**3GPP TSG-RAN WG2 Meeting #109bis-e *R2-200xxxx***

**, 20th – 30th April 2020**

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| *CR-Form-v12.0* |
| **CHANGE REQUEST** |
|  |
|  | **36.321** | **CR** |  | **rev** |  | **Current version:** | **16.0.0** |  |
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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 |  |
|  |
| ***Title:***  | Corrections to MAC for Rel-16 NB-IoT |
|  |  |
| ***Source to WG:*** | Ericsson |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** |  NB\_IOTenh3-Core |  | ***Date:*** | 2020-04-30 |
|  |  |  |  |  |
| ***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 canbe 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-12 (Release 12)Rel-13 (Release 13)Rel-14 (Release 14)Rel-15 (Release 15)Rel-16 (Release 16)* |
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| ***Reason for change:*** | Capturing agreements and clarifications in MAC from RAN2#109bis-e. |
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| ***Summary of change:*** | The following changes have been included:TBD |
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| ***Consequences if not approved:*** | Rel-16 corrections and functionality for NB-IoT Rel-16 will be missing from MAC. |
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| ***Clauses affected:*** | 5.4.7.1, 5.4.7.2, 5.9 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** | **X** |  |  Other core specifications  | TS 36.300 CR 1277TS 36.306 CR 1746TS 36.331 CR xxxx |
| ***affected:*** |  | **X** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

First Change

### 5.4.2 HARQ operation

#### 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, 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 not addressed to a Temporary C-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 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.

Next Change

### 5.4.7 Preconfigured Uplink Resource

#### 5.4.7.1 Transmission using PUR

Preconfigured Uplink Resource may be configured by upper layers for a UE in enhanced coverage or a BL UE or an NB-IoT UE. When PUR has been configured by upper layers, the following information is provided in *PUR-config,* as specified in TS 36.331 [8]:

- PUR C-RNTI;

- Duration of PUR response window *pur-ResponseWindowSize*;

- Number *pur-ImplicitReleaseAfter* of skipped preconfigured uplink grants before implicit release;

- Time alignment timer for PUR, *pur-TimeAlignmentTimer*, if configured;

- Periodicity of resources, *pur-Periodicity*;

- Offset indicating PUR starting time, *pur-StartTime*.

Editor's note: FFS wheter pur-NumOccasions should be counted in MAC or in RRC. FFS if any other configuration information is needed.

The MAC entity shall consider sequentially that the Nth preconfigured uplink grant occurs in the TTI according to *pur-StartTime* and N \* *pur-Periodicity.*

Editor's note: Exact calculation above depends on further details of the configuration.

When PUR configuration is released by upper layers, MAC entity shall discard the corresponding preconfigured uplink grants.

If the MAC entity has a PUR C-RNTI, the MAC entity shall in RRC\_IDLE for each TTI that has a preconfigured uplink grant:

- deliver the preconfigured uplink grant, and the associated HARQ information to the HARQ entity for this TTI.

After transmission using preconfigured uplink grant, the MAC entity shall monitor PDCCH identified by PUR C-RNTI in the PUR response window using timer *pur-ResponseWindowTimer*, which starts at the subframe that contains the end of the corresponding PUSCH transmission, plus 4 subframes and has the length *pur-ResponseWindowSize.* While *pur-ResponseWindowTimer* is running, the MAC entity shall:

- if an uplink grant has been received on PDCCH for PUR C-RNTI for retransmission:

- restart *pur-ResponseWindowTimer* at the last subframe of a PUSCH transmission corresponding to the retransmission indicated by the UL grant, plus 4 subframes;

- if PDCCH indicates L1 ACK for PUR; or

- if PDCCH transmission is addressed to its PUR C-RNTI and the MAC PDU is successfully decoded:

- stop *pur-ResponseWindowTimer*;

- consider transmission using PUR successful;

- if PDCCH indicates L1 ACK for PUR:

- indicate to upper layers the PUR transmission was successful.

- if PDCCH indicates fallback for PUR:

- stop *pur-ResponseWindowTimer*;

- consider transmission using PUR transmission has failed;

- indicate to upper layers PUR fallback indication was received.

- if the *pur-ResponseWindowTimer* expires:

- consider the preconfigured uplink grant as skipped;

- indicate to upper layers the PUR transmission has failed.

Additionally, MAC entity shall consider a preconfigured uplink grant skipped if no MAC PDU is generated according to 5.4.3.1 for the preconfigured uplink grant.

The MAC entity shall discard the preconfigured uplink grants immediately after *pur-ImplicitReleaseAfter* number of consecutive skipped preconfigured uplink grants in RRC\_IDLE. MAC entity shall notify RRC to release PUR configuration when preconfigured uplink grants are discarded.

Editor's note: How MAC entity knows whether UE is in RRC\_IDLE or RRC\_CONNECTED above.

#### 5.4.7.2 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:

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

- start or restart *pur-TimeAlignmentTimer.*

- 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 [5]:

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

- start or restart the *pur-TimeAlignmentTimer*.

Upon request from upper layers, MAC entity shall indicate if *pur-TimeAlignmentTimer* is running or not.

Editor's note: FFS whether cell change can be captured in MAC or whether only in RRC and the exact interaction needed.

### 5.4.8 Access Stratum Release Assistance Indication

Access Stratum Release Assistance Indication is used to provide the serving eNB with information whether subsequent DL or UL transmission is expected. AS RAI uses the DPQR and AS RAI MAC Control Element. Upper layers trigger AS RAI.

For EDT and transmission using PUR, if AS RAI is triggered by upper layers but is not included in the resulting MAC PDU with the MAC SDU, AS RAI is cancelled.

Editor's note: FFS non-EDT, non-PUR.

Next Change

## 5.9 MAC Reset

If a reset of the MAC entity is requested by upper layers, the MAC entity shall:

- initialize Bj for each logical channel to zero;

- except for *pur-timeAlignmentTimer,* if configured*,* stop (if running) all timers;

- consider all *timeAlignmentTimer*sas expired and perform the corresponding actions in clause 5.2;

- set the NDIs for all uplink HARQ processes to the value 0;

- stop, if any, ongoing RACH procedure;

- discard explicitly signalled *ra-PreambleIndex* and *ra-PRACH-MaskIndex*, if any;

- flush Msg3 buffer;

- cancel, if any, triggered Scheduling Request procedure;

- cancel, if any, triggered Buffer Status Reporting procedure;

- cancel, if any, triggered Power Headroom Reporting procedure;

- flush the soft buffers for all DL HARQ processes;

- for each DL HARQ process, consider the next received transmission for a TB as the very first transmission;

- release, if any, Temporary C-RNTI.

If a partial reset of the MAC entity is requested by upper layers, for a serving cell, the MAC entity shall for the serving cell:

- set the NDIs for all uplink HARQ processes to the value 0;

- flush all UL HARQ buffers;

- stop all running *drx-ULRetransmissionTimers*;

- stop all running UL HARQ RTT timers;

- stop, if any, ongoing RACH procedure;

- discard explicitly signalled *ra-PreambleIndex* and *ra-PRACH-MaskIndex*, if any;

- flush Msg3 buffer;

- release, if any, Temporary C-RNTI.

End of changes