**3GPP TSG-RAN/WG2 Meeting #120 *R2-******2213016***

**Toulouse, France, Nov 14 – Nov 18, 2022**

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| **CHANGE REQUEST** |
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|  | **36.321** | **CR** |  **1556** | **rev** | **2** | **Current version:** | **17.2.0** |  |
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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:***  | Corrections for Supporting Non-Terrestrial Network in NB-IoT and eMTC |
|  |  |
| ***Source to WG:*** | MediaTek |
| ***Source to TSG:*** | R2 |
|  |  |
| ***Work item code:*** | LTE\_NBIOT\_eMTC\_NTN |  | ***Date:*** | 2022-11-20 |
|  |  |  |  |  |
| ***Category:*** | **F** |  | ***Release:*** | Rel-17 |
|  | *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-16 (Release 16)Rel-17 (Release 17)2#11803Rel-18 (Release 18)Rel-19 (Release 19)* |
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| ***Reason for change:*** | Incorporate MAC Corrections in Release-17 to support IoT-NTN.  |
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| ***Summary of change:*** | This CR captures agreements in IoT-NTN Work Item of RAN2#119bis-e, based on the following offlines:“[offline-106] UP corrections”, which includes:* In NTN, the DRX Active Time starts after the first repetition within the bundle plus the UE-eNB RTT when repetitions within the bundle are being transmitted.
* Providing reference to RAN1 specs for Differential Koffset
* Providing unit of the field of Differential Koffset
* Add RTToffset to the UL HARQ RTT Timer for BL UEs and UEs in enhanced coverage

 This CR also capture agreements in IoT-NTN Work Item of RAN2#120:* Change “k\_Mac” in UE-eNB RTT definition to “k-Mac” in the MAC section 3.1.
* Introduce consistent use of “subframes” when UE-eNB RTT is used in MAC spec.
* Correct the PUR retransmission start of PUR response window timer and the expiry of PUR response window timer.
* In NTNs for BL UEs and UEs in enhanced coverage, the offset added to the formula used for calculating the HARQ RTT timer shall be Koffset+Kmac instead of RTToffset, where Koffset defined in 36.213 section 4.2 and k-Mac is a RRC configured parameter.

**Impact analysis**Impacted functionality:IOT NTNInter-operability:No interoperability issues. |
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| ***Consequences if not approved:*** | Support for Release-17 enhancements for NTN in IoT is not complete and incorrect. |
|  |  |
| ***Clauses affected:*** | 3.1, 5.1.4, 5.1.5, 5.4.7.1, 5.7, 6.1.3.20, 6.1.3.21, 7.7 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  | **X** |  Other core specifications  |  |
| ***affected:*** |  | **X** |  Test specifications |  |
| ***(show related CRs)*** |  | **X** |  O&M Specifications |  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

Start of changes

## 3.1 Definitions

For the purposes of the present document, the terms and definitions given in TR 21.905 [1] and the following apply. A term defined in the present document takes precedence over the definition of the same term, if any, in TR 21.905 [1].

**Active Time:** Time related to DRX operation, as defined in clause 5.7, during which the MAC entity monitors the PDCCH.

***mac-ContentionResolutionTimer***: Specifies the number of consecutive subframe(s) during which the MAC entity shall monitor the PDCCH after Msg3 is transmitted.

**DRX Cycle:** Specifies the periodic repetition of the On Duration followed by a possible period of inactivity (see figure 3.1-1 below).



Figure 3.1-1: DRX Cycle

***drx-InactivityTimer***: Except for NB-IoT UEs, BL UEs or UEs in enhanced coverage, it specifies the number of consecutive PDCCH-subframe(s) after the subframe in which a PDCCH indicates an initial UL, DL or SL user data transmission for this MAC entity. For NB-IoT UEs, it specifies the number of consecutive PDCCH-subframe(s) after the subframe in which the HARQ RTT timer or UL HARQ RTT timer expires. For BL UEs or UEs in enhanced coverage, it specifies the number of consecutive PDCCH-subframe(s) following the subframe containing the last repetition of the PDCCH reception that indicates an initial UL or DL user data transmission for this MAC entity.

***drx-RetransmissionTimer***: Specifies the maximum number of consecutive PDCCH-subframe(s) until a DL retransmission is received.

***drx-RetransmissionTimerShortTTI***: Specifies the maximum number of consecutive TTI(s) until a DL retransmission is received for HARQ processes scheduled using short TTI.

***drxShortCycleTimer***: Specifies the number of consecutive subframe(s) the MAC entity shall follow the Short DRX cycle.

***drxStartOffset***: Specifies the subframe where the DRX Cycle starts.

***drx-ULRetransmissionTimer***: Specifies the maximum number of consecutive PDCCH-subframe(s) until a grant for UL retransmission or the HARQ feedback is received.

***drx-ULRetransmissionTimeShortTTI***: Specifies the maximum number of consecutive TTI(s) until a grant for UL retransmission is received for HARQ processes scheduled using short TTI.

**Early Data Transmission**: Allows one uplink data transmission optionally followed by one downlink data transmission during the random access procedure as specified in TS 36.300 [20]. The S1 connection is established or resumed upon reception of the uplink data and may be released or suspended along with the transmission of the downlink data. Early data transmission refers to both CP-EDT and UP-EDT.

**HARQ information**: HARQ information for DL-SCH or for UL-SCH transmissions consists of New Data Indicator (NDI), Transport Block (TB) size. For DL-SCH transmissions and for asynchronous UL HARQ and for autonomous UL HARQ, the HARQ information also includes HARQ process ID, except for UEs in NB-IoT configured with a single HARQ process for which this information is not present. For UL-SCH transmission the HARQ information also includes Redundancy Version (RV). In case of spatial multiplexing on DL-SCH the HARQ information comprises a set of NDI and TB size for each transport block. HARQ information for SL-SCH and SL-DCH transmissions consists of TB size only.

**HARQ RTT Timer**: This parameter specifies the minimum amount of subframe(s) before a DL assignment for HARQ retransmission is expected by the MAC entity.

**Msg3**:Message transmitted on UL-SCH containing a C-RNTI MAC CE or a CCCH SDU optionally multiplexed with DTCH for the UP-EDT, submitted from upper layer and associated with the UE Contention Resolution Identity, as part of a random access procedure.

**NB-IoT**:NB-IoT allows access to network services via E-UTRA with a channel bandwidth limited to 200 kHz.

**NB-IoT UE**:A UE that uses NB-IoT.

**NR sidelink communication**: AS functionality enabling at least V2X Communication as defined in TS 23.287 [23], between two or more nearby UEs, using NR technology but not traversing any network node.

**Non-terrestrial networks:** An E-UTRAN consisting of eNBs, which provide non-terrestrial LTE access to UEs by means of an NTN payload embarked on a space-borne NTN vehicle and an NTN Gateway.

***onDurationTimer***: Specifies the number of consecutive PDCCH-subframe(s) at the beginning of a DRX Cycle.

**PDCCH:** Refers to the PDCCH (see TS 36.211 [7]), EPDCCH (in subframes when configured), MPDCCH (see TS 36.213 [2]), for an RN with R-PDCCH configured and not suspended, to the R-PDCCH, for NB-IoT to the NPDCCH or for short TTI to SPDCCH.

**PDCCH period (pp):** Refers to the interval between the start of two consecutive PDCCH occasions and depends on the currently used PDCCH search space, as specified in TS 36.213 [2]. A PDCCH occasion is the start of a search space and is defined by subframe k0 as specified in clause 16.6 of TS 36.213 [2]. The calculation of number of PDCCH-subframes for the timer configured in units of a PDCCH period is done by multiplying the number of PDCCH periods with *npdcch-NumRepetitions-RA* when the UE uses the common search space or by *npdcch-NumRepetitions* when the UE uses the UE specific search space. When counting a timer whose length is calculated in PDCCH-subframes, the UE shall include PDCCH-subframes that will be dropped or not required to be monitored as specified in clause 16.6 of TS 36.213 [2]. The calculation of number of subframes for the timer configured in units of a PDCCH period is done by multiplying the number of PDCCH periods with duration between two consecutive PDCCH occasions.

**PDCCH-subframe:** Refers to a subframe with PDCCH. This represents the union over PDCCH-subframes for all serving cells excluding cells configured with cross carrier scheduling for both uplink and downlink, as specified in TS 36.331 [8]; except if the UE is not capable of simultaneous reception and transmission in the aggregated cells where this instead represents the PDCCH-subframes of the SpCell.

- For FDD serving cells, all subframes represent PDCCH-subframes, unless specified otherwise in this clause.

- For TDD serving cells, all downlink subframes and subframes including DwPTS of the TDD UL/DL configuration indicated by *tdd-Config*, as specified in TS 36.331 [8] of the cell represent PDCCH-subframes, unless specified otherwise in this clause.

- For serving cells operating according to Frame structure Type 3, all subframes represent PDCCH-subframes.

- For RNs with an RN subframe configuration configured and not suspended, in its communication with the E-UTRAN, all downlink subframes configured for RN communication with the E-UTRAN represent PDCCH-subframes.

- For SC-PTM reception on an FDD cell, all subframes except MBSFN subframes represent PDCCH-subframes, unless specified otherwise in this clause.

- For SC-PTM reception on a TDD cell, all downlink subframes and subframes including DwPTS of the TDD UL/DL configuration indicated by *tdd-Config*, as specified in TS 36.331 [8] of the cell except MBSFN subframes represent PDCCH-subframes, unless specified otherwise in this clause.

- For BL UE or UE in enhanced coverage, all subframes in which the UE is required to monitor MPDCCH represent PDCCH-subframes among all valid subframes regardless of whether the subframe is dropped, see clause 9.1.5 of TS 36.213 [2].

- For NB-IoT UE, all subframes that are part of the NPDCCH search space represent PDCCH-subframes among all NB-IoT downlink subframes, including those which the UE is not required to monitor as specified in clause 16.6 of TS 36.213 [2].

**PDSCH**: Refers to subframe-PDSCH/slot-PDSCH/subslot-PDSCH or for NB-IoT to NPDSCH.

**PRACH**: Refers to PRACH or for NB-IoT to NPRACH.

**PRACH Resource Index**: The index of a PRACH within a system frame, see TS 36.211 [7]

**Primary Timing Advance Group:** Timing Advance Group containing the SpCell.

**PUCCH SCell:** An SCell configured with PUCCH/SPUCCH.

**PUSCH**: Refers to subframe-PUSCH/slot-PUSCH/subslot-PUSCH or for NB-IoT to NPUSCH.

***ra-PRACH-MaskIndex*:** Defines in which PRACHs within a system frame the MAC entity can transmit a Random Access Preamble (see clause 7.3).

**RA-RNTI:** The Random Access RNTI is used on the PDCCH when Random Access Response messages are transmitted. It unambiguously identifies which time-frequency resource was utilized by the MAC entity to transmit the Random Access preamble.

**SC Period:** Sidelink Control period, the time period consisting of transmission of SCI and its corresponding data.

**SCI:** The Sidelink Control Information contains the sidelink scheduling information such as resource block assignment, modulation and coding scheme, Group Destination ID (for sidelink communication) and PPPP (for V2X sidelink communication), see TS 36.212 [5].

**Secondary Timing Advance Group:** Timing Advance Group not containing the SpCell. A Secondary Timing Advance Group contains at least one Serving Cell with an UL configured.

**Serving Cell:** A Primary or a Secondary Cell, see TS 36.331 [8].

**Short Processing Time**: For 1 ms TTI length, the operation with short processing time in UL data transmission and DL data reception.

**Short TTI**: TTI length based on a slot or a subslot.

**Sidelink:** UE to UE interface for sidelink communication, sidelink discovery and V2X sidelink communication. The sidelink corresponds to the PC5 interface as defined in TS 23.303 [13] for sidelink communication and sidelink discovery, and as defined in TS 23.285 [14] for V2X sidelink communication.

**Sidelink communication**: AS functionality enabling ProSe Direct Communication as defined in TS 23.303 [13], between two or more nearby UEs, using E-UTRA technology but not traversing any network node.

**Sidelink Discovery Gap for Reception:** Time period during which the UE does not receive any channels in DL from any serving cell, except during random access procedure.

**Sidelink Discovery Gap for Transmission:** Time period during which the UE prioritizes transmission of sidelink discovery and associated procedures e.g. re-tuning and synchronisation over transmission of channels in UL, if they occur in the same subframe, except during random access procedure.

**Special Cell:** For Dual Connectivity operation the term Special Cell refers to the PCell of the MCG or the PSCell of the SCG, otherwise the term Special Cell refers to the PCell.

**Timing Advance Group:** A group of Serving Cells that is configured by RRC and that, for the cells with an UL configured, using the same timing reference cell and the same Timing Advance value.

**Transmission using PUR:** Allows one uplink data transmission using preconfigured uplink resource from RRC\_IDLE mode as specified in TS 36.300 [9]. Transmission using PUR refers to both CP transmission using PUR and UP transmission using PUR.

**UE-eNB RTT:** For non-terrestrial networks, the sum of the UE's Timing Advance value (see TS 36.211 [7], clause 8.1) and *k-Mac* in units of subframe, not rounded or truncated toward an integer number of subframes.

**UL HARQ RTT Timer**: This parameter specifies the minimum amount of subframe(s) before a UL HARQ retransmission grant is expected by the MAC entity.

**V2X sidelink communication**: AS functionality enabling V2X Communication as defined in TS 23.285 [14], between nearby UEs, using E-UTRA technology but not traversing any network node.

NOTE: A timer is running once it is started, until it is stopped or until it expires; otherwise it is not running. A timer can be started if it is not running or restarted if it is running. A Timer is always started or restarted from its initial value.

Next change

### 5.1.4 Random Access Response reception

Once the Random Access Preamble is transmitted and regardless of the possible occurrence of a measurement gap or a Sidelink Discovery Gap for Transmission or a Sidelink Discovery Gap for Reception, and regardless of the prioritization of V2X sidelink communication described in clause 5.14.1.2.2, the MAC entity shall monitor the PDCCH of the SpCell for Random Access Response(s) identified by the RA-RNTI defined below, in the RA Response window which starts at the subframe that contains the end of the preamble transmission,as specified in TS 36.211 [7], plus three subframes and has length *ra-ResponseWindowSize*.

If the UE is a BL UE or a UE in enhanced coverage:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus 3 subframes plus UE-eNB RTT and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level;

- else:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus three subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level.

If the UE is an NB-IoT UE:

- if the random access preamble was transmitted in a non-terrestrial network:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X subframes plus UE-eNB RTT and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level, where value X is determined from Table 5.1.4-1 based on the used preamble format and the number of NPRACH repetitions;

- else:

- RA Response window starts at the subframe that contains the end of the last preamble repetition plus X subframes and has length *ra-ResponseWindowSize* for the corresponding enhanced coverage level, where value X is determined from Table 5.1.4-1 based on the used preamble format and the number of NPRACH repetitions.

Table 5.1.4-1: Subframes between preamble transmission and RA Response Window in NB-IoT

|  |  |  |  |
| --- | --- | --- | --- |
| TDD/FDD mode | Preamble format | Number of NPRACH repetitions | X  |
| FDD | 0 or 1 | >= 64 | 41 |
| FDD | 0 or 1 | < 64 | 4 |
| FDD | 2 | >= 16 | 41 |
| FDD | 2 | < 16 | 4 |
| TDD | Any | Any | 4 |

The RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI= 1 + t\_id + 10\*f\_id

where t\_id is the index of the first subframe of the specified PRACH (0≤ t\_id <10), and f\_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f\_id< 6) except for NB-IoT UEs, BL UEs or UEs in enhanced coverage. If the PRACH resource is on a TDD carrier, the f\_id is set to , where  is defined in clause 5.7.1 of TS 36.211 [7].

For BL UEs and UEs in enhanced coverage, RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI=1+t\_id + 10\*f\_id + 60\*(SFN\_id mod (Wmax/10))

where t\_id is the index of the first subframe of the specified PRACH (0≤ t\_id <10), f\_id is the index of the specified PRACH within that subframe, in ascending order of frequency domain (0≤ f\_id< 6), SFN\_id is the index of the first radio frame of the specified PRACH, and Wmax is 400, maximum possible RAR window size in subframes for BL UEs or UEs in enhanced coverage. If the PRACH resource is on a TDD carrier, the f\_id is set to , where  is defined in clause 5.7.1 of TS 36.211 [7].

For NB-IoT UEs, the RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI=1 + floor(SFN\_id/4) + 256\*carrier\_id

where SFN\_id is the index of the first radio frame of the specified PRACH and carrier\_id is the index of the UL carrier associated with the specified PRACH. The carrier\_id of the anchor carrier is 0.

For NB-IoT UEs operating in TDD mode, the RA-RNTI associated with the PRACH in which the Random Access Preamble is transmitted, is computed as:

RA-RNTI = 1 + floor(SFN\_id/4) + 256\*(H-SFN mod 2)

where SFN\_id is the index of the first radio frame of the specified PRACH and H-SFN is the index of the first hyper frame of the specified PRACH. The PDCCH transmission and the PRACH resource are on the same carrier.

The MAC entity may stop monitoring for Random Access Response(s) after successful reception of a Random Access Response containing Random Access Preamble identifiers that matches the transmitted Random Access Preamble.

- If a downlink assignment for this TTI has been received on the PDCCH for the RA-RNTI and the received TB is successfully decoded, the MAC entity shall regardless of the possible occurrence of a measurement gap or a Sidelink Discovery Gap for Transmission or a Sidelink Discovery Gap for Reception, and regardless of the prioritization of V2X sidelink communication described in clause 5.14.1.2.2:

- if the Random Access Response contains a Backoff Indicator subheader:

- set the backoff parameter value as indicated by the BI field of the Backoff Indicator subheader and Table 7.2-1, except for NB-IoT where the value from Table 7.2-2 is used.

- else, set the backoff parameter value to 0 ms.

- if the Random Access Response contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble (see clause 5.1.3), the MAC entity shall:

- consider this Random Access Response reception successful and apply the following actions for the serving cell where the Random Access Preamble was transmitted:

- process the received Timing Advance Command (see clause 5.2);

- indicate the *preambleInitialReceivedTargetPower* and the amount of power ramping applied to the latest preamble transmission to lower layers (i.e., (PREAMBLE\_TRANSMISSION\_COUNTER – 1) \* *powerRampingStep*);

- if the SCell is configured with *ul-Configuration-r14*, ignore the received UL grant otherwise process the received UL grant value and indicate it to the lower layers;

- if, except for NB-IoT, *ra-PreambleIndex* was explicitly signalled and it was not 000000 (i.e., not selected by MAC):

- consider the Random Access procedure successfully completed.

- else if, the UE is an NB-IoT UE, *ra-PreambleIndex* was explicitly signalled and it was not 000000 (i.e., not selected by MAC) and *ra-CFRA-Config* is configured:

- consider the Random Access procedure successfully completed.

- the UL grant provided in the Random Access Response message is valid only for the configured carrier (i.e. UL carrier used prior to this Random Access procedure).

- else:

- if the Random Access Preamble was selected by the MAC entity; or

- if the UE is an NB-IoT UE, the *ra-PreambleIndex* was explicitly signalled and it was not 000000 and *ra-CFRA-Config* is not configured:

- set the Temporary C-RNTI to the value received in the Random Access Response message no later than at the time of the first transmission corresponding to the UL grant provided in the Random Access Response message;

- if the Random Access Preamble associated with EDT was transmitted and UL grant provided in the Random Access Response message is not for EDT:

- indicate to upper layers that EDT is cancelled due to UL grant not being for EDT;

- for CP-EDT, flush the Msg3 buffer.

- for UP-EDT, update the MAC PDU in the Msg3 buffer in accordance with the uplink grant received in the Random Access Response.

- if the Random Access Preamble associated with EDT was transmitted, the UL grant was received in a Random Access Response for EDT, and there is a MAC PDU in the Msg3 buffer:

- if the TB size according to *edt-SmallTBS-Enabled* and as described in clause 8.6.2 and 16.3.3 of TS 36.213 [2] does not match the size of the MAC PDU in the Msg3 buffer:

- the MAC entity shall update the MAC PDU in the Msg3 buffer in accordance with the TB size.

- if this is the first successfully received Random Access Response within this Random Access procedure; or

- if CP-EDT is cancelled due to the UL grant provided in the Random Access Response message not being for EDT:

- if the transmission is not being made for the CCCH logical channel, indicate to the Multiplexing and assembly entity to include a C-RNTI MAC control element in the subsequent uplink transmission;

- obtain the MAC PDU to transmit from the "Multiplexing and assembly" entity and store it in the Msg3 buffer.

NOTE 1: When an uplink transmission is required, e.g., for contention resolution, the eNB should not provide a grant smaller than 56 bits (or 88 bits for NB-IoT) in the Random Access Response.

NOTE 2: If within a Random Access procedure, an uplink grant provided in the Random Access Response for the same group of Random Access Preambles has a different size than the first uplink grant allocated during that Random Access procedure, the UE behavior is not defined except for EDT.

If no Random Access Response or, for NB-IoT UEs, BL UEs or UEs in enhanced coverage for mode B operation, no PDCCH scheduling Random Access Response is received within the RA Response window, or if none of all received Random Access Responses contains a Random Access Preamble identifier corresponding to the transmitted Random Access Preamble, the Random Access Response reception is considered not successful and the MAC entity shall:

- if the notification of power ramping suspension has not been received from lower layers:

- increment PREAMBLE\_TRANSMISSION\_COUNTER by 1;

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- if PREAMBLE\_TRANSMISSION\_COUNTER = *preambleTransMax-CE* + 1:

- if the Random Access Preamble is transmitted on the SpCell:

- indicate a Random Access problem to upper layers;

- if NB-IoT:

- consider the Random Access procedure unsuccessfully completed;

- else:

- if PREAMBLE\_TRANSMISSION\_COUNTER = *preambleTransMax* + 1:

- if the Random Access Preamble is transmitted on the SpCell:

- indicate a Random Access problem to upper layers;

- if the Random Access Preamble is transmitted on an SCell:

- consider the Random Access procedure unsuccessfully completed.

- if in this Random Access procedure, the Random Access Preamble was selected by MAC:

- based on the backoff parameter, select a random backoff time according to a uniform distribution between 0 and the Backoff Parameter Value;

- delay the subsequent Random Access transmission by the backoff time;

- else if the SCell where the Random Access Preamble was transmitted is configured with *ul-Configuration-r14*:

- delay the subsequent Random Access transmission until the Random Access Procedure is initiated by a PDCCH order with the same *ra-PreambleIndex and ra-PRACH-MaskIndex*;

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- increment PREAMBLE\_TRANSMISSION\_COUNTER\_CE by 1;

- if PREAMBLE\_TRANSMISSION\_COUNTER\_CE = *maxNumPreambleAttemptCE* for the corresponding enhanced coverage level+ 1:

- reset PREAMBLE\_TRANSMISSION\_COUNTER\_CE;

- consider to be in the next enhanced coverage level, if it is supported by the Serving Cell and the UE, otherwise stay in the current enhanced coverage level;

- if the UE is an NB-IoT UE:

- if the Random Access Procedure was initiated by a PDCCH order:

- select the PRACH resource in the list of UL carriers providing a PRACH resource for the selected enhanced coverage level for which the carrier index is equal to ((*Carrier Indication* from the PDCCH order) modulo (Number of PRACH resources in the selected enhanced coverage));

- consider the selected PRACH resource as explicitly signalled;

- proceed to the selection of a Random Access Resource (see clause 5.1.2).

Next change

### 5.1.5 Contention Resolution

Contention Resolution is based on either C-RNTI on PDCCH of the SpCell or UE Contention Resolution Identity on DL-SCH.

Once Msg3 is transmitted, the MAC entity shall:

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- if Msg3 is transmitted on a non-terrestrial network:

- if, for EDT, *edt-SmallTBS-Enabled* is set to *TRUE* for the corresponding PRACH resource:

- start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe corresponding to the last subframe of a PUSCH transmission corresponding to the largest TBS indicated by the UL grant plus UE-eNB RTT.

- else:

- start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe containing the last repetition of the corresponding PUSCH transmission plus UE-eNB RTT.

- else:

- if, for EDT, *edt-SmallTBS-Enabled* is set to *TRUE* for the corresponding PRACH resource:

- start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe corresponding to the last subframe of a PUSCH transmission corresponding to the largest TBS indicated by the UL grant.

- else:

- start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission of the bundle in the subframe containing the last repetition of the corresponding PUSCH transmission.

- else:

- start *mac-ContentionResolutionTimer* and restart *mac-ContentionResolutionTimer* at each HARQ retransmission.

- regardless of the possible occurrence of a measurement gap or Sidelink Discovery Gap for Reception, monitor the PDCCH until *mac-ContentionResolutionTimer* expires or is stopped;

- if notification of a reception of a PDCCH transmission is received from lower layers, the MAC entity shall:

- if the C-RNTI MAC control element was included in Msg3:

- if the Random Access procedure was initiated by the MAC sublayer itself or by the RRC sublayer and the PDCCH transmission is addressed to the C-RNTI and contains an UL grant for a new transmission; or

- if the Random Access procedure was initiated by a PDCCH order and the PDCCH transmission is addressed to the C-RNTI:

- consider this Contention Resolution successful;

- stop *mac-ContentionResolutionTimer*;

- discard the Temporary C-RNTI;

- if the UE is an NB-IoT UE:

- the UL grant or DL assignment contained in the PDCCH transmission is valid only for the configured carrier (i.e. UL/DL carrier used prior to this Random Access procedure).

- consider this Random Access procedure successfully completed.

- else if the CCCH SDU was included in Msg3 and the PDCCH transmission is addressed to its Temporary C-RNTI:

- if the MAC PDU is successfully decoded:

- stop *mac-ContentionResolutionTimer*;

- if the MAC PDU contains a UE Contention Resolution Identity MAC control element; and

- if the UE Contention Resolution Identity included in the MAC control element matches the 48 first bits of the CCCH SDU transmitted in Msg3:

- consider this Contention Resolution successful and finish the disassembly and demultiplexing of the MAC PDU;

- set the C-RNTI to the value of the Temporary C-RNTI;

- discard the Temporary C-RNTI;

- consider this Random Access procedure successfully completed.

- else:

- discard the Temporary C-RNTI;

- consider this Contention Resolution not successful and discard the successfully decoded MAC PDU.

- if *mac-ContentionResolutionTimer* expires:

- for BL UEs or UEs in CE or NB-IoT UEs:

- if notification of a reception of a PDCCH transmission has been received from lower layers before *mac-ContentionResolutionTimer* expired; and

- if the MAC PDU received until the subframe that contains the last repetition of the corresponding PDSCH transmission is successfully decoded; and

- if the MAC PDU contains a UE Contention Resolution Identity MAC control element; and

- if the UE Contention Resolution Identity included in the MAC control element matches the 48 first bits of the CCCH SDU transmitted in Msg3:

- consider this Contention Resolution successful and finish the disassembly and demultiplexing of the MAC PDU;

- set the C-RNTI to the value of the Temporary C-RNTI;

- discard the Temporary C-RNTI;

- consider this Random Access procedure successfully completed.

- else if Msg3 was transmitted on a non-terrestrial network:

- if no notification of a reception of a PDCCH transmission addressed to the Temporary C-RNTI indicating an uplink grant for a Msg3 retransmission was received after the start of the *mac-ContentionResolutionTimer*:

- discard the Temporary C-RNTI;

- consider the Contention Resolution not successful.

- else:

- discard the Temporary C-RNTI;

- consider this Contention Resolution not successful.

- except for BL UEs or UEs in CE or NB-IoT UEs:

- discard the Temporary C-RNTI;

- consider the Contention Resolution not successful.

- if the Contention Resolution is considered not successful the MAC entity shall:

- flush the HARQ buffer used for transmission of the MAC PDU in the Msg3 buffer;

- if the notification of power ramping suspension has not been received from lower layers:

- increment PREAMBLE\_TRANSMISSION\_COUNTER by 1;

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- if PREAMBLE\_TRANSMISSION\_COUNTER = *preambleTransMax-CE* + 1:

- indicate a Random Access problem to upper layers;

- if NB-IoT:

- consider the Random Access procedure unsuccessfully completed.

- else:

- if PREAMBLE\_TRANSMISSION\_COUNTER = *preambleTransMax* + 1:

- indicate a Random Access problem to upper layers.

- based on the backoff parameter, select a random backoff time according to a uniform distribution between 0 and the Backoff Parameter Value;

- delay the subsequent Random Access transmission by the backoff time;

- proceed to the selection of a Random Access Resource (see clause 5.1.2).

Next change

#### 5.4.7.1 Transmission using PUR

Transmission using PUR is initiated by the RRC layer. When transmission using PUR is initiated, RRC layer provides MAC with the following information:

- PUR-RNTI;

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

- UL grant information.

If the MAC entity has a PUR-RNTI, the MAC entity shall for each TTI for which RRC layer has provided uplink grant for transmission using PUR:

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

After transmission using PUR, the MAC entity shall monitor PDCCH identified by PUR-RNTI in the PUR response window using timer *pur-ResponseWindowTimer*:

- if PUR was transmitted in a non-terrestrial network:

- the MAC entity shall start *pur-ResponseWindowTimer* at the subframe that contains the end of the corresponding PUSCH transmission plus 4 subframes plus UE-eNB RTT.

- else:

- the MAC entity shall start *pur-ResponseWindowTimer* at the subframe that contains the end of the corresponding PUSCH transmission plus 4 subframes*.*

While *pur-ResponseWindowTimer* is running, the MAC entity shall:

- if the PDCCH transmission is addressed to the PUR-RNTI and contains an UL grant for a retransmission:

- if PUR was transmitted in a non-terrestrial network:

- restart *pur-ResponseWindowTimer* at the last subframe of a PUSCH transmission corresponding to the retransmission indicated by the UL grant plus 4 subframes plus UE-eNB RTT.

- else:

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

- if L1 ACK for transmission using PUR is received from lower layers; or

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

- stop *pur-ResponseWindowTimer*;

- if L1 ACK for transmission using PUR is received from lower layers or the MAC PDU contains only Timing Advance Command MAC control element:

- indicate to upper layers the transmission using PUR was successful;

- if repetition adjustment for transmission using PUR is received from lower layers:

- indicate the value of the repetition adjustment to upper layers.

- discard the PUR-RNTI.

- else if fallback indication for PUR is received from lower layers:

- stop *pur-ResponseWindowTimer*;

- indicate to upper layers PUR fallback indication is received;

- if repetition adjustment for transmission using PUR is received from lower layers:

- indicate the value of the repetition adjustment to upper layers.

- discard the PUR-RNTI.

- if the *pur-ResponseWindowTimer* expires:

- if PUR was transmitted in a non-terrestrial network:

- if no notification of a reception of a PDCCH transmission addressed to the PUR-RNTI containing an UL grant for a retransmission was received after the start of *pur-ResponseWindowTimer*:

- indicate to upper layers the transmission using PUR has failed;

- discard the PUR-RNTI.

- else:- indicate to upper layers the transmission using PUR has failed;

- discard the PUR-RNTI.

Next change

## 5.7 Discontinuous Reception (DRX)

The MAC entity may be configured by RRC with a DRX functionality that controls the UE's PDCCH monitoring activity for the MAC entity's C-RNTI, TPC-PUCCH-RNTI, TPC-PUSCH-RNTI, Semi-Persistent Scheduling C-RNTI (if configured), UL Semi-Persistent Scheduling V-RNTI (if configured), eIMTA-RNTI (if configured), SL-RNTI (if configured), SL-V-RNTI (if configured), CC-RNTI (if configured), SRS-TPC-RNTI (if configured), and AUL C-RNTI (if configured). When in RRC\_CONNECTED, if DRX is configured, the MAC entity is allowed to monitor the PDCCH discontinuously using the DRX operation specified in this clause; otherwise the MAC entity monitors the PDCCH continuously. When using DRX operation, the MAC entity shall also monitor PDCCH according to requirements found in other clauses of this specification. RRC controls DRX operation by configuring the timers *onDurationTimer*, *drx-InactivityTimer*, *drx-RetransmissionTimer* (for HARQ processes scheduled using 1ms TTI, one per DL HARQ process except for the broadcast process), *drx-RetransmissionTimerShortTTI* (for HARQ processes scheduled using short TTI, one per DL HARQ process), *drx-ULRetransmissionTimer* (for HARQ processes scheduled using 1ms TTI, one per asynchronous UL HARQ process), *drx-ULRetransmissionTimerShortTTI* (for HARQ processes scheduled using short TTI, one per asynchronous UL HARQ process), the *longDRX-Cycle*, the value of the *drxStartOffset* and optionally the *drxShortCycleTimer* and *shortDRX-Cycle*. A HARQ RTT timer per DL HARQ process (except for the broadcast process) and UL HARQ RTT Timer per asynchronous UL HARQ process is also defined (see clause 7.7).

When a DRX cycle is configured, the Active Time includes the time while:

*- onDurationTimer* or *drx-InactivityTimer* or *drx-RetransmissionTimer* or *drx-RetransmissionTimerShortTTI* or *drx-ULRetransmissionTimer* or *drx-ULRetransmissionTimerShortTTI* or *mac-ContentionResolutionTimer* (as described in clause 5.1.5) is running; or

- a Scheduling Request is sent on PUCCH/SPUCCH and is pending (as described in clause 5.4.4). If this Serving Cell is part of a non-terrestrial network, the Active Time is started after the Scheduling Request transmission that is performed when the *SR\_COUNTER* is 0 for all the SR configurations with pending SR(s) plus the UE-eNB RTT; or

- an uplink grant for a pending HARQ retransmission can occur and there is data in the corresponding HARQ buffer for synchronous HARQ process; or

- a PDCCH indicating a new transmission addressed to the C-RNTI of the MAC entity has not been received after successful reception of a Random Access Response for the preamble not selected by the MAC entity (as described in clause 5.1.4) ; or

- *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured and repetitions within a bundle are being transmitted according to UL\_REPETITION\_NUMBER. If this Serving Cell is part of a non-terrestrial network, the Active Time starts after the first repetition within the bundle plus the UE-eNB RTT when repetitions within the bundle are being transmitted.

When DRX is configured, the MAC entity shall for each subframe:

- if a HARQ RTT Timer expires in this subframe:

- if the data of the corresponding HARQ process was not successfully decoded:

- start the *drx-RetransmissionTimer* or *drx-RetransmissionTimerShortTTI* for the corresponding HARQ process;

*-* if NB-IoT:

- if lower layers had indicated multiple TBs were scheduled for the associated expired HARQ RTT Timer:

- start or restart *drx-InactivityTimer* when all HARQ RTT Timers have expired;

- else:

- start or restart the *drx-InactivityTimer*.

- if an UL HARQ RTT Timer expires in this subframe:

- start the *drx-ULRetransmissionTimer* or *drx-ULRetransmissionTimerShortTTI* for the corresponding HARQ process.

- if NB-IoT:

- if lower layers had indicated multiple TBs were scheduled for the associated expired HARQ RTT Timer:

- start or restart *drx-InactivityTimer* when all HARQ RTT Timers have expired;

- else:

- start or restart the *drx-InactivityTimer*.

- if a DRX Command MAC control element or a Long DRX Command MAC control element is received:

- stop *onDurationTimer*;

- stop *drx-InactivityTimer*.

- if *drx-InactivityTimer* expires or a DRX Command MAC control element is received in this subframe:

- if the Short DRX cycle is configured:

- start or restart *drxShortCycleTimer*;

- use the Short DRX Cycle.

- else:

- use the Long DRX cycle.

- if *drxShortCycleTimer* expires in this subframe:

- use the Long DRX cycle.

- if a Long DRX Command MAC control element is received:

- stop *drxShortCycleTimer*;

- use the Long DRX cycle.

- If the Short DRX Cycle is used and [(SFN \* 10) + subframe number] modulo (*shortDRX-Cycle*) = (*drxStartOffset*) modulo (*shortDRX-Cycle*); or

- if the Long DRX Cycle is used and [(SFN \* 10) + subframe number] modulo (*longDRX-Cycle*) = *drxStartOffset*:

- if NB-IoT:

- if there is at least one HARQ process for which neither HARQ RTT Timer nor UL HARQ RTT Timer is running, start *onDurationTimer*.

- else:

- start onDurationTimer.

- during the Active Time, for a PDCCH-subframe, if the subframe is not required for uplink transmission for half-duplex FDD UE operation, and if the subframe is not a half-duplex guard subframe, as specified in TS 36.211 [7], and if the subframe is not part of a configured measurement gap and if the subframe is not part of a configured Sidelink Discovery Gap for Reception, and for NB-IoT if the subframe is not required for uplink transmission or downlink reception other than on PDCCH; or

- during the Active Time, for a subframe other than a PDCCH-subframe and for a UE capable of simultaneous reception and transmission in the aggregated cells, if the subframe is a downlink subframe indicated by a valid eIMTA L1 signalling for at least one serving cell not configured with *schedulingCellId*, as specified in TS 36.331 [8] and if the subframe is not part of a configured measurement gap and if the subframe is not part of a configured Sidelink Discovery Gap for Reception; or

- during the Active Time, for a subframe other than a PDCCH-subframe and for a UE not capable of simultaneous reception and transmission in the aggregated cells, if the subframe is a downlink subframe indicated by a valid eIMTA L1 signalling for the SpCell and if the subframe is not part of a configured measurement gap and if the subframe is not part of a configured Sidelink Discovery Gap for Reception:

- monitor the PDCCH;

- if the PDCCH indicates a DL transmission or if a DL assignment has been configured for this subframe:

- if the UE is an NB-IoT UE, a BL UE or a UE in enhanced coverage:

- if lower layers have indicated scheduling of transmission of multiple TBs:

- start the HARQ RTT Timers for all HARQ processes corresponding to the scheduled TBs in the subframe containing the last repetition of the PDSCH corresponding to the last scheduled TB;

- else:

- start the HARQ RTT Timer for the corresponding HARQ process in the subframe containing the last repetition of the corresponding PDSCH reception;

- else:

- start the HARQ RTT Timer for the corresponding HARQ process;

- stop the *drx-RetransmissionTimer* or *drx-RetransmissionTimerShortTTI* for the corresponding HARQ process.

- if NB-IoT, stop *drx-ULRetransmissionTimer* for all UL HARQ processes.

- if the PDCCH indicates an UL transmission for an asynchronous HARQ process or if an UL grant has been configured for an asynchronous HARQ process for this subframe, or if the PDCCH indicates an UL transmission for an autonomous HARQ process or;

- if the uplink grant is a configured grant for the MAC entity's AUL C-RNTI and if the corresponding PUSCH transmission has been performed in this subframe:

- if *mpdcch-UL-HARQ-ACK-FeedbackConfig* is not configured:

- if lower layers have indicated scheduling of transmission of multiple TBs:

- start the UL HARQ RTT Timers for all scheduled HARQ processes in the subframe containing the last repetition of the PUSCH corresponding to the last scheduled TB;

- else:

- start the UL HARQ RTT Timer for the corresponding HARQ process in the subframe containing the last repetition of the corresponding PUSCH transmission;

- stop the *drx-ULRetransmissionTimer* or *drx-ULRetransmissionTimerShortTTI* for the corresponding HARQ process;

- if *mpdcch-UL-HARQ-ACK-FeedbackConfig* is configured and an UL HARQ-ACK feedback has not been received on PDCCH until the last repetition of the corresponding PUSCH transmission:

- start or restart the *drx-ULRetransmissionTimer* for the corresponding HARQ process in the subframe containing the last repetition of the corresponding PUSCH transmission;

- if NB-IoT, stop *drx-RetransmissionTimer* for all DL HARQ processes.

- if the PDCCH indicates a new transmission (DL, UL or SL):

- except for an NB-IoT UE configured with a single DL and UL HARQ process and when PDCCH indicates the transmission is not for multiple TBs:

- start or restart *drx-InactivityTimer*.

- if the PDCCH indicates a transmission (DL, UL) for an NB-IoT UE:

- if the NB-IoT UE is configured with a single DL and UL HARQ process; or

- if the PDCCH indicates the transmission is for multiple TBs:

- stop *drx-Inactivity*Timer.

- stop *onDurationTimer.*

- if the PDCCH indicates an UL HARQ-ACK feedback for an asynchronous UL HARQ process for a UE configured with *mpdcch-UL-HARQ-ACK-FeedbackConfig*:

- if the lower layer had indicated scheduling of transmission of multiple TBs:

- stop *drx-ULRetransmissionTimer* for the corresponding UL HARQ process(es).

- else if the PUSCH transmission is completed:

- stop *drx-ULRetransmissionTimer* for all UL HARQ processes.

- if the PDCCH indicates HARQ feedback for one or more HARQ processes for which UL HARQ operation is autonomous:

- stop the *drx-ULRetransmissionTimer* for the corresponding HARQ process(es).

- in current subframe n, if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC control elements/Long DRX Command MAC control elements received and Scheduling Request sent until and including subframe n-5 when evaluating all DRX Active Time conditions as specified in this clause, type-0-triggered SRS, as specified in TS 36.213 [2], shall not be reported.

- if CQI masking (*cqi-Mask*) is setup by upper layers:

- in current TTI n, if *onDurationTimer* would not be running considering grants/assignments/DRX Command MAC control elements/Long DRX Command MAC control elements received until and including TTI n-5 when evaluating all DRX Active Time conditions as specified in this clause, CQI/PMI/RI/PTI/CRI on PUCCH shall not be reported.

- else:

- in current TTI n, if the MAC entity would not be in Active Time considering grants/assignments/DRX Command MAC control elements/Long DRX Command MAC control elements received and Scheduling Request sent until and including TTI n-5 when evaluating all DRX Active Time conditions as specified in this clause, CQI/PMI/RI/PTI/CRI on PUCCH shall not be reported.

For NB-IoT, *onDurationTimer* may start within a PDCCH period and end within a PDCCH period. The UE shall monitor NPDCCH during these partial PDCCH periods while *onDurationTimer* is running.

Regardless of whether the MAC entity is monitoring PDCCH or not, the MAC entity receives and transmits HARQ feedback and transmits type-1-triggered SRS, as specified in TS 36.213 [2], when such is expected. The MAC entity monitors PDCCH addressed to CC-RNTI for a PUSCH trigger B, as specified in TS 36.213 [2], on the corresponding SCell even if the MAC entity is not in Active Time. when such is expected.

When the BL UE or the UE in enhanced coverage or NB-IoT UE receives PDCCH, the UE executes the corresponding action specified in this clause in the subframe following the subframe containing the last repetition of the PDCCH reception where such subframe is determined by the starting subframe and the DCI subframe repetition number field in the PDCCH specified in TS 36.213 [2], unless explicitly stated otherwise.

NOTE 1: The same Active Time applies to all activated serving cell(s).

NOTE 2: In case of downlink spatial multiplexing, if a TB is received while the HARQ RTT Timer is running and the previous transmission of the same TB was received at least N subframes before the current subframe (where N corresponds to the HARQ RTT Timer), the MAC entity should process it and restart the HARQ RTT Timer.

NOTE 3: The MAC entity does not consider PUSCH trigger B, as specified in TS 36.213 [2], to be an indication of a new transmission.

NOTE 4: For NB-IoT, for operation in FDD mode, and for operation in TDD mode with a single HARQ process, DL and UL transmissions will not be scheduled in parallel, i.e. if a DL transmission has been scheduled an UL transmission will not be scheduled until HARQ RTT Timer of the DL HARQ process has expired (and vice versa).

Next change

#### 6.1.3.20 Timing Advance Report MAC Control Element

The Timing Advance MAC CE is identified by MAC subheader with LCID as specified in Table 6.2.1-2.

It has a fixed size and consists of two octets defined as follows (Figure 6.1.3.20-1):

- R: Reserved bit, set to 0;

- Timing Advance: The Timing Advance field indicates the least integer number of subframes greater than or equal to the Timing Advance value (see TS 36.211 [7] clause 8.1). The length of the field is 14 bits.



Figure 6.1.3.20-1: Timing Advance MAC CE

#### 6.1.3.21 Differential Koffset MAC Control Element

The Differential Koffset MAC CE is identified by MAC subheader with LCID as specified in Table 6.2.1-1.

It has a fixed size and consists of a single octet defined as follows (Figure 6.1.3.21-1):

- R: Reserved bit, set to 0;

- Differential Koffset: This field indicates the differential Koffset in subframes (see TS 36.213 [2], clause 4.2.3). The length of the field is 6 bits.



Figure 6.1.3.21-1: Differential Koffset MAC CE

Next change

## 7.7 HARQ RTT Timers

For each serving cell, in case of FDD configuration not configured with *subframeAssignment-r15* and in case of Frame Structure Type 3 configuration on the serving cell which carries the HARQ feedback for this serving cell the HARQ RTT Timer is set to 8 subframes. For each serving cell, in case of TDD configuration or FDD with *subframeAssignment-r15* configured on the serving cell which carries the HARQ feedback for this serving cell the HARQ RTT Timer is set to k + 4 subframes, where k is the interval between the downlink transmission and the transmission of associated HARQ feedback, as indicated in clauses 10.1 and 10.2 of TS 36.213 [2], and for an RN configured with *rn-SubframeConfig*, as specified in TS 36.331 [8] and not suspended, as indicated in Table 7.5.1-1 of TS 36.216 [11].

For each serving cell, for HARQ processes scheduled using Short Processing Time (TS 36.331 [8]) the HARQ RTT Timer is set to 6 subframes for FDD and Frame Structure Type 3 and set to k + 3 subframes for TDD, where k is the interval between the downlink transmission and the transmission of associated HARQ feedback, as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For each serving cell, for HARQ processes scheduled using short TTI (TS 36.331 [8]) the HARQ RTT Timer is set to 8 TTIs if the TTI length is one slot or if *proc-Timeline* is set to n+4 set1, to 12 TTIs if *proc-Timeline* is set to n+6 set1 or n+6 set2 and to 16 TTIs if *proc-Timeline* is set to n+8 set2 for FDD and Frame Structure Type 3.

For TDD short TTI the HARQ RTT Timer is set to k + 4 TTIs, where k is the interval between the downlink transmission and the transmission of associated HARQ feedback, as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For BL UEs and UEs in enhanced coverage, when single TB is scheduled by PDCCH the HARQ RTT Timer corresponds to 7 + N subframes plus DLoffset, where N is the used PUCCH repetition factor, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for N. In case of TDD, HARQ RTT Timer corresponds to 3 + k + N subframes plus RTToffset, where k is the interval between the last repetition of downlink transmission and the first repetition of the transmission of associated HARQ feedback, and N is the used PUCCH repetition factor, where only valid UL subframes are counted for N as indicated in clauses 10.1 and 10.2 of TS 36.213 [2].

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is not configured, the HARQ RTT Timer corresponds to 7 + m \* N subframes plus DLoffset, where N is the used PUCCH repetition factor and m is the number of scheduled TBs as indicated in PDCCH, where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for m \* N.

For BL UEs and UEs in enhanced coverage, when multiple TBs are scheduled by PDCCH and HARQ-ACK bundling is configured the HARQ RTT Timer corresponds to 7 + M \* N subframes plus DLoffset, where N is the used PUCCH repetition factor and M is the number of TB bundles as specified in clause 7.3 of TS 36.213 [2], where only valid (configured) UL subframes as configured by upper layers in *fdd-UplinkSubframeBitmapBR* are counted for M \* N.

For NB-IoT, when single TB is scheduled by PDCCH or when multiple TBs are scheduled for the interleaved case when HARQ-ACK bundling is configured the HARQ RTT Timer is set to k+3+N subframes plus RTToffset + deltaPDCCH, where k is the interval between the last subframe of the downlink transmission and the first subframe of the associated HARQ feedback transmission and N is the transmission duration in subframes of the associated HARQ feedback, and deltaPDCCH is the interval starting from the subframe following the last subframe of the associated HARQ feedback transmission plus 3 subframes plus RTToffset to the first subframe of the next PDCCH occasion.

For NB-IoT, when multiple TBs are scheduled by PDCCH for the non-interleaved case or for the interleaved case when HARQ-ACK bundling is not configured, the HARQ RTT Timer is set to k+2\*N+1 subframes plus RTToffset + deltaPDCCH where k is the interval between the last subframe of the downlink transmission and the first subframe of the first HARQ feedback transmission and N is the transmission duration in subframes of the associated HARQ feedback, and deltaPDCCH is the interval starting from the subframe following the last subframe of the last HARQ feedback transmission plus 1 subframes plus RTToffset to the first subframe of the next PDCCH occasion.

Except for NB-IoT and for HARQ processes scheduled using Short Processing Time and for short TTI, UL HARQ RTT Timer length is set to 4 subframes plus RTToffset for FDD and Frame Structure Type 3, and set to kULHARQRTT subframes plus RTToffset for TDD, where kULHARQRTT equals to the kPHICH value indicated in Table 9.1.2-1 of TS 36.213 [2] if the UE is not configured with upper layer parameter *symPUSCH-UpPts* for the serving cell, otherwise the kPHICH value is indicated in Table 9.1.2-3.

For NB-IoT, when single TB is scheduled by PDCCH the UL HARQ RTT timer length is set to 4 subframes plus RTToffset + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe following the last subframe of the PUSCH transmission plus 3 subframes plus RTToffset to the first subframe of the next PDCCH occasion.

For NB-IoT, when multiple TBs are scheduled by PDCCH the UL HARQ RTT timer length is set to 1 subframes plus RTToffset + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe following the last subframe of the PUSCH transmission plus 1 subframes plus RTToffset to the first subframe of the next PDCCH occasion.

For HARQ processes scheduled using Short Processing Time (TS 36.331 [8]), the UL HARQ RTT Timer length is set to 3 subframes for FDD and for Frame Structure Type 3, and set to kULHARQRTT subframes for TDD, where kULHARQRTT equals the value indicated in Table 7.7-1 and Table 7.7-2.

For HARQ processes scheduled using short TTI (TS 36.331 [8]), the UL HARQ RTT Timer length is set to 8 TTIs if the TTI length is one slot or if *proc-Timeline* is set to n+4 set1, to 12 TTIs if *proc-Timeline* is set to n+6 set1 or n+6 set2 and to 16 TTIs if *proc-Timeline* is set to n+8 set2 for FDD and Frame Structure Type 3. For TDD short TTI the UL HARQ RTT Timer is set to kULHARQRTT TTIs, where kULHARQRTT equals the value indicated in Table 7.7-3, Table 7.7-4 and Table 7.7-5.

Table 7.7-1: kULHARQRTT for TDD Short Processing Time when special subframe configurations 0~9 is configured

|  |  |
| --- | --- |
| **TDD UL/DLConfiguration** | **subframe index *n*** |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 0 |  |  | 3 | 3 | 6 |  |  | 3 | 3 | 6 |
| 1 |  |  | 3 | 3 |  |  |  | 3 | 3 |  |
| 2 |  |  | 3 |  |  |  |  | 3 |  |  |
| 3 |  |  | 3 | 3 | 3 |  |  |  |  |  |
| 4 |  |  | 3 | 3 |  |  |  |  |  |  |
| 5 |  |  | 3 |  |  |  |  |  |  |  |
| 6 |  |  | 3 | 3 | 5 |  |  | 3 | 3 |  |

Table 7.7-2: kULHARQRTT for TDD Short Processing Time applied when special subframe configuration 10 is configured

|  |  |
| --- | --- |
| **TDD UL/DLConfiguration** | **subframe index n** |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** |
| 0 |  | 4 | 3 | 3 | 6 |   | 4 | 3 | 3 | 6 |
| 1 |  | 3 | 3 | 3 |   |   | 3 | 3 | 3 |   |
| 2 |  | 3 | 3 |  |  |  | 3 | 3 |  |   |
| 3 |  | 4 | 3 | 3 | 3 |  |  |  |  |   |
| 4 |  | 3 | 3 | 3 |  |  |  |  |  |   |
| 5 |  | 3 | 3 |  |  |  |  |  |  |   |
| 6 |  | 4 | 3 | 3 | 5 |  | 3 | 3 | 3 |   |

Table 7.7-3: kULHARQRTT for TDD short TTI applied when special subframe configurations 1, 2, 3, 4, 6, 7 and 8 are configured

|  |  |
| --- | --- |
| **TDD UL/DLConfiguration** | **sTTI index *n*** |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** |
| 0 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 4 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 4 |
| 1 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |  |  |  |  | 4 | 4 | 4 | 4 |  |  |
| 2 |  |  |  |  | 4 | 4 |  |  |  |  |  |  |  |  | 4 | 4 |  |  |  |  |
| 3 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 4 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |

Table 7.7-4: kULHARQRTT for TDD short TTI applied when special subframe configurations 0, 5 and 9 are configured

|  |  |
| --- | --- |
| **TDD UL/DLConfiguration** | **sTTI index *n*** |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** |
| 0 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 11 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 11 |
| 1 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |  |  |  |  | 4 | 4 | 4 | 4 |  |  |
| 2 |  |  |  |  | 4 | 4 |  |  |  |  |  |  |  |  | 4 | 4 |  |  |  |  |
| 3 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  |  | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  |  | 6 | 5 | 4 | 4 | 4 | 9 |  |  |  |  | 4 | 4 | 4 | 4 |  |  |

Table 7.7-5: kULHARQRTT for TDD short TTI applied when special subframe configuration 10 is configured

|  |  |
| --- | --- |
| **TDD UL/DLConfiguration** | **sTTI index *n*** |
| **0** | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** |
| 0 |  |  |  | 7 | 6 | 5 | 4 | 4 | 4 | 11 |  |  |  | 7 | 6 | 5 | 4 | 4 | 4 | 11 |
| 1 |  |  |  | 5 | 4 | 4 | 4 | 4 |  |  |  |  |  | 5 | 4 | 4 | 4 | 4 |  |  |
| 2 |  |  |  | 4 | 4 | 4 |  |  |  |  |  |  |  | 4 | 4 | 4 |  |  |  |  |
| 3 |  |  |  | 7 | 6 | 5 | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |
| 4 |  |  |  | 5 | 4 | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |
| 5 |  |  |  | 4 | 4 | 4 |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 6 |  |  |  | 7 | 6 | 5 | 4 | 4 | 4 | 9 |  |  |  | 5 | 4 | 4 | 4 | 4 |  |  |

NOTE 1: RTToffset = 0 in terrestrial networks and RTToffset = UE-eNB RTT in Non-terrestrial networks.

NOTE 2: DLoffset = 0 in terrestrial networks and DLoffset = Koffset + *k-Mac* in Non-terrestrial networks where Koffset is defined in TS 36.213 [2], clause 4.2.3.

End of change