**3GPP TSG RAN WG1 #109-e** **R1-22xxxxx**

**e-Meeting, May 9th – 20th, 2022**

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| *CR-Form-v12.2* |
| **DRAFT CHANGE REQUEST** |
|  |
|  | **38.213** | **CR** |  | **rev** |  | **Current version:** | **17.1.0** |  |
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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 IIoT/URLLC enhancements in NR |
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| ***Source to WG:*** | Samsung |
| ***Source to TSG:*** | R1 |
|  |  |
| ***Work item code:*** | NR\_IIOT\_URLLC\_enh-Core |  | ***Date:*** | 2022-05-24 |
|  |  |  |  |  |
| ***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)Rel-18 (Release 18)Rel-19 (Release 19)* |
|  |  |
| ***Reason for change:*** | 1. Undefined prioritization of power allocation for a PUSCH with HARQ-ACK of different priority value than the PUSCH in clause 7.5.
2. Undefined UE behavior for multiplexing HP HARQ-ACK and all negative SR(s) in a LP PUSCH in clause 9.
3. Undefined UE procedure for PUCCH transmission with SPS HARQ-ACK in case of DCI-based cell switching in clause 9A.
4. Undefined UE behavior when a DCI-indicated slot for PUCCH on PUCCH-sSCell overlaps with another PUCCH on PCell in clause 9A.
5. Undefined UE behavior when a UE has RRC-configured PUCCH transmission on one cell in a slot and the PUCCH cell switching pattern indicates another cell for the slot in clause 9A.
6. Misaligned RRC parameter name with TS 38.331 in clause 9.1.2, 9.1.3.1, and 9.2.5.2.
7. The cell of an UL BWP change for the Type 1 and Type 2 HARQ-ACK codebook construction is, generally, the cell of the PUCCH transmission in clauses 9.1.2.1, 9.1.3.1, 16.5.1.1, and 16.5.1.2.
8. Incorrect DCI field name for the enhanced Type 3 codebook indication in clause 9.1.4.
9. Error in pseudocode description in clause 9.1.4.
10. Missing support for HARQ-ACK codebook re-transmission for multi-TRP operation in clause 9.1.5.
11. Incorrect slot definition for HARQ-ACK reporting for slot/sub-slot based PUCCH configuration in clause 9.2.3.
12. Missing description for UE procedure to report UCI of different priorities in case the PUCCH transmission is over interlaces in clause 9.2.5.3.
13. Missing description for determination of resource for a PUCCH that includes deferred HARQ-ACK information in clause 9.2.5.4.
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|  |  |
| ***Summary of change:*** | 1. Capture prioritization of power allocation for a PUSCH with HARQ-ACK of different priority value than the PUSCH in clause 7.5.
2. Capture UE behavior for multiplexing HP HARQ-ACK and all negative SR(s) in a LP PUSCH in clause 9
3. Capture that DCI-based cell switching is not supported for PUCCH transmission with SPS HARQ-ACK in clause 9A.
4. Clarify that a UE does not expect overlapping between a DCI-indicated PUCCH slot on PUCCH-sSCell and another UCI on PCell in clause 9A.
5. Clarify that a UE does not transmit an RRC-configured PUCCH on one cell in a slot where the PUCCH cell switching pattern indicates another cell for the slot in clause 9A.
6. Align RRC parameter name with TS 38.331 in clause 9.1.2, 9.1.3.1, and 9.2.5.2.
7. Clarify that the cell of an UL BWP change for the Type 1 and Type 2 HARQ-ACK codebook construction is, generally, the cell of the PUCCH transmission in clauses 9.1.2.1 and 9.1.3.1.
8. Update DCI field name for the enhanced Type 3 codebook indication in clause 9.1.4.
9. Correct the pseudocode description in clause 9.1.4.
10. Extend support for HARQ-ACK codebook re-transmission for multi-TRP operation in clause 9.1.5.
11. Update slot definition for HARQ-ACK reporting for slot/sub-slot based PUCCH configuration in clause 9.2.3.
12. Capture description for UE procedure to report UCI of different priorities in case the PUCCH transmission is over interlaces in clause 9.2.5.3.
13. Capture that a UE also performs the multiplexing procedures in clauses 9.2.1 and 9.2.3 to determine a PUSCH/PUCCH to multiplex deferred HARQ-ACK in clause 9.2.5.4.
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| ***Consequences if not approved:*** | Incomplete support for IIoT/URLLC enhancements in NR. |
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| ***Clauses affected:*** | 7.5, 9, 9A, 9.1.2, 9.1.2.1, 9.1.3.1, 9.1.4, 9.1.5, 9.2.3, 9.2.5.2, 9.2.5.3, 9.2.5.4, 16.5.1.1, 16.5.1.2 |
|  |  |
|  | **Y** | **N** |  |  |
| ***Other specs*** |  |  |  Other core specifications  | TS 38.331 |
| ***affected:*** |  |  |  Test specifications | TS/TR ... CR ...  |
| ***(show related CRs)*** |  |  |  O&M Specifications | TS/TR ... CR ...  |
|  |  |
| ***Other comments:*** |  |
|  |  |
| ***This CR's revision history:*** |  |

\*\*\* Unchanged text is omitted \*\*\*

## 7.5 Prioritizations for transmission power reductions

For single cell operation with two uplink carriers or for operation with carrier aggregation, if a total UE transmit power for PUSCH or PUCCH or PRACH or SRS transmissions on serving cells in a frequency range in a respective transmission occasion would exceed , where is the linear value of in transmission occasion as defined in [8-1, TS 38.101-1] for FR1 and [8-2, TS38.101-2] for FR2, the UE allocates power to PUSCH/PUCCH/PRACH/SRS transmissions according to the following priority order (in descending order) so that the total UE transmit power for transmissions on serving cells in the frequency range is smaller than or equal to for that frequency range in every symbol of transmission occasion . For the purpose of power allocation in this clause, if a UE is provided *UCI-MuxWithDifferentPriority* and the UE multiplexes HARQ-ACK information in a PUSCH, a priority index of the PUSCH is the larger of (a) the priority index of the PUSCH prior to multiplexing the HARQ-ACK information and (b) the larger priority index of the HARQ-ACK information. When determining a total transmit power for serving cells in a frequency range in a symbol of transmission occasion , the UE does not include power for transmissions starting after the symbol of transmission occasion . The total UE transmit power in a symbol of a slot is defined as the sum of the linear values of UE transmit powers for PUSCH, PUCCH, PRACH, and SRS in the symbol of the slot.

- PRACH transmission on the PCell

- PUCCH or PUSCH transmissions with larger priority index

- For PUCCH or PUSCH transmissions with same priority index

- PUCCH transmission with HARQ-ACK information, and/or SR, and/or LRR, or PUSCH transmission with HARQ-ACK information of the priority index

- PUCCH transmission with CSI or PUSCH transmission with CSI

- PUSCH transmission without HARQ-ACK information of the priority index or CSI and, for Type-2 random access procedure, PUSCH transmission on the PCell

- SRS transmission, with aperiodic SRS having higher priority than semi-persistent and/or periodic SRS, or PRACH transmission on a serving cell other than the PCell

In case of same priority order and for operation with carrier aggregation, the UE prioritizes power allocation for transmissions on the primary cell of the MCG or the SCG over transmissions on a secondary cell. In case of same priority order and for operation with two UL carriers, the UE prioritizes power allocation for transmissions on the carrier where the UE is configured to transmit PUCCH. If PUCCH is not configured for any of the two UL carriers, the UE prioritizes power allocation for transmissions on the non-supplementary UL carrier.

\*\*\* Unchanged text is omitted \*\*\*

# 9 UE procedure for reporting control information

\*\*\* Unchanged text is omitted \*\*\*

If a UE

- is provided *simultaneousPUCCH-PUSCH* and would transmit a PUCCH with a first priority index and PUSCHs with a second priority index that is different than the first priority index, where the PUCCH and the PUSCHs overlap in time

- can simultaneously transmit the PUCCH and the PUSCHs [18, TS 38.306],

the UE excludes the PUSCHs for resolving the time overlapping between the PUCCH and PUSCHs, where the timeline conditions are not required for the excluded PUSCHs.

When a UE determines overlapping for PUCCH and/or PUSCH transmissions of different priority indexes, other than PUCCH transmissions with SL HARQ-ACK reports, before considering limitations for transmission as described in clause 11.1 and clause 11.1.1, including repetitions if any, if the UE is provided *UCI-MuxWithDifferentPriority* and the timeline conditions in clause 9.2.5 for multiplexing UCI in a PUCCH or a PUSCH are satisfied

- first, the UE resolves overlapping for PUCCH and/or PUSCH transmissions of a same priority index as described in clauses 9.2.5 and 9.2.6

- second, the UE resolves the overlapping for PUCCH transmissions of different priority indexes, and

- if the UE is provided *subslotLengthForPUCCH* in the second *PUCCH-Config*, a PUCCH transmission of smaller priority index is associated with the first overlapping slot with *subslotLengthForPUCCH* symbols of larger priority index; otherwise, the PUCCH transmission of smaller priority index is associated with the overlapping slot with symbols [4, TS 38.211] of larger priority index.

- the UE first resolves the overlapping for PUCCH transmissions, where at least one of the PUCCH transmissions is with repetitions, within a slot of larger priority index as is subsequently described in this clause, if any, and then the UE resolves the overlapping for PUCCH transmissions without repetitions within the slot using the pseudo-code in clause 9.2.5

- if the UE determines that a first PUCCH transmission of the smaller priority index is not dropped and the UCI of the first PUCCH transmission is not multiplexed in a second PUCCH transmission of larger priority index in an overlapping slot with *subslotLengthForPUCCH* symbols, the first PUCCH transmission is associated with the next overlapping slot with *subslotLengthForPUCCH* symbols for PUCCH transmissions with the larger priority index

- the UE does not expect a PUCCH transmission that includes UCI of different priority indexes to overlap with a PUCCH transmission with repetitions after resolving the overlapping for PUCCH transmissions without repetitions within a slot

- the UE does not expect a PUCCH transmission with UCI of first and second priority indexes to overlap with a PUCCH transmission with HARQ-ACK information of the first priority index, or with a PUCCH transmission or with a PUSCH transmission of the second priority index when the second priority index is larger than the first priority index

- the UE does not expect a PUCCH transmission with HARQ-ACK information of larger priority index to overlap with more than one PUCCH transmissions with HARQ-ACK information of smaller priority index

- third, the UE resolves the overlapping for PUCCH and PUSCH transmissions of different priority indexes

- the UE drops PUSCH transmissions of smaller priority index that overlap with a PUCCH transmission with positive SR of larger priority index prior to multiplexing UCI in a PUSCH transmission of smaller priority index, if any

- the UE drops PUSCH transmissions of smaller priority index that overlap with a PUCCH transmission with repetitions of larger priority index prior to multiplexing UCI in a PUSCH transmission of smaller priority index, if any

- the UE multiplexes HARQ-ACK information in a PUSCH transmission, as is subsequently described in this clause for multiplexing HARQ-ACK information from a PUCCH transmission in a PUSCH transmission of a same priority index, if a PUCCH transmission with HARQ-ACK information of a first priority index overlaps with one or more PUSCH transmissions of a second priority index that is different than the first priority index

- if // this is for cases the UE supports multiplexing information of different priorities in a PUCCH/PUSCH transmission

- a PUCCH transmission with HARQ-ACK information, without repetitions, with smaller priority index overlaps with a PUCCH transmission only with HARQ-ACK information, without repetitions, with larger priority index, or

- a PUCCH transmission without repetitions that includes HARQ-ACK information of smaller priority index overlaps with a PUCCH transmission without repetitions using a PUCCH resource with PUCCH format 2/3/4 with HARQ-ACK information and SR of larger priority index, or

- a PUCCH transmission with HARQ-ACK information, without repetitions, with smaller or larger priority index overlaps, respectively, with a PUSCH transmission with larger or smaller priority index

the UE

- multiplexes HARQ-ACK information of different priority indexes and SR information of larger priority index, if any, in a same PUCCH transmission of larger priority index, or multiplexes HARQ-ACK information the UE would provide in a PUCCH transmission of smaller or larger priority index in a PUSCH transmission of larger or smaller priority index, respectively, and applies the procedures in clause 9.2.5.3 or 9.3, respectively, and

- drops CSI and/or SR carried in the PUCCH transmission of smaller priority index, if any

- drops negative SR carried in the PUCCH transmission of larger priority index, if any, if the UE would multiplex the HARQ-ACK information of larger priority index in a PUSCH transmission of smaller priority index

- drops HARQ-ACK information of smaller priority index if the UE would multiplex the HARQ-ACK information of smaller priority index in a PUSCH transmission where the UE multiplexes Part 1 CSI reports and Part 2 CSI reports of larger priority index

- drops Part 2 CSI reports of smaller priority index if the UE would multiplex the HARQ-ACK information of smaller and larger priority indexes in a PUSCH transmission where the UE multiplexes Part 1 CSI reports and Part 2 CSI reports of smaller priority index

- else

\*\*\* Unchanged text is omitted \*\*\*

## 9.A PUCCH cell switching

This clause is applicable when a UE is provided a PUCCH-sSCell by *pucch-sSCell* and the PUCCH-sSCell is activated and does not have a dormant UL/DL active BWP.

A UE can be provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern.* Each bit of the pattern corresponds to a slot for a reference SCS configuration provided by *tdd-UL-DL-ConfigurationCommon* for the PCell with a value of '0' or a value of '1' indicating, respectively, the PCell or the PUCCH-sSCell as the cell for PUCCH transmissions during the slot of the reference SCS configuration. The UE does not transmit a PUCCH in a slot on a cell if the pattern indicates a different cell for PUCCH transmission during the slot. A slot on the active UL BWP of the PUCCH-sSCell does not overlap with more than one slot on the active UL BWP of the PCell. If a slot for the active UL BWP of the PCell overlaps with more than one slot on the active BWP of the PUCCH-sSCell and the UE would transmit a PUCCH on the PUCCH-sSCell, the UE considers the first of the overlapping slots for the PUCCH transmission on the PUCCH-sSCell. The pattern is not applicable for a PUCCH transmission with repetitions.

If a UE is provided *pucch-sSCellDyn* or *pucch-sSCellDynDCI-1-2*, a corresponding DCI format associated with generation of HARQ-ACK information by the UE can include a PUCCH cell indicator field [5, TS 38.212] with a value of '0' or a value of '1' indicating, respectively, whether a PUCCH transmission with the HARQ-ACK information by the UE is on the PCell or on the PUCCH-sSCell. When the UE transmits a PUCCH with HARQ-ACK information that is associated only with SPS PDSCH receptions, the UE transmits the PUCCH on the PCell. The UE does not expect the PUCCH cell indicator field to indicate the PUCCH-sSCell for a PUCCH transmission in a slot that overlaps with a slot on the PCell where the UE would transmit another PUCCH of same or different priority index.

A UE transmits a PUCCH on a PUCCH-sSCell with a power that the UE determines as described in clause 7.2.1, where the UE applies

- a *p0-PUCCH-Value* from *pucch-PowerControl* in *PUCCH-Config* for the PUCCH-sSCell for the determination of

- a *pucch-PathlossReferenceRS-Id* from *pucch-PowerControl* in *PUCCH-Config* for the PUCCH-sSCell for the determination of

- a PUCCH power control adjustment state for active UL BWP of the UL carrier of PUCCH-sSCell and PUCCH transmission occasion where is a TPC command value included in a DCI format associated with generation of HARQ-ACK information for multiplexing in a PUCCH transmission on the PUCCH-sSCell as indicated either by a *pucch-sSCellPattern* or by a PUCCH cell indicator field in the DCI format, or provided by DCI format 2\_2 with CRC scrambled by TPC-PUCCH-RNTI for the PUCCH-sSCell as described in clause 11.3

\*\*\* Unchanged text is omitted \*\*\*

### 9.1.2 Type-1 HARQ-ACK codebook determination

\*\*\* Unchanged text is omitted \*\*\*

A UE reports HARQ-ACK information for a corresponding PDSCH reception or SPS PDSCH release or TCI state update only in a HARQ-ACK codebook that the UE transmits in a slot indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format or provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI format as described in clause 9.2.3. The UE reports NACK value(s) for HARQ-ACK information bit(s) in a HARQ-ACK codebook that the UE transmits in a slot not indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format.

\*\*\* Unchanged text is omitted \*\*\*

and is a number of slots indicated by the PDSCH-to-HARQ\_feedback timing indicator field in a corresponding DCI format, or provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI format. If the UE reports HARQ-ACK information for the PDSCH reception in a slot other than slot , the UE sets a value for each corresponding HARQ-ACK information bit to NACK.

If a UE reports HARQ-ACK information in a PUCCH only for

\*\*\* Unchanged text is omitted \*\*\*

#### 9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel

\*\*\* Unchanged text is omitted \*\*\*

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the serving cell of PUCCH transmission and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the serving cell of PUCCH transmission, or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , , where is a DL slot with a smallest index among DL slots overlapping with UL slot ,

;

else

\*\*\* Unchanged text is omitted \*\*\*

Set to the cardinality of

Set – index of row in set

if slot starts at a same time as or after a slot for an active DL BWP change on serving cell or an active UL BWP change on the serving cell of PUCCH transmission and slot is before the slot for the active DL BWP change on serving cell or the active UL BWP change on the serving cell of PUCCH transmission where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and slot overlaps with UL slot , ,

;

else

\*\*\* Unchanged text is omitted \*\*\*

#### 9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel

\*\*\* Unchanged text is omitted \*\*\*

A UE determines monitoring occasions for PDCCH with DCI format scheduling PDSCH receptions, or having associated HARQ-ACK information without scheduling PDSCH reception, on an active DL BWP of a serving cell , as described in clause 10.1, and for which the UE transmits HARQ-ACK information in a same PUCCH in slot based on

- PDSCH-to-HARQ\_feedback timing indicator field values, or a *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* value if the PDSCH-to-HARQ\_feedback timing indicator field is not present in a DCI format, for PUCCH transmission with HARQ-ACK information in slot , as described in clause 9.2.3, in response to PDSCH receptions, or in response to a DCI format having associated HARQ-ACK information without scheduling PDSCH reception

- slot offsets [6, TS 38.214] provided by time domain resource assignment field in a DCI format scheduling PDSCH receptions and by *pdsch-AggregationFactor*, or *pdsch-AggregationFactor-r16*, or *repetitionNumber*, when provided.

\*\*\* Unchanged text is omitted \*\*\*

Set to the number of PDCCH monitoring occasion(s)

while

Set – serving cell index: lower indexes correspond to lower RRC indexes of corresponding cell

while

if PDCCH monitoring occasion is before an active DL BWP change on serving cell or an active UL BWP change on the serving cell of PUCCH transmission and an active DL BWP change is not triggered in PDCCH monitoring occasion

;

else

\*\*\* Unchanged text is omitted \*\*\*

### 9.1.4 Type-3 HARQ-ACK codebook determination

If a UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the UE determines HARQ-ACK information bits, for a total number of HARQ-ACK information bits, of a Type-3 HARQ-ACK codebook according to the following procedure. If the UE is provided *pdsch-HARQ-ACK-enhType3List* and a DCI format scheduling PDSCH reception and triggering the Type-3 HARQ-ACK codebook includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-enhType3Index*, the UE determines a size of a set of indicated serving cells and a size of a set of indicated numbers of HARQ processes for each indicated serving cell and each indicated HARQ process number from the entry in *pdsch-HARQ-ACK-enhType3List* corresponding to the *pdsch-HARQ-ACK-enhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-enhType3Index* value is zero.

Set to the number of configured serving cells or, when applicable, to

Set to the value of *nrofHARQ-ProcessesForPDSCH* for serving cell , if provided; else, set . When applicable, set to

Set to the value of *maxNrofCodeWordsScheduledByDCI* for serving cell if *harq-ACK-SpatialBundlingPUCCH* is provided and , or if *harq-ACK-SpatialBundlingPUCCH* is not provided, or if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell ; else, set

Set to the number of HARQ-ACK information bits per TB for PDSCH receptions on serving cell as described in clause 9.1.1 if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell and *pdsch-HARQ-ACK-OneShotFeedbackCBG* or *pdsch-HARQ-ACK-enhType3CBG* is provided; else, set

Set if *pdsch-HARQ-ACK-OneShotFeedbackNDI* or *pdsch-HARQ-ACK-enhType3NDI* is provided; else set

Set – serving cell index in the set of serving cells

Set – HARQ process number index in the set of numbers of HARQ processes

Set – TB index

Set – CBG index

Set

while

while

if *HARQ-feedbackEnabling-disablingperHARQprocess* is not provided, or is provided and indicates enabled HARQ-ACK information for , or *HARQ-feedbackEnablingforSPSactive* is provided and corresponds to a transport block in a first SPS PDSCH reception after an activation of SPS PDSCH receptions

if

if

while

while

= HARQ-ACK information bit for CBG of TB for HARQ process number index in the set of numbers of HARQ processes of serving cell , if any; else,

end while

= NDI value indicated in the DCI format corresponding to the HARQ-ACK information bit(s) for TB for HARQ process number index in the set of numbers of HARQ processes on serving cell , if any; else,

end while

else

while

= HARQ-ACK information bit for TB for HARQ process index in the set of numbers of HARQ processes of serving cell , if any; else,

= NDI value indicated in the DCI format corresponding to the HARQ-ACK information bit(s) for TB for HARQ process number index in the set of numbers of HARQ processes on serving cell , if any; else,

end while

end if

else

if

while

if UE has obtained HARQ-ACK information for TB for HARQ process number index in the set of numbers of HARQ processes on serving cell corresponding to a PDSCH reception and has not reported the HARQ-ACK information corresponding to the PDSCH reception

while

= HARQ-ACK information bit for CBG of TB for HARQ process number index in the set of numbers of HARQ processes of serving cell

end while

else

while

end while

end if

end while

else

while

if UE has obtained HARQ-ACK information for TB for HARQ process number index in the set of numbers of HARQ processes on serving cell corresponding to a PDSCH reception and has not reported the HARQ-ACK information corresponding to the PDSCH reception

if *harq-ACK-SpatialBundlingPUCCH* is not provided

= HARQ-ACK information bit for TB for HARQ process number index in the set of numbers of HARQ processes of serving cell

else

= binary AND operation of the HARQ-ACK information bits corresponding to first and second transport blocks for HARQ process number index in the set of numbers of HARQ processes of serving cell . If the UE receives one transport block, the UE assumes ACK for the second transport block

end if

else

end if

end while

end if

end if

end if

end while

end while

If , when a UE receives a PDSCH with one transport block, the HARQ-ACK information is associated with the first transport block.

If a UE receives a SPS PDSCH, or a PDSCH that is scheduled by a DCI format that does not support CBG-based PDSCH receptions for a serving cell , and if *maxCodeBlockGroupsPerTransportBlock* is provided for serving cell , and *pdsch-HARQ-ACK-OneShotFeedbackCBG* or *pdsch-HARQ-ACK-enhType3CBG* is provided, the UE repeats times the HARQ-ACK information for the transport block, if any, in the PDSCH.

If a UE detects a DCI format that includes a One-shot HARQ-ACK request field with value 1, the UE determines a PUCCH or a PUSCH to multiplex a Type-3 HARQ-ACK codebook for transmission in a slot as described in clauses 9.2.3 and 9.2.5. If the UE is provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern*, the UE determines the slot and a corresponding cell based on the periodic cell switching pattern as described in clause 9.A. The UE multiplexes only the Type-3 HARQ-ACK codebook in the PUCCH or the PUSCH for transmission in the slot.

If

- a UE detects a DCI format that includes a One-shot HARQ-ACK request field with value 1, and

- the CRC of the DCI is scrambled by a C-RNTI or an MCS-C-RNTI, and

- *resourceAllocation* = *resourceAllocationType0* and all bits of the frequency domain resource assignment field in the DCI format are equal to 0, or

- *resourceAllocation* = *resourceAllocationType1* and all bits of the frequency domain resource assignment field in the DCI format are equal to 1, or

- *resourceAllocation = dynamicSwitch* and all bits of the frequency domain resource assignment field in the DCI format are equal to 0 or 1

the DCI format provides a request for a Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception. If the UE is provided *pdsch-HARQ-ACK-enhType3List* and the DCI format includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-enhType3Index*, the UE determines a number of indicated serving cells and a number of indicated HARQ processes for each indicated serving cell from the entry in *pdsch-HARQ-ACK-enhType3List* corresponding to the *pdsch-HARQ-ACK-enhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-enhType3Index* value is provided by the value of MCS field in the DCI format. The UE is expected to provide HARQ-ACK information in response to the request for the Type-3 HARQ-ACK codebook after symbols from the last symbol of a PDCCH providing the DCI format, where the value of for is provided in clause 10.2 by replacing "SPS PDSCH release" with "DCI format".

If a UE multiplexes HARQ-ACK information in a PUSCH transmission, the UE generates the HARQ-ACK codebook as described in this clause except that *harq-ACK-SpatialBundlingPUCCH* is replaced by *harq-ACK-SpatialBundlingPUSCH*.

### 9.1.5 HARQ-ACK codebook retransmission

With reference to slots of PUCCH transmissions on the primary cell and for Type-1 or Type-2 HARQ-ACK codebooks, a UE that transmitted or would transmit a PUCCH or a PUSCH with a first HARQ-ACK codebook in slot can be indicated by a DCI format with CRC scrambled by a C-RNTI or a MCS-C-RNTI that does not schedule a PDSCH reception [4, TS 38.212] and is received in a PDCCH ending in slot , to transmit a PUCCH with the first HARQ-ACK codebook in slot , where slot is after slot . The UE determines and a resource for the PUCCH transmission as described in clauses 9.2.3 and 9.2.5. If the UE is provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern*, the UE further determines a corresponding cell based on the periodic cell switching pattern as described in clause 9.A.

If the *pdsch-HARQ-ACK-retx* or *pdsch-HARQ-ACK-retxDCI-1-2* field value in the DCI format 1\_1 or 1\_2, respectively, is '1', the UE determines slot as where is determined by a one-to-one mapping in ascending order among the values of the MCS field in the DCI format 1\_1 or 1\_2 and the values from -7 to 24.

If the DCI format 1\_1 or 1\_2 includes a priority indicator field having a value, a priority value of first HARQ-ACK information in the first HARQ-ACK codebook is same as the value of the priority indicator field; otherwise, the priority value of the first HARQ-ACK information is zero.

If a UE

- is not provided *coresetPoolIndex* or is provided *coresetPoolIndex* with a value of 0 for first CORESETs on active DL BWPs of serving cells, and

- is provided *coresetPoolIndex* with a value of 1 for second CORESETs on active DL BWPs of the serving cells, and

- is provided *ackNackFeedbackMode* = *separate*

the first HARQ-ACK codebook is associated with the first CORESETs or with the second CORESETs, as described in clause 9, when the UE receives the PDCCH providing the DCI format in a CORESET from the first CORESETs or from the second CORESETs, respectively.

If the UE would also multiplex in the PUCCH transmission in slot a second HARQ-ACK codebook with second HARQ-ACK information of same priority value as for the first HARQ-ACK information in the first HARQ-ACK codebook, the UE appends the first HARQ-ACK codebook to the second HARQ-ACK codebook. The UE determines to multiplex the second HARQ-ACK information in the PUCCH transmission in slot as described in clause 9.2.3.

If in slot the UE performs a procedure for deferring first HARQ-ACK information for SPS PDSCH receptions, as described in clause 9.2.5.4, and the first HARQ-ACK information has same priority value as a priority value indicated by the DCI format triggering the PUCCH transmission in slot , the UE multiplexes in the PUCCH transmission in slot second HARQ-ACK information with the priority value that results in slot according to the procedure in this clause, by appending the first HARQ-ACK information to the second HARQ-ACK information. If the UE would also multiplex in the PUCCH transmission in slot third HARQ-ACK information with the priority value, the UE appends the second HARQ-ACK information followed by the first HARQ-ACK information to the third HARQ-ACK information. The UE determines to multiplex the third HARQ-ACK information in the PUCCH transmission in slot as described in clause 9.2.3.

If in slot the UE would transmit a first PUCCH with first HARQ-ACK information over more than one slot and a second PUCCH with second HARQ-ACK information over one or more slots, where the first and second HARQ-ACK information have same priority value, the UE multiplexes in the PUCCH transmission in slot one of

- the first HARQ-ACK information if the first PUCCH starts at an earlier slot than the second PUCCH, or

- the second HARQ-ACK information if the second PUCCH starts at an earlier slot than the first PUCCH.

\*\*\* Unchanged text is omitted \*\*\*

### 9.2.3 UE procedure for reporting HARQ-ACK

\*\*\* Unchanged text is omitted \*\*\*

If the UE is provided *subslotLengthForPUCCH*, is the last UL slot for PUCCH transmission that overlaps with a PDSCH reception or with a PDCCH reception providing a DCI format having associated HARQ-ACK information without scheduling a PDSCH reception; otherwise, is the last UL slot for PUCCH transmission that overlaps with the DL slot for the PDSCH reception or with the DL slot for the PDCCH reception in case of a DCI format that triggers a HARQ-ACK information report and does not schedule a PDSCH reception.

For a SPS PDSCH reception ending in DL slot , the UE transmits the PUCCH in UL slot where is provided by the PDSCH-to-HARQ\_feedback timing indicator field, if present, in a DCI format activating the SPS PDSCH reception.

If the UE detects a DCI format that does not include a PDSCH-to-HARQ\_feedback timing indicator field and schedules a PDSCH reception or activates a SPS PDSCH reception ending in DL slot , the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot where is provided by *dl-DataToUL-ACK*, or *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1*.

If the UE detects a DCI format scheduling a number of PDSCH receptions ending in DL slot  or if the UE detects a DCI format generating a HARQ-ACK information bit and does not schedule a PDSCH reception through a PDCCH reception ending in DL slot , the UE provides corresponding HARQ-ACK information in a PUCCH transmission within UL slot , where is a number of slots and is indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI format, if present, or provided by *dl-DataToUL-ACK*, *dl-DataToUL-ACK-r16*, or *dl-DataToUL-ACK-DCI-1-2*, or *dl-DataToUL-ACK-r17*, or *dl-DataToUL-ACK-MulticastDciFormat4\_1*.

A PUCCH transmission with HARQ-ACK information is subject to the limitations for UE transmissions described in clause 11.1 and clause 11.1.1.

\*\*\* Unchanged text is omitted \*\*\*

#### 9.2.5.2 UE procedure for multiplexing HARQ-ACK/SR/CSI in a PUCCH

\*\*\* Unchanged text is omitted \*\*\*

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation*, the UE has HARQ-ACK, SR and wideband or sub-band CSI reports to transmit, and the UE determines a PUCCH resource with PUCCH format 2, or the UE has HARQ-ACK, SR and wideband CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 3, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field in a last of a number of DCI formats with a value of a PDSCH-to-HARQ\_feedback timing indicator field, or a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in a DCI format, indicating a same slot for the PUCCH transmission, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clauses 9.2.1 and 9.2.3 for UCI bits

and

\*\*\* Unchanged text is omitted \*\*\*

If a UE has HARQ-ACK, SR and sub-band CSI reports to transmit and the UE determines a PUCCH resource with PUCCH format 3 or PUCCH format 4, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field [5, TS 38.212] in a last of a number of DCI formats with a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission, or by a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the last DCI format, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clause 9.2.1 and clause 9.2.3 for  UCI bits

and

\*\*\* Unchanged text is omitted \*\*\*

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation*, the UE has HARQ-ACK, SR and sub-band CSI reports to transmit, and the UE determines a PUCCH resource with PUCCH format 3, where

- the UE determines the PUCCH resource using the PUCCH resource indicator field in a last of a number of DCI formats that have a value of a PDSCH-to-HARQ\_feedback timing indicator field indicating a same slot for the PUCCH transmission, or a value provided by *dl-DataToUL-ACK* or *dl-DataToUL-ACK-r16* or *dl-DataToUL-ACK-DCI-1-2* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the last DCI format, from a PUCCH resource set provided to the UE for HARQ-ACK transmission, and

- the UE determines the PUCCH resource set as described in clauses 9.2.1 and 9.2.3 for UCI bits

and

\*\*\* Unchanged text is omitted \*\*\*

#### 9.2.5.3 UE procedure for reporting UCI of different priorities

If a UE

- is provided *PUCCH-ConfigurationList* for PUCCH transmissions with priority 0 and 1,

- is provided *UCI-MuxWithDifferentPriority*, and

- would transmit overlapping PUCCHs that include a first PUCCH with HARQ-ACK information bits of priority 0 and a second PUCCH with HARQ-ACK information bits of priority 1

- if the PUCCH resource for the second PUCCH includes PUCCH format 2, 3, or 4 and additionally includes SR bits of priority 1, is replaced by where is determined according to clause 9.2.5.1

the UE

- determines

- a PUCCH resource set from the second *PUCCH-Config* using as described in clause 9.2.1, and a PUCCH resource from the PUCCH resource set as described in clause 9.2.3 where a DCI format, if any, triggers PUCCH transmission of priority 1, or

- a PUCCH resource from the second *sps-PUCCH-AN-List* using as described in clause 9.2.1, and

- multiplexes the and HARQ-ACK information bits in a same PUCCH using the PUCCH resource.

If the PUCCH resource includes PUCCH format 2 or PUCCH format 3 and PRBs, the UE determines a number of PRBs for the PUCCH transmission to be the minimum number of PRBs that starts from the first PRB from the PRBs and results to

where or is a number of CRC bits, if any, for encoding the or the HARQ-ACK information bits, respectively, is provided by *maxCodeRateLP*, and the remaining parameters are as defined in clause 9.2.5.2 with . For PUCCH format 3, if is not equal to [4, TS 38.211], is increased to a nearest value that is equal to and does not exceed *nrofPRBs*.

If , the UE transmits the PUCCH over the PRBs.

If a UE transmits a PUCCH that includes HARQ-ACK information bits of priority 0 and 1 using a PUCCH resource that includes PUCCH format 2, 3 or 4, the UE determines a power for the PUCCH transmission as described in clause 7.2.1 assuming that the PUCCH includes only UCI bits of priority 1, where .

If a UE transmits a PUCCH that includes one HARQ-ACK information bit of priority 0 and one HARQ-ACK information bit of priority 1

- if the PUCCH transmission uses a resource that includes PUCCH format 0, the HARQ-ACK information bits of priority 1 and priority 0 are set as the first and second bits in Table 9.2.3-4, respectively, to derive the of the PUCCH transmission

- if the PUCCH transmission uses a resource that includes PUCCH format 1, the HARQ-ACK information bits of priority 1 and priority 0 are the first and second bits, respectively, of the QPSK modulated symbol for the PUCCH transmission

If a UE transmits a PUCCH that includes HARQ-ACK information bits of priority 0 and 1 using PUCCH format 1, the UE determines a power for the PUCCH transmission as described in clause 7.2.1 assuming that all HARQ-ACK information bits have priority 1.

If a UE is provided a first interlace of PRBs by *interlace0* in *InterlaceAllocation*

- if the UE is provided a second interlace of PRBs by *interlace1* in *InterlaceAllocation*

- if , the UE transmits the PUCCH over the first interlace

- else, the UE transmits the PUCCH over both the first and second interlaces

- else the UE transmits the PUCCH over the first interlace

If the UE transmits a PUCCH that includes HARQ-ACK information bits of priority 0 and 1 over interlaces, the UE determines a power for the PUCCH transmission as described in clause 7.2.1 assuming that the PUCCH includes only UCI bits of priority 1.

#### 9.2.5.4 UE procedure for deferring HARQ-ACK for SPS PDSCH

If a UE is provided *spsHARQdeferral* and, after performing the procedures in clauses 9 and 9.2.5 to resolve overlapping among PUCCHs and PUSCHs in a first slot, if any, the UE determines a PUCCH resource for a PUCCH transmission with first HARQ-ACK information bits for SPS PDSCH receptions that the UE would report for a first time, and the PUCCH resource

- is provided by *SPS-PUCCH-AN-List* as described in clause 9.2.1, or by *n1PUCCH-AN* if *SPS-PUCCH-AN-List* is not provided

- is not cancelled by an overlapping PUCCH or PUSCH transmission of larger priority index

- overlaps with a symbol indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated*, or indicated for a SS/PBCH block by *ssb-PositionsInBurst*, or belonging to a CORESET associated with a Type0-PDCCH CSS set

the UE

- determines an earliest second slot and, after performing the procedures in clauses 9.2.1 and 9.2.3 to determine a PUCCH with HARQ-ACK information bits including second HARQ-ACK information bits and then performing the procedures in clauses 9 and 9.2.5 to resolve overlapping among PUCCHs and PUSCHs, if any, a PUSCH or a PUCCH in the earliest second slot to multiplex HARQ-ACK information bits that include second HARQ-ACK information bits from the first HARQ-ACK information bits

- if the UE detects a DCI format in a PDCCH reception that triggers a PUCCH transmission with a Type-3 HARQ-ACK codebook in a slot as described in clause 9.1.4, the UE stops the procedure to determine the earliest second slot in the slot

- if the UE is provided a periodic cell switching pattern for PUCCH transmissions by *pucch-sSCellPattern*, the UE determines the earliest second slot and a corresponding cell based on the periodic cell switching pattern as described in clause 9.A

- if the UE multiplexes the second HARQ-ACK information in a PUSCH, or in a PUCCH using a resource that is not from *SPS-PUCCH-AN-List*, or from *n1PUCCH-AN* if *SPS-PUCCH-AN-List* is not provided, the UE stops the procedure to determine the earliest second slot in the slot

- if the UE multiplexes the second HARQ-ACK information in a first PUCCH using a resource provided by *SPS-PUCCH-AN-List*, or by *n1PUCCH-AN* if *SPS-PUCCH-AN-List* is not provided, of smaller priority index and the UE drops the first PUCCH transmission due to an overlapping with a second PUSCH or PUCCH transmission of larger priority index, the UE stops the procedure to determine the earliest second slot in the slot

- the second HARQ-ACK information bits correspond to SPS PDSCH configurations with *spsHARQdeferral* values that are larger than or equal to a time difference, with reference to slots for PUCCH transmissions on the primary cell, between the second slot and the slot of the SPS PDSCH reception, if any

- if the UE multiplexes the second HARQ-ACK information in a first PUCCH using a resource provided by *SPS-PUCCH-AN-List*, or by *n1PUCCH-AN* if *SPS-PUCCH-AN-List* is not provided, and the PUCCH transmission is not dropped due to an overlapping with a PUSCH or PUCCH transmission of larger priority and does not have any symbol that overlaps with a symbol indicated as downlink by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigDedicated*, or indicated for a SS/PBCH block by *ssb-PositionsInBurst*, or belonging to a CORESET associated with a Type0-PDCCH CSS set, the UE stops the procedure to determine the earliest second slot in the slot

- the second HARQ-ACK information bits, generated as described in clause 9.1.2, are appended in a HARQ-ACK codebook the UE generates as described in clauses 9.1.2, 9.1.2.1, 9.1.3.1, or 9.1.5

- if the UE would receive a PDSCH providing a TB for a same HARQ process as a HARQ-ACK information bit from the second HARQ-ACK information bits prior to transmitting the PUCCH or the PUSCH, the UE does not include the HARQ-ACK information bit in the HARQ-ACK information bits.

The UE does not expect to be provided both *spsHARQdeferral* and *nrofSlots* or *PUCCH-nrofSlots* for any PUCCH resource of same priority.

\*\*\* Unchanged text is omitted \*\*\*

#### 16.5.1.1 Type-1 HARQ-ACK codebook in physical uplink control channel

\*\*\* Unchanged text is omitted \*\*\*

while C

if

Set – index of a SL slot within an UL slot

while

if slot starts at a same time as or after a slot for an active UL BWP change on the serving cell of PUCCH transmission and slot is before the slot for the active UL BWP change on the serving cell of PUCCH transmission

;

else

\*\*\* Unchanged text is omitted \*\*\*

#### 16.5.2.1 Type-2 HARQ-ACK codebook in physical uplink control channel

\*\*\* Unchanged text is omitted \*\*\*

Set to the number of PDCCH monitoring occasions

while

if PDCCH monitoring occasion is before an active UL BWP change on the serving cell of PUCCH transmission

;

else

if there is a PSFCH reception occasion associated with a PSSCH transmission scheduled by a DCI format in PDCCH monitoring occasion

\*\*\* Unchanged text is omitted \*\*\*