUR transmission from this process. The change example is as following:- except for transmission on preconfigured uplink grant for PUR: *- if the timeAlignmentTimer, associated with the TAG containing the serving cell on which the HARQ feedback is to be transmitted, is stopped or expired:**- do not indicate the generated positive or negative acknowledgement to the physical layer.**- else:**- indicate the generated positive or negative acknowledgement for this TB to the physical layer.* |
| Ericsson2 |  | OK to us to clarify this considering there is support.  |
| Qualcomm2 | Yes | In IDLE mode, pur-TAT should be still valid if configured before sending the HARQ feedback for RRC release msg in response to PUR. But, as commented above also, this should not interfere with (connected-mode) TA timer. In connected mode, only *timeAlignmentTimer* should be checked. |
| LG | Yes | Clarification is needed. |