**3GPP TSG-RAN2 Meeting #114-e *R2-2106606***

**Online, 19th May 2021 - 27th May 2021**

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| *CR-Form-v12.1* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  | **36.321** | **CR** | **1524** | **rev** | **1** | **Current version:** | **16.4.0** |  |
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| *For* [***HE******LP***](http://www.3gpp.org/3G_Specs/CRs.htm#_blank)*on using this form: comprehensive instructions can be found at* [*http://www.3gpp.org/Change-Requests*](http://www.3gpp.org/Change-Requests)*.* | | | | | | | | |
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| ***Proposed change affects:*** | UICC apps |  | ME | **x** | Radio Access Network | **x** | Core Network |  |

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| ***Title:*** | MAC clarifications for PUR | | | | | | | | | |
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| ***Source to WG:*** | ZTE Corporation, Sanechips, MediaTek Inc., Qualcomm Incorporated, vivo | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
|  |  | | | | | | | | | |
| ***Work item code:*** | LTE\_eMTC5-Core, NB\_IOTenh3-Core | | | | |  | ***Date:*** | | | 2021-06-04 |
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| ***Category:*** | **F** |  | | | | | ***Release:*** | | | Rel-16 |
|  | *Use one of the following categories:* ***F*** *(correction)* ***A*** *(mirror corresponding to a change in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)*  Detailed explanations of the above categories can be found in 3GPP [TR 21.900](http://www.3gpp.org/ftp/Specs/html-info/21900.htm). | | | | | | | | *Use one of the following releases: Rel-8 (Release 8) Rel-9 (Release 9) Rel-10 (Release 10) Rel-11 (Release 11) … Rel-15 (Release 15) Rel-16 (Release 16) Rel-17 (Release 17) Rel-18 (Release 18)* | |
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| ***Reason for change:*** | | 1. It is possible that a UE configured with PUR triggers a legacy RA procedure between PUR occasions. When the UE receives RAR carrying a TAC, UE applies the Timing Advance Command (see 5.2). According to the current specification, the updated NTA would also apply to the next PUR transmission regardless of whether the Random Access procedure completes successfully. However, if the contention resolution in this RA procedure fails, the updated NTA may be incorrect for the UE. This is not an issue for the legacy RA procedure but might cause that the next PUR transmission fails (note that this incorrect NTA would not be discarded when MAC is reset and would be used in the next PUR transmission). Also in the scenario that a UE configured with PUR triggers a legacy RA procedure, when the UE receives a RAR carrying a TAC, UE starts the *timeAlignmentTimer* but does not restart *pur-TimeAlignmentTimer*. Therefore, even if the UE can get NTA (when the contention resolution successfully completes), later *pur-TimeAlignmentTimer* would still expire and the PUR resource is not available. 2. In 5.2 and 5.4.7.2 existing text, there is duplicated description of “*apply the Timing Advance Command…*” upon reception of TAC MAC CE. This duplication should be addressed. 3. PUR supports only one HARQ process. It is assumed that HARQ process ID 0 is used for transmission using PUR. But this is not clear in current MAC spec. | | | | | | | | |
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| ***Summary of change:*** | | 1. In section 5.2, to clarify that UE firstly stores the NTA as a temporary NTA before applying the Timing Advance Command upon receiving RAR carrying a TAC. In section 5.4.7.2, to clarify that if Random Access procedure is unsuccessfully completed, the NTA should be set to the stored temporary NTA, e.g., fallback to previous NTA; If Random Access procedure successfully completed, the *pur-TimeAlignmentTimer* should also start or restart. 2. In section 5.2, to exclude PUR case from the description of “apply the Timing Advance Command…” upon reception of TAC MAC CE. In section 5.4.7.2, to clarify that the condition for “*apply the Timing Advance Command…*” is receiving TAC MAC CE or PDCCH indicating timing advance adjustment addressed with a PUR-RNTI. 3. In section 5.4.2.1, to clarify HARQ process identifier 0 is used for transmission using PUR.   **Impact Analysis**  Impacted functionality:  The changes only impact PUR procedure.  Inter-operability analysis:  For the changes related to *pur-TimeAlignmentTimer*:   * if the UE is implemented according to this CR and the network is not, after succesful RAR, the UE will restart the PUR TAT but not the NW, which may consider PUR is no longer valid. And the UE may use PUR which is no longer allocated to this UE, resulting in potential collision with other UE’s transmission and PUR failure. * if the network is implemented according to this CR and the UE is not, after succesful RAR, the UE would not restart the PUR TAT even though the network has restarted this timer for the particular UE, and the UE may stop using PUR sooner than the network has allocated it. That would result in network resource wastage, but there is no interoperability issue.   For the third change, as it is just a clarification, no inter-operability issue is identified. | | | | | | | | |
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| ***Consequences if not approved:*** | | If the first and second changes are not approved, the UE behaviour for handling of NTA and PUR TAT remains incorrect.  If the third change is not approved, specification remains unclear about HARQ process ID applicable for PUR. | | | | | | | | |
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| ***Clauses affected:*** | | 5.2, 5.4.7.2, 5.4.2.1 | | | | | | | | |
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|  | | **Y** | **N** |  | | | |  | | |
| ***Other specs*** | |  | **X** | Other core specifications | | | | TS/TR ... CR ... | | |
| ***affected:*** | |  | **X** | Test specifications | | | | TS/TR ... CR ... | | |
| ***(show related CRs)*** | |  | **X** | O&M Specifications | | | | TS/TR ... CR ... | | |
|  | |  | | | | | | | | |
| ***Other comments:*** | |  | | | | | | | | |
|  | |  | | | | | | | | |
| ***This CR's revision history:*** | |  | | | | | | | | |

**<First change>**

## 5.2 Maintenance of Uplink Time Alignment

The MAC entity has a configurable timer *timeAlignmentTimer* per TAG. The *timeAlignmentTimer* is used to control how long the MAC entity considers the Serving Cells belonging to the associated TAG to be uplink time aligned, as specified in TS 36.331 [8].

The MAC entity shall:

- when a Timing Advance Command MAC control element is received and if a NTA has been stored or maintained with the indicated TAG:

- except when the received Timing Advance Command MAC control element is addressed with a PUR-RNTI:

- apply the Timing Advance Command for the indicated TAG;

- start or restart the *timeAlignmentTimer* associated with the indicated TAG.

- when a Timing Advance Command is received in a Random Access Response message for a serving cell belonging to a TAG:

- if the UE is configured with *pur-Config* (see TS 36.331 [8]) and if a NTA has been stored or maintained and no temporary NTA has been stored:

- store current NTA as temporary NTA (see clause 5.4.7.2).

- if the Random Access Preamble was not selected by the MAC entity:

- apply the Timing Advance Command for this TAG;

- start or restart the *timeAlignmentTimer* associated with this TAG.

- else, if the *timeAlignmentTimer* associated with this TAG is not running:

- apply the Timing Advance Command for this TAG;

- start the *timeAlignmentTimer* associated with this TAG;

- when the contention resolution is considered not successful as described in clause 5.1.5, stop *timeAlignmentTimer* associated with this TAG*.*

- else:

- ignore the received Timing Advance Command.

- when the MAC entity is configured with *rach-Skip* or *rach-SkipSCG*:

- apply timing advance value indicated by *targetTA* in *rach-Skip* or *rach-SkipSCG* for the pTAG;

- start the *timeAlignmentTimer* associated with this TAG.

- when a *timeAlignmentTimer* expires:

- if the *timeAlignmentTimer* is associated with the pTAG:

- flush all HARQ buffers for all serving cells;

- notify RRC to release PUCCH/SPUCCH for all serving cells;

- notify RRC to release SRS for all serving cells;

- for NB-IoT, notify RRC to release all dedicated resources for SR;

- clear any configured downlink assignments and uplink grants;

- consider all running *timeAlignmentTimer*s as expired;

- else if the *timeAlignmentTimer* isassociated with an sTAG, then for all Serving Cells belonging to this TAG*:*

- flush all HARQ buffers;

- notify RRC to release SRS;

- notify RRC to release PUCCH/SPUCCH, if configured;

- clear any configured downlink assignments and uplink grants.

- upon indication from upper layers to start *timeAlignmentTimer*, if a NTA has been stored or maintained with the indicated TAG:

- start or restart the *timeAlignmentTimer* associated with the indicated TAG.

When the MAC entity stops uplink transmissions for an SCell due to the fact that the maximum uplink transmission timing difference (as described in clause 7.9.2 of TS 36.133 [9]) or the maximum uplink transmission timing difference the UE can handle between TAGs of any MAC entity of the UE is exceeded, the MAC entity considers the *timeAlignmentTimer* associated with the SCell as expired.

The MAC entity shall not perform any uplink transmission on a Serving Cell, except the Random Access Preamble transmission and transmissions corresponding to a PUR-RNTI, when the *timeAlignmentTimer* associated with the TAG to which this Serving Cell belongs is not running. Furthermore, when the *timeAlignmentTimer* associated with the pTAG is not running, the MAC entity shall not perform any uplink transmission on any Serving Cell except the Random Access Preamble transmission on the SpCell.

The MAC entity shall not perform any sidelink transmission which is performed based on UL timing of the corresponding serving cell and any associated SCI transmissions when the corresponding *timeAlignmentTimer* is not running.

NOTE: A MAC entity stores or maintains NTA upon expiry of associated *timeAlignmentTimer*, where NTA is defined in TS 36.211 [7]. The MAC entity applies a received Timing Advance Command MAC control element and starts associated *timeAlignmentTimer* also when the *timeAlignmentTimer* is not running.

**<Next change>**

5.4.7.2 Maintenance of PUR Uplink Time Alignment

MAC entity may be configured with timer *pur-TimeAlignmentTimer* by upper layers as specified in TS 36.331 [8], clause 5.3.8.3.

The MAC entity shall:

- when *pur-TimeAlignmentTimer* configuration is received from upper layers:

- start or restart *pur-TimeAlignmentTimer*.

- when *pur-TimeAlignmentTimer* is released by upper layers:

- stop the *pur-TimeAlignmentTimer*, if running.

- when a Timing Advance Command MAC control element is received or PDCCH indicates timing advance adjustment as specified in TS 36.212 [5] and if a NTA has been stored or maintained:

- if the Timing Advance Command MAC control element or PDCCH indicating timing advance adjustment is addressed with a PUR-RNTI:

- apply the Timing Advance Command or the timing advance adjustment;

- start or restart the *pur-TimeAlignmentTimer*, if configured;

- indicate to upper layers that the Timing Advance value has been adjusted.

- upon considering a Random Access procedure successfully completed:

- start or restart the *pur-TimeAlignmentTimer*, if configured;

- indicate to upper layers that the Timing Advance value has been adjusted;

- if a temporary NTA has been stored, delete the stored temporary NTA.

- upon considering a Random Access procedure unsuccessfully completed, if a temporary NTA has been stored:

- set the NTA to the stored temporary NTA;

- delete the stored temporary NTA.

Upon request from upper layers, MAC entity shall indicate whether *pur-TimeAlignmentTimer* is running.

**<Next change>**

5.4.2.1 HARQ entity

There is one HARQ entity at the MAC entity for each Serving Cell with configured uplink, which maintains a number of parallel HARQ processes allowing transmissions to take place continuously while waiting for the HARQ feedback on the successful or unsuccessful reception of previous transmissions.

The number of parallel HARQ processes per HARQ entity is specified in TS 36.213 [2], clause 8. NB-IoT has one or two UL HARQ processes.

When the physical layer is configured for uplink spatial multiplexing, as specified in TS 36.213 [2], there are two HARQ processes associated with a given TTI. Otherwise there is one HARQ process associated with a given TTI.

At a given TTI, if an uplink grant is indicated for the TTI, the HARQ entity identifies the HARQ process(es) for which a transmission should take place. It also routes the received HARQ feedback (ACK/NACK information), MCS and resource, relayed by the physical layer, to the appropriate HARQ process(es).

In asynchronous HARQ operation, a HARQ process is associated with a TTI based on the received UL grant except for UL grant in RAR. Except for NB-IoT UE configured with a single HARQ process, each asynchronous HARQ process is associated with a HARQ process identifier. For UL transmission with UL grant in RAR and for transmission using PUR, HARQ process identifier 0 is used. HARQ feedback is not applicable for asynchronous UL HARQ except if *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured.

In autonomous HARQ operation, HARQ feedback is applicable.

When TTI bundling is configured, the parameter TTI\_BUNDLE\_SIZE provides the number of TTIs of a TTI bundle. TTI bundling operation relies on the HARQ entity for invoking the same HARQ process for each transmission that is part of the same bundle. Within a bundle HARQ retransmissions are non-adaptive and triggered without waiting for feedback from previous transmissions according to TTI\_BUNDLE\_SIZE. The HARQ feedback of a bundle is only received for the last TTI of the bundle (i.e the TTI corresponding to TTI\_BUNDLE\_SIZE), regardless of whether a transmission in that TTI takes place or not (e.g. when a measurement gap occurs). A retransmission of a TTI bundle is also a TTI bundle. TTI bundling is not supported when the MAC entity is configured with one or more SCells with configured uplink.

Uplink HARQ operation is asynchronous for NB-IoT UEs, BL UEs or UEs in enhanced coverage except for the repetitions within a bundle, in serving cells configured with *pusch-EnhancementsConfig*, serving cells operating according to Frame Structure Type 3, for HARQ processes scheduled using short TTI, for HARQ processes scheduled using Short Processing Time, and for HARQ processes associated with an SPS configuration with *totalNumberPUSCH-SPS-STTI-UL-Repetitions* or *totalNumberPUSCH-SPS-UL-Repetitions* exceptfor the repetitions within a bundle.

For serving cells configured with *pusch-EnhancementsConfig*, NB-IoT UEs, BL UEs or UEs in enhanced coverage, the parameter UL\_REPETITION\_NUMBER provides the number of transmission repetitions within a bundle. For each bundle, UL\_REPETITION\_NUMBER is set to a value provided by lower layers. Bundling operation relies on the HARQ entity for invoking the same HARQ process for each transmission that is part of the same bundle. Within a bundle HARQ retransmissions are non-adaptive and are triggered without waiting for feedback from previous transmissions according to UL\_REPETITION\_NUMBER. An uplink grant corresponding to a new transmission of the bundle is only received after the last repetiton of the bundle if *mpdcch-UL-HARQ-ACK-FeedbackConfig* is not configured. An uplink grant corresponding to a retransmission of the bundle is only received after the last repetition of the bundle. For UEs configured with *mpdcch-UL-HARQ-ACK-FeedbackConfig*, repetitions within a bundle are stopped if an UL HARQ-ACK feedback or an uplink grant corresponding to a new transmission of the bundle is received on PDCCH during the bundle transmission. A retransmission of a bundle is also a bundle.

For a SPS configuration with *totalNumberPUSCH-SPS-STTI-UL-Repetitions* or *totalNumberPUSCH-SPS-UL-Repetitions* (TS 36.331 [8]), the parameter *totalNumberPUSCH-SPS-STTI-UL-Repetitions* or *totalNumberPUSCH-SPS-UL-Repetitions* provides the number of transmission repetitions within a configured grant bundle. Bundling operation relies on the HARQ entity invoking the same HARQ process for each transmission that is part of the same bundle. Within a bundle HARQ retransmissions are non-adaptive and are triggered without waiting for feedback from previous transmissions.

TTI bundling is not supported for RN communication with the E-UTRAN in combination with an RN subframe configuration.

For transmission of Msg3 during Random Access (see clause 5.1.5) TTI bundling does not apply. For UEs configured with *pusch-EnhancementsConfig* performing contention free Random Access, NB-IoT UEs, BL UEs or UEs in enhanced coverage, uplink repetition bundling is used for transmission of Msg3.

For each TTI, the HARQ entity shall:

- identify the HARQ process(es) associated with this TTI, and for each identified HARQ process:

- if an uplink grant has been indicated for this process and this TTI:

- if the received grant was addressed neither to a Temporary C-RNTI nor to a PUR-RNTI on PDCCH and if the NDI provided in the associated HARQ information has been toggled compared to the value in the previous transmission of this HARQ process; or

- if the uplink grant was received on PDCCH for the C-RNTI and the HARQ buffer of the identified process is empty; or

- if the uplink grant was provided by RRC for transmission using PUR; or

- if the uplink grant was received in a Random Access Response:

- if there is a MAC PDU in the Msg3 buffer and the uplink grant was received in a Random Access Response:

- if the MAC PDU in the Msg3 buffer contains the Data Volume and Power Headroom Report MAC control element:

- the MAC entity shall update the Data Volume and Power Headroom Report MAC control element in the MAC PDU in the Msg3 buffer.

- if the UE is an NB-IoT UE and *cqi-Reporting* is configured by upper layers:

- the MAC entity shall update the MAC PDU in the Msg3 buffer in accordance with the DL channel quality measurement result.

- obtain the MAC PDU to transmit from the Msg3 buffer.

- else if the uplink grant is a configured grant with *totalNumberPUSCH-SPS-STTI-UL-Repetitions* or *totalNumberPUSCH-SPS-UL-Repetitions* and if a retransmission within a bundle is triggered for another configured grant with *totalNumberPUSCH-SPS-STTI-UL-Repetitions* or *totalNumberPUSCH-SPS-UL-Repetitions* in this TTI:

- ignore the uplink grant.

- else if the MAC entity is configured with *semiPersistSchedIntervalUL* shorter than 10 subframes and if the uplink grant is a configured grant, and if the HARQ buffer of the identified HARQ process is not empty, and if HARQ\_FEEDBACK of the identified HARQ process is NACK; or if the MAC entity is configured with *ul-SchedInterval* shorter than 10 subframes and if the uplink grant is a preallocated uplink grant, and if the HARQ buffer of the identified HARQ process is not empty, and if HARQ\_FEEDBACK of the identified HARQ process is NACK:

- instruct the identified HARQ process to generate a non-adaptive retransmission.

- else:

- if the UL HARQ operation is synchronous, and the uplink grant is a preallocated uplink grant, and a MAC PDU has previously been obtained from the "Multiplexing and assembly" entity during this handover attempt:

- ignore the uplink grant;

- else:

- obtain the MAC PDU to transmit from the "Multiplexing and assembly" entity, if any;

- if a MAC PDU to transmit has been obtained:

- deliver the MAC PDU and the uplink grant and the HARQ information to the identified HARQ process;

- instruct the identified HARQ process to trigger a new transmission.

- else:

- flush the HARQ buffer of the identified HARQ process.

- else:

- if the MAC entity is configured with *skipUplinkTxSPS* and if the uplink grant received on PDCCH was addressed to the Semi-Persistent Scheduling C-RNTI or to the UL Semi-Persistent Scheduling V-RNTI and if the HARQ buffer of the identified process is empty; or

- if UL HARQ operation is autonomous for the identified HARQ process and if the uplink grant is a configured UL grant and if the HARQ buffer of the identified process is empty; or

- if the previous uplink grant delivered to the HARQ entity for the same HARQ process was a configured uplink grant for which the UL HARQ operation was autonomous, and if the corresponding UL grant size was different from the UL grant size indicated by the uplink grant for this TTI:

- ignore the uplink grant;

- else:

- deliver the uplink grant and the HARQ information (redundancy version) to the identified HARQ process;

- if UL HARQ operation is autonomous for the identified HARQ process and if the uplink grant is a configured UL grant:

- instruct the identified HARQ process to generate a non adaptive retransmission.

- else:

- instruct the identified HARQ process to generate an adaptive retransmission.

- else, if the HARQ buffer of this HARQ process is not empty:

- instruct the identified HARQ process to generate a non-adaptive retransmission;

- if the non-adaptive retransmission collides with a transmission of another HARQ process scheduled using Short Processing Time:

- instruct the identified HARQ process to generate a positive acknowledgement (ACK) of the data in the corresponding TB.

When determining if NDI has been toggled compared to the value in the previous transmission the MAC entity shall ignore NDI received in all uplink grants on PDCCH for its Temporary C-RNTI and PUR-RNTI.