3GPP TSG-RAN WG1 Meeting #109-e DRAFT R2-200xx

Online, February 24th – March 6th, 2020

Agenda Item: 7.2.4, 7.1.4

Source: Qualcomm (Rapporteur)

Title: Report of [AT109e][307][NBIOT] PUR RRC-MAC-PHY interactions

Document for: Discussion, Decision

# Introduction

A summary of proposals from [1] - [23] on RRC-MAC-PHY interactions for PUR was discussed in [25]. Based on the discussion, following was agreed in RAN2#109e:

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| Agreements:   * PUR TA timer configuration is provided to MAC when RRC receives PUR configuration from eNB. * When TA validation fails due to other than expiration of TA timer, the PUR TA timer is not stopped (i.e. keeps running until expiry). |

An offline discussion was setup to discuss the remaining proposals from the summary [25] as follows:

* [AT109e][307][NBIOT] PUR RRC-MAC-PHY interactions (QC)

Status: Not started

Scope: Discuss and progress on the open issues and proposals in [R2-2002021](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109_e\Docs\R2-2002021.zip), excluding 4 and 9 (already agreed) and those marked as ASN.1/CR issues

Intended outcome: report with categorisation of proposals – agreeable, needs further discussion, postpone

Deadline: Thursday 27th 0900 CET

This document provides the report of the above offline discussion.

NOTE 1: Although the offline discussion tag only includes NBIOT, the discussion and outcome below is equally applicable for eMTC.

NOTE 2: The proposals from [25] are referred to as **PXX** in the discussion below. (The proposal numbers from [25] are preserved for easy reference, and as such may not be continuous in this document.)

NOTE 3: For the questions where the request is to provide comments if you disagree with PXX, rapporteur will assume blank answer as no objection (i.e., ok with proposal).

Editor’s Note: Proposals as outcome of this discussion will be furnished later.

# Discussion

## Which layer maintains PUR grant and m counter

One aspect which does not seems to have clear consensus is which layer (RRC or MAC) maintains the PUR grant. From [7] and [11], there are two options for the handling of PUR grant:

* Option 1: PUR grant is maintained in MAC layer.

In Option 1, similar to SPS, PUR resource is delivered to MAC when configured by RRC (upon reception of RRC release message). MAC layer maintains the resource in IDLE mode.

* Option 2: PUR grant is delivered to MAC upon initiation of each transmission using PUR.

In Option 2, similar to PRACH resources (not grant) for RA or EDT, PUR grant is only delivered to MAC when transmission using PUR is initiated.

Following proposals are relevant to the above:

* PUR grant is maintained in RRC and delivered to MAC upon initiation of transmission using PUR. [7]
* Discuss whether RRC provides PUR configuration or PUR grant to the MAC.[9]
* RRC layer provides UL grant and necessary PUR configuration to MAC when triggering PUR transmission.[11]
* The interaction between RRC layer and MAC layer for PUR configuration is up to UE implementation. E.g. the PUR configuration can be stored as MAC parameters.[15]

Additionally, it is described in the contributions that the conclusion on the above would affect how/which layer maintains “m” counter and where the operation of “m” is specified.

Following are the relevant proposals:

* “m” counter is maintained in RRC. [7]
* ‘m’ counter is maintained in MAC.[9]
* RRC layer handles counting of 'm' implicit skips of PUR transmissions.[11]
* It’s suggested to capture the “m” counter maintenance in MAC layer.[13]

In general companies proposing to have PUR “configuration” to be provided to MAC and MAC to handle the PUR grant propose “m” counter should be maintained in MAC. Companies who propose to have PUR “grant” maintained in RRC and informed to MAC on each PUR occasion propose that ‘m’ counter should be maintained in RRC layer.

Further, if “m” counter is maintained in MAC, maximum value of such counter is configured by RRC field (currently captured as implicitReleaseAfter) and when the counter value reaches the configured max value, MAC should send indication to RRC so that RRC can release PUR configuration.

* When the counter value reaches the configured max value, MAC should send indication to RRC so that RRC can release PUR configuration.[9]

As there is no clear consensus, this should be further discussed.

**P1: [FFS] Which layer (RRC or MAC) maintains PUR grant (i.e., whether RRC provides PUR configuration to MAC once and MAC calculates the grant, or whether RRC calculates the grant before each PUR transmission), or whether to leave it up to UE implementation.**

**Offline discussion Q1: Companies are requested to provide their view on above proposal considering the following options for PUR grant handling:**

Option 1: RRC provides PUR configuration to MAC once and MAC calculates the grant

Option 2: RRC calculates the grant before each PUR transmission and provides the grant to the MAC

Option 3: Leave it up to UE implementation.

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| **Company** | **Option** | **Comments, with potential TPs, if any.** |
| ZTE | Slightly prefer Option 1 or Option 3 | High level to say, we expect PUR grant maintenance can be left to UE implementation and change on spec would be as less as possible.  We are thankful for the detailed analysis and comparison on the options in [7]. But:   * Firstly, we have a general understanding that MAC reset only reset the resources used in connected mode. The PUR grant and PUR timer would be irrelevant. For example, the *timeAlignmentTimers* mentioned in current section 5.9 are the timers running in RRC\_CONNECTED. We already introduce a new *pur-timeAlignmentTimer* for IDLE mode with the intention that this timer would be maintained separately and not be impacted by the process to the existing *timeAlignmentTimers*. * Secondly, for another mentioned impact that “*Upon transmission using PUR, default MAC configuration cannot be used*”, we are not crystal clear the reason. Per our understanding, no matter option 1 and option 2, the PUR grant would be maintained separately as a resources for IDLE and be used at next PUR occasion. It’s same for option 1 and option 2 that default MAC configuration would be used upon transmission using PUR. * Thirdly, we have the feeling that option 2 may have more RRC-MAC interaction for RRC delivering and MAC acquiring the PUR configuration on each time PUR transmission. * Finally, if companies think “stop (if running) all timers” in MAC section 5.9 may cause confusion, we are fine to make some clarification and think the change would be small.   With the above consideration, we slightly prefer Option 1 or Option 3. |
| Ericsson | Option 2 | Leaving this up to UE implementation would mean in the future it would be very difficult to do e.g. further enhancements or changes. There are lot of dependencies and interactions between e.g. MAC and RRC layer in PUR as discussed so far. |

Response Summary TBD

1. TBD

While it is not necessary that the 'm' counter is tied to how the grant is provided, rapporteur agrees with conclusion from [7] that less cross-layer interaction is needed if the ‘m’ counter is maintained in the same layer which handles the PUR grant. Therefore, it was proposed to agree only one of the following two proposals based on the outcome of above.

**P2: Conditional on RRC providing PUR grant to MAC: “m” counter is maintained in RRC.**

**P3: Conditional on MAC receiving PUR configuration and calculating PUR grant: “m” counter is maintained in MAC. When the counter value reaches the configured max value, MAC sends indication to RRC to release PUR configuration.**

**Offline discussion Q2: Please provide your comment if you are NOT ok with the above conditional proposals. The objective is that once there is conclusion on Q1, the outcome of Q2 should be automatic, unless there are objections.**

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| **Company** | **Disagree with conditional proposals P2 and P3?** | **Comments (especially if you disagree, please explain).** |
| ZTE | We slightly prefer P3 | If Option 1 is selected for Question 1, the PUR configuration is maintained in MAC, then it is convenient for MAC to maintain the “m” counter, which needs less MAC-RRC interaction. |
| Ericsson |  | In general, no strong opinion, but as principle we should go for the "simplest" or least complex method in the end, regardless of how the grant is provided. Likely simplest way depends on the grant mechanism but we shouldn't unnecessarily tie our hands beforehand. |

## PUR TA timer

RAN2 have agreed that PUR TA timer is a MAC timer, hence the PUR TA timer needs to be maintained in MAC. RAN2 also agreed “PUR TA timer configuration is provided to MAC when RRC receives PUR configuration from eNB.”

Following are related proposals from various contributions on when does the timer start:

* PUR TA timer is configured to MAC upon reception of RRC release message including PUR configuration. [7]
* PUR TA timer is started on the first subframe of the first PUR transmission opportunity after the PUR configuration has been received.[11]
* the MAC entity starts the D-PUR TA timer when the MAC entity is configured with the D-PUR TA timer.[23]

It seems [7] assumes the above proposal also means PUR TA timer is started when MAC entity is configured with the D-PUR TA timer, [23] has explicit proposal on this, however [11] proposes a different starting time while explaining the caveats that if PUR TA timer is started on the first PUR occasion, it may be “too far” in the future so that the TA timer would not work as intended. Given that PUR TA timer is specific to IDLE mode, rapporteur thinks it makes sense that the timer is started when UE goes to IDLE, i.e. when the MAC is configured with the TA timer.

**P5: [FFS] MAC entity starts the PUR TA timer [when the MAC entity is configured with the PUR TA timer]/[when the UE moves to IDLE]/[upon first PUR transmission opportunity after the PUR configuration has been received].**

**Offline discussion Q3: Companies are requested to provide their view on above proposal considering the following options for starting time of PUR TA timer:**

Option 1: when the MAC entity is configured with the PUR TA timer

Option 2: when the UE moves to IDLE

Option 3: upon first PUR transmission opportunity after the PUR configuration has been received

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| **Company** | **Option** | **Comments, with potential TPs, if any.** |
| ZTE | Option 1 | We think option 1 is straightforward that TA timer is started at the time when the MAC entity is configured with the PUR TA timer.  For option 2, with the consideration that not every time the UE moves to IDLE, there will have PUR configuration or reconfiguration, we think this option is not suitable, or it’s too general and may cause unnecessary TA timer restart.  For option 3, we are not crystal clear why there has risk that the actual (re)starting times of the timers may be misalignment between UE and eNB. Does the consideration is message repetition or retransmission or round-trip delay? If this is the case, as the determination on first PUR transmission opportunity is also based on the timing upon reception of RRC release message including PUR configuration and the configured time offset, we think there also has risk about inconsistent understanding on first PUR transmission opportunity. Moreover, if the TA timer would start at first PUR transmission opportunity, the network may need to adjust TA timer value, e.g., to subtract the value of time offset from the initial setting of TA timer value. We think this is unnecessary complexity. |
| Ericsson | Option 3 | The starting time should be such that both eNB and UE can start the timer in the same subframe. Issue with Option 1 and 2 is that eNB does not know when UE actually configures MAC or moves to idle – these depend on the UE implementation and a common time reference is needed. This was already discussed e.g. during email discussion on TA validation, where we have agreement from RAN2#107:   * The (re)starting times for TA timer need to be aligned between UE and eNB. The details of the mechanism are FFS.   Option 3 would work in this sense considering the offset configuration would be done in the way which results in common reference between UE and eNB. In any case, the starting time of PUR transmission needs to be aligned between UE and eNB, how it would work otherwise? Also we don't think the offset should put the first PUR opportunity too far in the future, see reply to the other discussion as well. |

TA validation by L1:

* MAC restarts PUR TA timer if L1 signalling including TA is received. [7]
* TA adjustment by DCI is captured in MAC specification 5.4.x.2 to include the condition “when a Timing Advance Command MAC control element is received or PDCCH indicates timing advance adjustment as specified in TS 36.213 subclause 9.1.5.3”.[9]
* When PUR ACK DCI indicates TA adjustment, the PUR TA timer is restarted and TA is adjusted by the value provided in the DCI.[11]

Regarding TA by L1 signalling, RAN1 has agreed the following:

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| If format 6-0A CRC is scrambled by PUR-RNTI and Resource block assignment is set to all ones, the remaining fields are set as follows:  <skip>  -     Timing advance adjustment – 6 bits as defined in subclause 4.2.3 of [3]. The field is only present if ACK or Fallback indicator is set to 0. |

Based on the proposals, it should not be controversial that MAC applies the TA value and restarts PUR TA if L1 signalling include TA. Current MAC running CR R2-2000983 includes the following in 5.4.x.2:

- when a Timing Advance Command MAC control element is received:

- apply the Timing Advance Command;

- start or restart the *pur-timeAlignmentTimer*.

The above can be updated as follows in the MAC CR (taking current CR text as baseline)

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| 5.4.x.2 Maintenance of PUR Uplink Time Alignment MAC entity may have a configurable timer *pur-TimeAlignmentTimer* when upper layers have configured Preconfigured Uplink Resource.  The MAC entity shall:  - if upper layers indicate PUR TA is validated:  - start or restart the *pur-timeAlignmentTimer.*  - when a Timing Advance Command MAC control element is received or PDCCH indicates timing advance adjustment as specified in TS 36.212 subclauses 5.3.3.1.10 and 5.3.3.1.11:  - apply the Timing Advance Command;  - start or restart the *pur-timeAlignmentTimer*.  - when a *pur-timeAlignmentTimer* expires:  - indicate to upper layers the expiry of PUR TA timer.  Editor's note: FFS when to start the *pur-timeAlignmentTimer.*  Upon request from upper layers, MAC entity shall indicate if *pur-TimeAlignmentTimer* is running or not.  If *pur-TimeAlignmentTimer* is configured, the MAC entity shall not perform any uplink transmission using preconfigured grant corresponding to PUR except the Random Access Preamble transmission when the *pur-timeAlignmentTimer* is not running or when the TA for PUR is considered invalid.  Editor's note: FFS whether cell change can be captured in MAC or whether only in RRC and the exact interaction needed. |

**P6: A adjustment by DCI is captured in MAC specification 5.4.x.2 to include the condition “when a Timing Advance Command MAC control element is received or PDCCH indicates timing advance adjustment as specified in TS 36.212 subclauses 5.3.3.1.10 and 5.3.3.1.11”.**

**Offline discussion Q4: Please provide your comment only if you are NOT ok with the above proposal.**

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| **Company** | **Disagree with P6?** | **Comments** |
| Ericsson |  | Don't think exact reference is necessary but OK if others are. |
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## PUR TA validation

One contribution proposes on where to capture the TA validation:

* It’s suggested to capture the TA validation procedure in MAC specification.[13]

Given that the following are already captured in the current RRC running CRs after lengthy discussions, rapporteur thinks RAN2 should not spend time to rewrite it. However, a quick discussion is proposed.

eMTC:

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| 5.3.3.x Timing alignment validation for transmission using PUR A UE shall consider the timing alignment value for transmission using PUR to be valid when all of the following conditions are fulfilled:  1> if *idleModeTAT* is configured:  2> timing alignment timer for PUR is running as confirmed by lower layers;  1> if *rsrp-ChangeThresh* is configured:  2> since the last TA validation, the serving cell RSRP has not increased by more than *rsrp-IncreaseThresh*; and  2> since the last TA validation, the serving cell RSRP has not decreased by more than *rsrp-DecreaseThresh*;  Editor’s Note: FFS: Further details about serving cell change and interaction with MAC. |

NB-IoT:

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| 5.3.3.x Timing alignment validation for transmission using PUR  A UE shall consider the timing alignment value for transmission using PUR to be valid when all of the following conditions are fulfilled:  1> if pur-TimingAlignmentTimer is configured:  2> pur-TimingAlignmentTimer is running as confirmed by lower layers;  1> if pur-NRSRPThreshold is configured:  2> the TA validation criterion based on change in serving cell (N)RSRP is fulfilled;  Editor's Note: FFS how to capture TA validation criteria. |

1. Current running CR already captures TA validation criteria in RRC.

**P8: RAN2 confirms TA validation procedure is captured/kept in RRC spec.**

**Offline discussion Q5: Please provide your comment if you are NOT ok with the above proposal.**

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| **Company** | **Disagree with P8?** | **Comments** |
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## PUR completion/fallback indication from PHY

In the RRC running CR, following is captured:

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| 5.3.3.3x UE actions upon receiving PUR completion indication from lower layers  Upon indication from lower layers that CP transmission using PUR is successfully completed, the UE shall perform the actions specified in 5.3.3.4b as if an empty *RRCEarlyDataComplete* message was received.  Editor’s Note: Additional details is needed for the case if any RRC parameter is updated by L1 ACK.  Editor’s Note: Additional details may be needed regarding RRC-MAC interaction. |

Related RAN1 agreement is the following:

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| If format 6-0A CRC is scrambled by PUR-RNTI and Resource block assignment is set to all ones, the remaining fields are set as follows:  -     ACK or Fallback indicator – 1 bit, where value 0 indicates ACK and value 1 indicates fallback as defined in subclause 9.1.5.3 of [3] |

The procedure about the ACK/fallback indicator is captured in RAN1 specification TS 36.213, subclause 9.1.5.3 as follows:

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| **9.1.5.3            Preconfigured Uplink Resource ACK/fallback procedure**  If a UE has initiated a PUSCH transmission using preconfigured uplink resource on a given serving cell, and upon detection of a PDCCH with DCI format 6-0A/6-0B with CRC scrambled by PUR C-RNTI intended for the UE within the PUR search space window as defined in Subclause 9.1.5, and the corresponding DCI is for PUR ACK feedback indication (as defined in [4]), the UE shall deliver the PUR ACK/fallback indication, as signalled on the PDCCH, to the higher layers. |

It is clear from the above that PHY shall deliver the PUR ACK/fallback indication as signalled on the PDCCH to the higher layers.

For the case of PUR ACK, MAC running CR section 5.4.x.1 captures some MAC procedure and further captures that PUR success indication is provided to upper layers. Additionally, behavior on PUR ACK is already captured in TS 36.331 as shown above. For the case of PUR NACK/fallback, there is FFS note in the MAC running CR. And nothing is captured in RRC so far.

Following proposals are relevant to the PUR completion and fallback indication from PHY (i.e. L1 indication)

* Adopt the TP given in section 2.1 for MAC running CR section 5.4.x.1.[9]
* Adopt the TP given in section 2.1 for RRC running CR section 5.3.3.3x.[9].
* When "PUR fallback indication" is received by MAC layer, MAC will stop monitoring PDCCH in PUR response window and higher layers are informed that PUR transmission was not successful.[11]

Further, based on previous RAN2 agreements, [9] proposes that MAC is agnostic to the indication and forward it to “upper layers” in both success and fallback case. This seems to align with the above proposal from [11].

**P10: When "PUR fallback indication" is received, MAC stops monitoring PDCCH in PUR response window.**

**Offline discussion Q6: Please provide your comment if you are NOT ok with the above proposal.**

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| **Company** | **Disagree with P10?** | **Comments** |
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If MAC forwards the L1 ACK/PUR fallback indication received from lower layers to the RRC, then RRC specification can capture the previous agreement that UE actions upon reception of fallback indication from lower layers is left up to implementation. So, the following two proposals are covered by next question.

**P11: MAC forwards the L1 ACK/PUR fallback indication received from lower layers to the RRC.**

**P13: In RRC CR 5.3.3.3x, add “NOTE: UE actions upon reception of fallback indication from lower layers (see TS 36.213 subclause 9.1.5.3) is left up to implementation.” Remove Editor’s Notes.**

**Offline discussion Q7: Please provide your comment if you are NOT ok with the above proposals.**

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| **Company** | **Disagree with P11 and/or P13?** | **Comments** |
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## PUR release due to RACH on new cell

Following is proposed in [13]

* It’s suggested to capture PUR configuration release upon RA in another cell in MAC specification and delete the related description in RRC specification.[13]

In [9], it is described that since the UE is in IDLE, when RACH is initiated in a new cell, RRC should be aware of the initiation because it is the one which triggered the connection/resume request. If RRC submitted an RRC message to to the lower layers for transmission while it is aware that UE is in a different cell, RRC can proactively release PUR without any indication from MAC (consequently, MAC would initiate RACH instead of trying to use PUR). Therefore, handling of PUR release due to RACH initiation in new cell should be captured in RRC specification.

**P14: [FFS] Where to capture PUR release due to RACH initiation on a new cell.**

**Offline discussion Q8: Companies are requested to provide their view on above proposal considering the following options for handling of PUR release due to RACH initiation in new cell:**

Option 1: captured in MAC.

1a. Indication(s) required across layers.

1b. No indication required across layers.

Option 2: captured in RRC.

2a. Indication(s) required across layers.

2b. No indication required across layers.

Option 3: other.

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| **Company** | **Option** | **Comments, with potential TPs, if any.**  **Also describe whether/which indication(s) need(s) to be passed across MAC and RRC layers.** |
| ZTE | 1b | If captured in MAC, initiation of RA procedure in a new cell can be accurately captured in Random Access procedure. And according to our comments for Question 1, we think PUR release can be purely performed by MAC, so no need of across layers indication.  If captured in RRC, the description can only be captured in each transmission of RRC Msg3. Then if RA failure occurs before RRC Msg3 transmission, it’s no way for RRC to capture this trigger for PUR release. |
| Ericsson | 2 (a?) | The issue with Option 1 is that MAC layer may not have the information on cells without relying on implementation or additional indications between layers. Option 1 would also suggest that MAC would handle most of the configuration – which we haven't agreed to at least yet.  For Option 2, RRC would anyways handle initiation of PUR, and would know about cell change. It may be that indication to MAC is needed to be defined, depending on some further details on where e.g. grant is maintained.  In general, we think we should first agree e.g. where the grant is maintained as that may affect the most viable way to do this. |

## Other

[11] explains if RRC ACK is received for a PUR transmission, it should be indicated to MAC layer so that MAC can stop monitoring PUR response window.

* RRC layer indicates successful PUR transmission to MAC layer when higher layer ACK is received.[11]

To the summary rapporteur, this seemed to be straightforward and following was proposed in the discussion summary [25]:

**P15: Upon reception of RRC message indicating successful PUR transmission, RRC indicates this to MAC layer.**

**Offline discussion Q9: Please provide your comment if you are NOT ok with the above proposal.**

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| **Company** | **Disagree with P15?** | **Comments** |
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# Summary

**To be updated.**

# References

1. R2-2000250, "Remaining clarifications on PUR configuration", THALES
2. R2-2000435, "T300 applicability for PUR", Qualcomm Incorporated
3. R2-2000443, "TA validation based on serving cell RSRP", Sierra Wireless, S.A.
4. R2-2000559, "Security Aspects of D-PUR for control plane solution", Nokia, Nokia Shanghai Bell
5. R2-2000640, "Handling of D-PUR configuration for CP solution", Huawei, HiSilicon
6. R2-2000641, "[Draft] LS on handling of D-PUR configuration for the CP solution", Huawei
7. R2-2000642, "RRC-MAC-PHY interactions for PUR", Huawei, HiSilicon
8. R2-2000643, "Signalling aspect of PUR configuration", Huawei, HiSilicon
9. R2-2000695, "Remaining FFSes on RRC-MAC interaction for PUR", Qualcomm Incorporated
10. R2-2000984, "PUR periodicity and UE multiplexing", Ericsson
11. R2-2000985, " RRC-MAC interaction details and other FFSs for PUR in running MAC CR", Ericsson
12. R2-2001198, "D-PUR reconfiguration and release for CP solution", ZTE Corporation, Sanechips
13. R2-2001200, "MAC-RRC coordination for TA validation and some FFS for D-PUR", ZTE Corporation, Sanechips
14. R2-2001201, "Remaining FFSs for D-PUR in 36.331", ZTE Corporation, Sanechips
15. R2-2001202, "Remaining FFSs for D-PUR in 36.321", ZTE Corporation, Sanechips
16. R2-2001394, "Clarification for the condition of PUR configuration request procedure", LG Electronics UK
17. R2-2001395, "Handling application response for D-PUR transmission", LG Electronics UK
18. R2-2001397, "Discussion on delivery of D-PUR configuration request", LG Electronics UK
19. R2-2001398, "Paging response usign D-PUR", LG Electronics UK
20. R2-2001399, "Discussion on preconfigured shared uplink resource transmission", LG Electronics UK
21. R2-2001516, "Further Pre-configured UL Resources Design Considerations", Sierra Wireless, S.A.
22. R2-2001601, "Handling D-PUR configuration in RRC\_CONNECTED state", ASUSTeK
23. R2-2001602, "Remaining issues of D-PUR TA timer", ASUSTeK
24. R2-2002028, "Summary of RRC in general and L1 signalling impact to RRC (including e.g. how/when to configure PHY)", Ericsson
25. R2-2002021, “Summary of Other RRC-MAC-PHY interactions”, Qualcomm