**3GPP TSG- Meeting #**

**Fukuoka City, Fukuoka, , -**

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| *CR-Form-v12.3* | | | | | | | | |
| **CHANGE REQUEST** | | | | | | | | |
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|  |  | **CR** |  | **rev** | **3** | **Current version:** |  |  |
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| *For* [***HELP***](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 on UE behaviour on DRX for IoT NTN | | | | | | | | | |
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| ***Source to WG:*** |  | | | | | | | | | |
| ***Source to TSG:*** | R2 | | | | | | | | | |
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| ***Work item code:*** |  | | | | |  | ***Date:*** | | |  |
|  |  | | | |  | |  | | |  |
| ***Category:*** |  |  | | | | | ***Release:*** | | |  |
|  | *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-17 (Release 17) Rel-18 (Release 18) Rel-19 (Release 19)  Rel-20 (Release 20)* | |
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| ***Reason for change:*** | | 1. RAN2#125bis made the following agreeement regarding to the remaining issue:  |  | | --- | | * For single TB scheduled by DCI, for a HARQ process configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, NB-IoT UE behaviour on DRX follows the case when HARQ feedback is disabled (clarification of a previous agreement) * For multiple TBs scheduled by DCI, for a HARQ process configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, NB-IoT UE behaviour on DRX follows the case when HARQ feedback is enabled. |  1. For UL HARQ mode B and multiple TBs are scheduled, the condition of “HARQ B” is missing. 2. The RRC parameter *downlinkHARQ-FeedbackDisable* name need to be aligned with RRC spec. 3. The agreement in RAN2#123bis is not correctly captured.  |  | | --- | | * GNSS Duration Report MAC CE will not trigger SR; instead CBRA will be used. |  1. To capture the agreements made in RAN2#126 as follows:  |  | | --- | | * When the MAC entity receives a trigger to send the GNSS validity duration report, the UE shall stop the timeAlignmentTimer of the pTAG * In MAC 5.4.10, add a NOTE that during inactive time of C-DRX, it is up to UE implementation whether to stop timeAlignmentTimer and initiate CBRA * Take TP in R2-2405761 as a basis, moving the Note up (and reflecting updated p2) | | | | | | | | | |
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| ***Summary of change:*** | | 1. For multiple TBs scheduled by DCI, for a HARQ process configured as HARQ feedback disabled by RRC and further reversed to HARQ feedback enabled by DCI, NB-IoT UE behaviour on DRX follows the case when HARQ feedback is enabled. 2. For UL HARQ mode B and multiple TBs are scheduled, adding “if a HARQ process is configured with HARQ mode B”. 3. Correct the RRC parameter *downlinkHARQ-FeedbackDisable* to *downlinkHARQ-FeedbackDisabledBitmap(-NB)* 4. When the MAC entity receives a trigger to send the GNSS validity duration report, the UE shall stop the timeAlignmentTimer of the pTAG and initiate CBRA. During inactive time of C-DRX, it is up to UE implementation whether to stop timeAlignmentTimer and initiate CBRA. | | | | | | | | |
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| ***Consequences if not approved:*** | | UE behaviour on DRX for Rel-18 IoT NTN is not correct. | | | | | | | | |
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| ***Clauses affected:*** | | 5.3.2.1, 5.4.10, 5.7 | | | | | | | | |
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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:*** | |  | | | | | | | | |
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| ***This CR's revision history:*** | |  | | | | | | | | |

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| Start of fist change |

### 5.3.2 HARQ operation

#### 5.3.2.1 HARQ Entity

There is one HARQ entity at the MAC entity for each Serving Cell which maintains a number of parallel HARQ processes. Each HARQ process is associated with a HARQ process identifier. The HARQ entity directs HARQ information and associated TBs received on the DL-SCH to the corresponding HARQ processes (see clause 5.3.2.2).

The number of DL HARQ processes per HARQ entity is specified in TS 36.213 [2], clause 7.

When the physical layer is configured for downlink spatial multiplexing, as specified in TS 36.213 [2], one or two TBs are expected per TTI and they are associated with the same HARQ process. Otherwise, one TB is expected per TTI.

For NB-IoT UEs or BL UEs or UEs in enhanced coverage, the parameter DL\_REPETITION\_NUMBER provides the number of transmissions repeated in a bundle. For each bundle, DL\_REPETITION\_NUMBER is set to a value provided by lower layers. Within a bundle, after the initial (re)transmission, DL\_REPETITION\_NUMBER-1 HARQ retransmissions follow. The HARQ feedback is transmitted for the bundle and a downlink assignment corresponding to a new transmission or a retransmission of the bundle is received after the last repetition of the bundle. A retransmission of a bundle is also a bundle. HARQ feedback may be disabled per HARQ process by configuring *downlinkHARQ-FeedbackDisabledBitmap(-NB)* and/or by indication from lower layers.

If the MAC entity is configured with *blindSlotSubslotPDSCH-Repetitions* or *blindSubframePDSCH-Repetitions* on a serving cell (TS 36.331 [8]), the parameter DL\_REPETITION\_NUMBER provides the number of transmissions repeated in a bundle for a downlink assignment received on that serving cell. For each bundle, DL\_REPETITION\_NUMBER and the redundancy version for each transmission within a bundle are set to values provided by lower layers. Within a bundle, after the initial (re-)transmission, DL\_REPETITION\_NUMBER-1 HARQ retransmissions follow. The HARQ feedback is sent only one time for the bundle and after the last transmission of the bundle.

In addition to the broadcast HARQ process, NB-IoT has one or two DL HARQ processes.

The MAC entity shall:

- If a downlink assignment has been indicated for this TTI; or

- If this TTI is for a retransmission within a bundle:

- allocate the TB(s) received from the physical layer and the associated HARQ information to the HARQ process indicated by the associated HARQ information.

- If a downlink assignment has been indicated for the broadcast HARQ process:

- allocate the received TB to the broadcast HARQ process.

NOTE: In case of BCCH and BR-BCCH a dedicated broadcast HARQ process is used.

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| Next change |

### 5.4.10 GNSS validity duration reporting

For a NB-IoT UE, a BL UE or a UE in enhanced coverage in a non-terrestrial network, an indication may be sent by upper layer to report the remaining GNSS measurement validity duration.

If the MAC entity receives an indication from upper layers to report the remaining GNSS measurement validity duration:

- stop the *timeAlignmentTimer* associated with the pTAG, if running.

- initiate a Random Access procedure (see clause 5.1).

NOTE: In RRC\_CONNECTED Mode, if the UE autonomously start and complete GNSS acquisition while the UE is not in Active Time, it is up to UE implementation whether to stop *timeAlignmentTimer* and initiate CBRA.

If the GNSS validity duration reporting procedure has been triggered and not cancelled:

- if the MAC entity has UL resources allocated for new transmission for this TTI, and;

- if the allocated UL resources can accommodate the GNSS Validity Duration Report MAC control element plus its subheader, as a result of logical channel prioritization:

- instruct the Multiplexing and Assembly procedure to generate the GNSS Validity Duration Report MAC control element as defined in clause 6.1.3.23.

All triggered GNSS validity duration reports shall be cancelled when a GNSS Validity Duration Report MAC control element is included in a MAC PDU for transmission.

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| 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). The HARQ mode per HARQ process can be configured in *uplinkHARQ-Mode*.

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 the HARQ feedback is disabled by lower layers when *downlinkHARQ-FeedbackDisabledBitmap(-NB)* is not configured for the corresponding HARQ process; or

- except for the HARQ feedback enabled by lower layers when lower layers have indicated scheduling of transmission of multiple TBs, if the HARQ feedback is disabled by *downlinkHARQ-FeedbackDisabledBitmap(-NB)* for the corresponding HARQ process; or

- if the HARQ feedback is enabled by downlinkHARQ-FeedbackDisabled*Bitmap(-NB)* for the corresponding HARQ process and further reversed to disabled by lower layers:

*-* if NB-IoT:

- if the UE is configured with a single DL and UL HARQ process:

- start or restart *drx-InactivityTimer* in the subframe containing the last repetition of the corresponding PDSCH reception + 12 subframes + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe containing the last repetition of the corresponding PDSCH reception plus 12 subframes to the first subframe of the next PDCCH occasion.

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

- start or restart *drx-InactivityTimer* in the subframe containing the last repetition of the PDSCH reception corresponding to the last scheduled TB + 12 subframes + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe containing the last repetition PDSCH reception corresponding to the last scheduled TB plus 12 subframes to the first subframe of the next PDCCH occasion.

- else if the HARQ feedback is enabled for the corresponding HARQ process:

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

- start the HARQ RTT Timers for all HARQ processes which the HARQ feedback are enabled 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; and

- if the corresponding HARQ process is not configured with HARQ mode B:

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

- start the UL HARQ RTT Timers for all scheduled HARQ processes which are not configured with HARQ mode B 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:

- if the corresponding HARQ process is not configured with HARQ mode B:

- 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:

- if the UE is configured with single UL and DL HARQ process and if the corresponding HARQ process is configured with HARQ mode B:

- start or restart *drx-InactivityTimer* in the subframe containing the last repetition of the corresponding PUSCH transmission + 1 subframe + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe containing the last repetition of the corresponding PUSCH transmission plus 1 subframes to the first subframe of the next PDCCH occasion.

- if lower layers have indicated scheduling of transmission of multiple TBs and if a HARQ process is configured with HARQ mode B:

- start or restart *drx-InactivityTimer* in the subframe containing the last repetition of the PUSCH transmission corresponding to the last scheduled TB + 1 subframe + deltaPDCCH, where deltaPDCCH is the interval starting from the subframe containing the last repetition of the PUSCH transmission corresponding to the last scheduled TB plus 1 subframes to the first subframe of the next PDCCH occasion.

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

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

- if the UE is an NB-IoT UE:

- if the UE is configured with more than one HARQ process and PDCCH indicate the transmission is for a single TB:

- start or restart *drx-InactivityTimer*.

- else:

- 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).