3GPP TSG-RAN WG1 Meeting #100bis-e R1-20xxxxx

e-Meeting, April 20th – 30th, 2020

Agenda Item: 6.2.1.4

Source: Moderator (Ericsson)

Title: Feature lead summary for Multi-TB scheduling for LTE-MTC

Document for: Discussion, Decision

# Introduction

In the Rel-16 work item on “Additional MTC enhancements for LTE” [1], one of the objectives is to specify support for scheduling of multiple DL/UL transport blocks.

|  |
| --- |
| The objective is to specify the following set of improvements for machine-type communications for BL/CE UEs.[...]**Scheduling enhancement:*** Specify scheduling multiple DL/UL transport blocks with single DCI for SC-PTM and unicast [RAN1, RAN2]
 |

RAN1 agreements made until RAN1#99 are summarized in [2] and RAN1 agreements made in RAN1#100e are listed below. RAN2 agreements are summarized in [3]. The endorsed L1 configuration parameter list can be found in [4], the initial RAN1 UE feature list in [5], and the endorsed RAN1 CRs in [6] – [16].

|  |
| --- |
| [**R1-2001056**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001056.zip) Feature lead summary for Multi-TB scheduling for LTE-MTC Ericsson[**R1-2001185**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001185.zip) Feature lead summary#2 for Multi-TB scheduling for LTE-MTC Ericsson[**R1-2001220**](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001220.zip) Feature lead summary#3 for Multi-TB scheduling for LTE-MTC Ericsson[100e-LTE-eMTC5-Multi-TB-01] – Johan (Ericsson)Email discussion/approval onHARQ/NDI/RV/FH encoding for both FDD and TDDby 2/27; if there is a spec impact, followed by endorsing the corresponding TP by 3/2**Conclusion**For FDD case:* For 36.212, use Futurewei’s TP in [R1-2001086](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001086.zip) as a basis, possibly with the clarification “From MSB to LSB” in each section.
* For 36.211 and 36.213, take the provided comments and proposals into account in contributions to the next meeting.

For TDD case:* There is no consensus in RAN1#100e for optimization (or elimination) of the TDD HARQ process grouping. The 36.212 seems adequate and potential corresponding 36.213 text can be added in the next meeting.

As per email decision posted on Mar. 4th, two companies prefer not to add “From MSB to LSB”, so:Agreement: The text proposal in [R1-2001086](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001086.zip) is endorsed for inclusion into TS36.212 editor’s CR.[100e-LTE-eMTC5-Multi-TB-02] – Johan (Ericsson)Email discussion/approval onHARQ-ACK bundling for both FDD and TDDby 2/27; if there is a spec impact, followed by endorsing the corresponding TP by 3/2As per email decision posted on Mar. 5th,:Agreement: The TP provided in [R1-2001214](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001214.zip) for TS36.213 section 10.2 is endorsed. To be included as part of the editor’s CR for TS36.213.[100e-LTE-eMTC5-Multi-TB-03] – Johan (Ericsson)Email discussion/approval onscheduling gaps for both unicast and multicastby 2/27; if there is a spec impact, followed by endorsing the corresponding TP by 3/2**Conclusion**For the unicast case* There is no consensus in RAN1#100e for the proposal to specify explicit unicast scheduling gaps.
* Since unicast scheduling gaps are included in the draft RAN1 UE feature list, there may be a need to update the feature list, and this is something that can be brought up in the email discussion for the feature list.

For the multicast case* There is no consensus in RAN1#100e for the proposal to insert the scheduling gaps before each TB instead of after each TB.
 |

This document provides a prioritized list of issues and proposals based on the contributions in [17] – [23].

# Issue #1: TBS/MCS/RV determination

RAN1#100e agreed a text proposal on HARQ/NDI/RV/FH encoding for 36.212. It was noted in the RAN1 email discussion “[100e-LTE-eMTC5-Multi-TB-01] HARQ/NDI/RV/FH encoding” that corresponding updates may be needed in other RAN1 specifications than 36.212.

Huawei’s contribution [17] has the following 36.213 TP on TBS/MCS/RV determination (see Section 2.4 in Huawei’s contribution for further discussion).

1. Consider the following 36.213 TP on TBS/MCS/RV determination.

|  |
| --- |
| 7.1.7.2 Transport block size determination**<Unchanged parts are omitted>**For a BL/CE UE, if the UE is configured with higher layer parameter *multi-TB-DL-config* and multiple TB, , are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, the HARQ process ID for each of the scheduled  TBs are determined from the value *r* of the HARQ index field in the corresponding DCI,- if UE is configured with CEModeB and  =3, *r* indicates the HARQ process ID that is not scheduled among the 4 downlink HARQ processes;- otherwise, *r* is defined as , where- the set , () contains the sorted HARQ process IDs and  is the extended binomial coefficient, resulting in unique label ,**<Unchanged parts are omitted>**8.0 UE procedure for transmitting the physical uplink shared channel**<Unchanged parts are omitted>**- the HARQ process ID for each of the scheduled  TBs are determined from the value *r* of the HARQ index field in the correspoding DCI, - if UE is configured with CEModeB and  =3, *r* indicates the HARQ process ID that is not scheduled among the 4 uplink HARQ processes;- otherwise, *r* is defined as , where- the set , () contains the sorted HARQ process IDs and  is the extended binomial coefficient, resulting in unique label ,**<Unchanged parts are omitted>** |

LG’s contribution [19] has the following 36.213 TP on TBS/MCS/RV determination (see LG’s contribution for further discussion).

1. Consider the following 36.213 TP on TBS/MCS/RV determination.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| 7.1.7 Modulation order and transport block size determination To determine the modulation order and transport block size(s) in the physical downlink shared channel, the UE shall first- if the UE is a BL/CE UE- if PDSCH is assigned by MPDCCH DCI format 6-1A- if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config-r15* and the DCI is mapped onto the UE specific search space and the repetition number field in the DCI indicates PDSCH repetition level 1 - if “Scheduling TBs for Unicast filed” in DCI format 6-1A is present and either 4 or 6 TBs are scheduled by the corresponding DCI,  - read the 4-bit “modulation and coding scheme ()" field in the DCI - the UE is not expected to receive a DCI format 6-1A indicating - otherwise, read the 5-bit extended "modulation and coding scheme ()" field in the DCI- otherwise- read the 4-bit "modulation and coding scheme ()" field in the DCI- The UE is not expected to receive a DCI format 6-1A indicating - else if PDSCH is assigned by MPDCCH DCI format 6-2- read the 3-bit "modulation and coding scheme ()" field in the DCI- The UE is not expected to receive a DCI format 6-2 indicating - else if PDSCH is assigned by MPDCCH DCI format 6-1B- read the 4-bit "modulation and coding scheme ()" field in the DCI and set =. - else if PDSCH carriers *SystemInformationBlockType1-BR*- set  to the value of the parameter *schedulingInfoSIB1-BR* configured by higher-layers- otherwise- read the 5 or 6-bit "modulation and coding scheme" field () in the DCI**<Unchanged parts are omitted>**7.1.7.1 Modulation order and redundancy version determination**<Unchanged parts are omitted>**For BL/CE UEs, the same redundancy version is applied to PDSCH transmitted in a given block of  consecutive subframes, if the PDSCH is not carrying *SystemInformationBlockType1-BR* or SI message. The subframe number of the first subframe in each block of consecutive subframes, denoted as , satisfies , where  for FDD and  for TDD. Denote  as the subframe number of the first downlink subframe intended for PDSCH, given by *n+x* as defined in Subclause 7.1.11. The PDSCH transmission spans  consecutive subframes including non-BL/CE subframes where the PDSCH transmission is postponed. Note that BL/CE subframe(s) refers to either BL/CE DL subframe(s) or BL/CE UL subframe(s). For the  block of consecutive subframes within the set of  subframes, the redundancy version (*rvidx*) is determined according to Table 7.1.7.1-2 using , where , and . The  blocks of subframes are sequential in time, starting with  to which subframe belongs. For a BL/CE UE configured in CEModeA, . For a BL/CE UE configured in CEModeA, and single TB is scheduled in the corresponding DCI with CRC scrambled by C-RNTI,  is determined by the 'Redundancy version' field in DCI format 6-1A. For a BL/CE UE configured in CEModeA, if the UE is configured with higher layer parameter *multi-TB-DL-config* and multiple TB are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, and * if is indicated by the corresponding DCI, and HARQ process ID for each scheduled TBs are h1 and h2 (h1<h2),  of the scheduled TB with HARQ process ID h1 is determined by the ‘Redundancy version for TB 1’ field in DCI format 6-1A, and
	+ if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config* and the repetition number field in the DCI indicates no PDSCH repetition,  of the scheduled TB with HARQ process ID h2 is determined by the ‘Redundancy version for TB 1’ field in DCI format 6-1A.
	+ else if the UE is configured with higher layer parameter *mpdcch-pdsch-HoppingConfig* set to 'on' and the repetition number field in the DCI indicates PDSCH repetition,  of the scheduled TB with HARQ process ID h2 is determined by the ‘Redundancy version for TB 1’ field in DCI format 6-1A.
	+ else  of the scheduled TB with HARQ process ID h2 is determined by the ‘Redundancy version for TB 2’ field in DCI format 6-1A.
* else if = 4 or 6, is indicated in the corresponding DCI with scrambled C-RNTI,  for all schedueld TBs.
* else
	+ if the UE is configured with higher layer parameter *ce-PDSCH-64QAM-Config* and the repetition number field in the DCI indicates no PDSCH repetition,  for all TBs.
	+ else if the UE is configured with higher layer parameter *mpdcch-pdsch-HoppingConfig* set to 'on' and the repetition number field in the DCI indicates PDSCH repetition,  for all TBs.
	+ else  of all TBs is determined by the ‘Redundancy version for all TBs’ field in DCI format 6-1A.

For a BL/CE UE configured with CEModeB, or a BL/CE UE receiving PDSCH associated with P-RNTI,  for FDD and  for TDD, and .**Table 7.1.7.1-2: Redundancy version**

|  |  |
| --- | --- |
| **Redundancy version Index** | ***rvidx*** |
| **0** | 0 |
| **1** | 2 |
| **2** | 3 |
| **3** | 1 |

7.1.7.2 Transport block size determination**<Unchanged parts are omitted>**For a BL/CE UE, if the UE is configured with higher layer parameter *multi-TB-DL-config* and multiple TB, , are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, the HARQ process ID for each of the scheduled  TBs are determined from the value of the ‘HARQ index with offset’ field for CE mode A or the ‘HARQ index’ field for CE mode B in the corresponding DCI which is a combinatorial index *r* defined as , where - the set , () contains the sorted HARQ process IDs and  is the extended binomial coefficient, resulting in unique label ,- is the offset value as defined in 5.3.3.1.12 of [4] for CE mode A, and for CE mode B,-  is the number of scheduled TB, and-  if UE is configured with CEModeA, and  if UE is configured with CEModeB,-  if UE is configured with CEModeA, and ‘Multi-TB HARQ processes group’ field is present and set to '1' in the corresponding DCI,  otherwise.For a BL/CE UE, if the UE is configured with higher layer parameter *multi-TB-DL-config* and TBs are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, the HARQ process ID for each scheduled TBs are , , where -  if UE is configured with CEModeA, and  if UE is configured with CEModeB,-  if UE is configured with CEModeA, and ‘Multi-TB HARQ processes group’ field is present and set to '1' in the corresponding DCI,  otherwise.The NDI and HARQ process ID, as signalled on PDCCH/EPDCCH/MPDCCH/SPDCCH, and the TBS, as determined above, shall be delivered to higher layers.**<Unchanged parts are omitted>**8.0 UE procedure for transmitting the physical uplink shared channel**<Unchanged parts are omitted>**A BL/CE UE shall upon detection on a given serving cell of an MPDCCH with DCI format 6-0A/6-0B scheduling PUSCH intended for the UE, perform a corresponding PUSCH transmission in subframe(s) *ni* = *n+ki* if a transport block(s) corresponding to the HARQ process(es) of the PUSCH transmission is generated as described in [8] with *i = 0, 1, …, NTBN-1* according to the MPDCCH, where- subframe *n* is the last subframe in which the MPDCCH is transmitted; - the value of is the number of scheduled TB determined by the corresponding DCI if present,  otherwise;*-*  and the value of  is determined by the *repetition number* field in the corresponding DCI, where- if the UE is configured with higher layer parameter *ce-pdsch-puschEnhancement-config* with value 'On' are given by {1,2,4,8,12,16,24,32} - otherwise, are given in Table 8-2b and Table 8-2c; and- if the UE is configured with higher layer parameter *ce-PUSCH-SubPRB-Config-r15*, and the PUSCH resource assignment in the corresponding DCI is using uplink resource allocation type 5,  where *N* ≤ 32 for CE Mode A and *N* ≤ 2048 for CE Mode B,  is defined in [3] and  is determined according to procedure in subclause 8.1.6,  otherwise- in case *N>1*, subframe(s) *n+ki* with *i=0,1,…, NTBN-1* are *NTBN* consecutive BL/CE UL subframe(s) starting with subframe *n+x*, and in case *N=1*, *k0=x*; - for , - if the UE is configured with higher layer parameter *multi-TB-UL-Unicast-Interleaving-config*, and PUSCH corresponding to a MPDCCH with DCI CRC scrambled by C-RNTI and where  for BL/CE UE configured with CEModeA,  for BL/CE UE configured with CEModeB, - BL/CE UL subframes  with  are associated with TB*r+*1 ,- otherwise,- BL/CE UL subframes  with  are associated with TB*r+*1 ,- the HARQ process ID for each of the scheduled  TBs are determined from the value of the ‘HARQ index with offset’ field for CE mode A, and the HARQ index field for CE mode B in the corresponding DCI which is a combinatorial index *r* defined as , where- the set , () contains the sorted HARQ process IDs and  is the extended binomial coefficient, resulting in unique label ,- is the offset value as defined in 5.3.3.1.10 of [4] for CE mode A, and for CE mode B,-  if UE is configured with CEModeA, and  if UE is configured with CEModeB.- for , the HARQ process ID for each scheduled TBs are , , where,  if UE is configured with CEModeA, and  if UE is configured with CEModeB,**<Unchanged parts are omitted>**8.6.1 Modulation order and redundancy version determination **<Unchanged parts are omitted>**A BL/CE UE configured with CEModeB is not expected to receive a DCI format 6-0B indicating .For a BL/CE UE or for UEs configured with higher layer parameter *PUSCH-EnhancementsConfig*, - if the UE is configured with higher layer parameter *ce-PUSCH-SubPRB-Config-r15*, and the PUSCH resource assignment is using uplink resource allocation type 5, the redundancy version (*rvidx*) to use for the i-th BL/CE UL subframe in the physical uplink shared channel is determined according to Table 7.1.7.1-2 using  where *,* and *N* is the number of BL/CE UL subframes for the PUSCH transmission as determined in subclause 8.0. For a BL/CE UE configured in CEModeA,  is determined by the 'Redundancy version' field in DCI format 6-0A. For a BL/CE UE configured with CEModeB, .- otherwise, the same redundancy version is applied to PUSCH transmitted in a given block of  consecutive subframes. The subframe number of the first subframe in each block of consecutive subframes, denoted as , satisfies . Denote  as the subframe number of the first uplink subframe intended for PUSCH. For BL/CE UEs, the PUSCH transmission spans  consecutive subframes including non-BL/CE subframes where the PUSCH transmission is postponed. For the  block of consecutive subframes within the set of  subframes, the redundancy version (*rvidx*) is determined according to Table 7.1.7.1-2 using , where , and . The  blocks of subframes are sequential in time, starting with  to which subframe belongs. For a BL/CE UE configured in CEModeA, . For a BL/CE UE configured in CEModeA, and single TB is scheduled in the corresponding DCI with CRC scrambled with C-RNTI,  is determined by the 'Redundancy version' field in DCI format 6-0A. For a BL/CE UE configured with CEModeB,  for FDD and  for TDD, and . For a UE configured with higher layer parameter *PUSCH-EnhancementsConfig*,  and  is determined by the 'Redundancy version' field in DCI format 0C. For UEs configured with higher layer parameter *PUSCH-EnhancementsConfig,* . For a BL/CE UE configured in CEModeA, if the UE is configured with higher layer parameter *multi-TB-UL-config* and multiple TB are scheduled in the corresponding DCI, and* + if is indicated by the corresponding DCI, and HARQ process ID for each scheduled TBs are h1 and h2 (h1<h2),  of the scheduled TB with HARQ process ID h1 is determined by the ‘Redundancy version for TB 1’ field in DCI format 6-0A, and
		- if the UE is configured with higher layer parameter *mpdcch-pdsch-HoppingConfig* set to 'on' and the repetition number field in the DCI indicates PDSCH repetition,  of the scheduled TB with HARQ process ID h2 is determined by the ‘Redundancy version for TB 1’ field in DCI format 6-0A.
		- otherwise  of the scheduled TB with HARQ process ID h2 is determined by the ‘Redundancy version for TB 2’ field in DCI format 6-0A.
	+ else if = 4 or 6, is indicated in the corresponding DCI with scrambled C-RNTI,  for all schedueld TBs.
	+ else
		- if the UE is configured with higher layer parameter *mpdcch-pdsch-HoppingConfig* set to 'on' and the repetition number field in the DCI indicates PDSCH repetition,  for all TBs.
		- otherwise  of all TBs is determined by the ‘Redundancy version for all TBs’ field in DCI format 6-0A.

**Table 8.6.1-2: Modulation and TBS index table for PUSCH**

|  |  |  |
| --- | --- | --- |
| **MCS Index** | **Modulation Order** | **TBS Index** |
| **0** | 2 | 0 |
| **1** | 2 | 1 |
| **2** | 2 | 2 |
| **3** | 2 | 3 |
| **4** | 2 | 4 |
| **5** | 2 | 5 |
| **6** | 2 | 6 |
| **7** | 2 | 7 |
| **8** | 2 | 8 |
| **9** | 2 | 9 |
| **10** | 2 | 10 |
| **11** | 4 | 10 |
| **12** | 4 | 11 |
| **13** | 4 | 12 |
| **14** | 4 | 13 |
| **15** | 4 | 14 |

**Table 8.6.1-2A: Modulation and TBS index table for PUSCH**

|  |  |  |
| --- | --- | --- |
| **MCS Index** | **Modulation Order** | **TBS Index** |
| **0** | 2 | 0 |
| **1** | 2 | 2 |
| **2** | 2 | 4 |
| **3** | 2 | 5 |
| **4** | 2 | 6 |
| **5** | 2 | 8 |
| **6** | 2 | 10 |
| **7** | 4 | 10 |
| **8** | 4 | 12 |
| **9** | 4 | 14 |
| **10** | 4 | 16 |
| **11** | 4 | 17 |
| **12** | 4 | 18 |
| **13** | 4 | 19 |
| **14** | 4 | 20 |
| **15** | 4 | 21 |

**Table 8.6.1-3: Modulation, TBS index and redundancy version table for PUSCH**

|  |  |  |  |
| --- | --- | --- | --- |
| **MCS Index** | **Modulation Order** | **TBS Index** | **Redundancy Version*rvidx*** |
| 0 | 2 | 0 | 0 |
| 1 | 2 | 2 | 0 |
| 2 | 2 | 4 | 0 |
| 3 | 2 | 6 | 0 |
| 4 | 2 | 8 | 0 |
| 5 | 2 | 10 | 0 |
| 6 | 4 | 11 | 0 |
| 7 | 4 | 12 | 0 |
| 8 | 4 | 13 | 0 |
| 9 | 4 | 14 | 0 |
| 10 | 4 | 16 | 0 |
| 11 | 4 | 17 | 0 |
| 12 | 4 | 18 | 0 |
| 13 | 4 | 19 | 0 |
| 14 | 6 | 20 | 0 |
| 15 | 6 | 21 | 0 |
| 16 | 6 | 22 | 0 |
| 17 | 6 | 23 | 0 |
| 18 | 6 | 24 | 0 |
| 19 | 6 | 25 | 0 |
| 20 | 6 | 27 | 0 |
| 21 | 6 | 28 | 0 |
| 22 | 6 | 29 | 0 |
| 23 | 8 | 30 | 0 |
| 24 | 8 | 31 | 0 |
| 25 | 8 | 32 | 0 |
| 26 | 8 | 32A | 0 |
| 27 | 8 | 33 | 0 |
| 28 | 8 | 34 | 0 |
| 29 | reserved | 1 |
| 30 | 2 |
| 31 | 3 |

**Table 8.6.1-4: Void****<Unchanged parts are omitted>** |

# Issue #2: RV cycling, TB interleaving and frequency hopping

Qualcomm’s contribution [20] provides a 36.213 TP to clarify that for RV cycling should be interpreted to be initialized at each TB and that the corresponding is interpreted to include all the subframes associated with the TB excluding those associated with other TBs, whereas Nokia’s contribution [22] argues that it is already clear from the specification that should be interpreted as the first subframe for each TB (see Issue #2 in Qualcomm’s contribution and Issue #3 in Nokia’s contribution for further discussion).

1. Discuss and decide on potential changes to RV cycling, e.g. based on the following 36.213 TP.

|  |
| --- |
| 7.1.7.1 Modulation order and redundancy version determination**<Unchanged parts are omitted>**For BL/CE UEs, the same redundancy version is applied to PDSCH associated with a TB transmitted in a given block of  consecutive subframes associated with the TB, including subframes that are not BL/CE DL subframes, if the PDSCH is not carrying *SystemInformationBlockType1-BR* or SI message. The subframe number of the first subframe in each block of such consecutive subframes, denoted as , satisfies , where  for FDD and  for TDD. Denote  as the subframe number of the first downlink subframe intended for PDSCH associated with a TB,as defined in Subclause 7.1.11. The PDSCH transmission associated with the TB spans  consecutive subframes associated with the TB, including subframes that are not BL/CE DL subframes where the PDSCH transmission is postponed and excluding subframes associated with other TBs. For the  block of consecutive subframes within the set of  subframes associated with the TB as described above, the redundancy version (*rvidx*) associated with the TB is determined according to Table 7.1.7.1-2 using , where , and . The  blocks of subframes are sequential in time, starting with  to which subframe belongs. For a BL/CE UE configured in CEModeA,  and  for a TB is determined by the 'Redundancy version' field in DCI format 6-1A. For a BL/CE UE configured in CEModeA, if the UE is configured with higher layer parameter *multi-TB-DL-config* and multiple TB are scheduled in the corresponding DCI with CRC scrambled by C-RNTI, and the 'Redundancy version' field for a scheduled TB is not present in the corresponding DCI,  for all TBs scheduled by the DCI. For a BL/CE UE configured with CEModeB, or a BL/CE UE receiving PDSCH associated with P-RNTI,  for FDD and  for TDD, and .**<Unchanged parts are omitted>**8.6.1 Modulation order and redundancy version determination **<Unchanged parts are omitted>**otherwise, the same redundancy version is applied to PUSCH associated with a TB transmitted in a given block of  consecutive subframes associated with a TB, including subframes that are not BL/CE UL subframes. The subframe number of the first subframe in each block of  such consecutive subframes, denoted as , satisfies . Denote  as the subframe number of the first uplink subframe intended for PUSCH associated with a TB. For BL/CE UEs, the PUSCH transmission associated with a TB spans  consecutive subframes associated with the TB, including subframes that are not BL/CE UL subframes where the PUSCH transmission is postponed and excluding subframes associated with other TBs. For the  block of consecutive subframes within the set of  subframes associated with the TB as described above, the redundancy version (*rvidx*) associated with the TB is determined according to Table 7.1.7.1-2 using , where , and . The  blocks of subframes are sequential in time, starting with  to which subframe belongs. For a BL/CE UE configured in CEModeA,  and  for a TB is determined by the 'Redundancy version' field in DCI format 6-0A. For a BL/CE UE configured in CEModeA, if the UE is configured with higher layer parameter *multi-TB-UL-config* and multiple TB are scheduled in the corresponding DCI, and the 'Redundancy version' field for a scheduled TB is not present in the corresponding DCI,  for all TBs scheduled by the DCI. For a BL/CE UE configured with CEModeB,  for FDD and  for TDD, and . For a UE configured with higher layer parameter *PUSCH-EnhancementsConfig*,  and  is determined by the 'Redundancy version' field in DCI format 0C. For UEs configured with higher layer parameter *PUSCH-EnhancementsConfig,* .**<Unchanged parts are omitted>** |

Huawei’s contribution [17] proposes to modify the TB interleaving pattern to take into account the frequency hopping pattern, whereas Nokia’s contribution [22] argues it is not necessary (see Section 2.1 in Huawei’s contribution and Issue #2 in Nokia’s contribution for further discussion).

1. Discuss and decide on potential changes to TB interleaving with frequency hopping, e.g. based on the following 36.213 TP.

|  |
| --- |
| 7.1.11 PDSCH subframe assignment for BL/CE UE**<Unchanged parts are omitted>**- if the UE is configured with higher layer parameter *multi-TB-DL-Unicast-Interleaving-config*, and PDSCH corresponding to a MPDCCH with DCI CRC scrambled by C-RNTI and where  for BL/CE UE configured with CEModeA, C= for BL/CE UE configured with CEModeB, where is configured by *interval-DlHoppingConfigCommonModeB,* **<Unchanged parts are omitted>**8.0 UE procedure for transmitting the physical uplink shared channel**<Unchanged parts are omitted>**- if the UE is configured with higher layer parameter *multi-TB-UL-Unicast-Interleaving-config*, and PUSCH corresponding to a MPDCCH with DCI CRC scrambled by C-RNTI and where  for BL/CE UE configured with CEModeA, *C*= for BL/CE UE configured with CEModeB, where is configured by *interval-UlHoppingConfigCommonModeB,***<Unchanged parts are omitted>** |

ZTE’s contribution [18] proposes to modify the TB interleaving granularity in the PUSCH sub-PRB case to take into account the TB repetition as for NB-IoT (see Section 2.2.5 in ZTE’s contribution for further discussion).

1. Discuss and decide on potential changes to the TB interleaving pattern to consider the TB repetition as for NB-IoT.

# Issue #3: HARQ-ACK bundling size

RAN1#100e identified a need to define the mapping between DCI field ‘Multi-TB HARQ-ACK bundling size’ in 36.212 and parameter ‘M’ in 36.213. The 36.212 editor’s interpretation of the earlier RAN1 agreements is presented in Futurewei’s contribution [23].

Huawei’s contribution [17] and ZTE’s contribution [18] propose to map 0-3 in 36.212 to 1-4 in 36.213, whereas Qualcomm’s contribution [20] proposes to use 1 instead of 2 bits in the DCI and derive the bundle size from a table in the specification (see Section 2.3 in Huawei’s contribution, Section 2.2.4 in ZTE’s contribution, Issue #1 in Qualcomm’s contribution and Issue #2 in Ericsson’s contribution for further discussion).

1. Discuss and decide on a mapping between DCI field ‘Multi-TB HARQ-ACK bundling size’ in 36.212 and parameter ‘M’ in 36.213.

# Issue #4: DL HARQ process grouping

ZTE’s contribution [18] proposes various modifications of the DL HARQ process grouping in TDD (see Sections 2.3.1 and 2.3.2 in ZTE’s contribution for further discussion).

1. Discuss and decide whether any modifications of the DL HARQ process grouping in TDD are needed.

ZTE’s contribution [18] also proposes that the multi-TB feature can be used in FDD together with the Rel-14 feature for 10 DL HARQ processes if a similar HARQ process grouping is used as in TDD (see Section 2.2.5 in ZTE’s contribution for further discussion).

1. Discuss and decide whether to use DL HARQ process grouping in FDD when 10 DL HARQ processes are configured.

# Issue #5: TDD HARQ-ACK bundling mechanism

ZTE’s contribution [18] proposes that the TDD HARQ-ACK bundling should be based on legacy TDD bundling mechanism, whereas Qualcomm’s contribution [20] proposes to disallow bundling spanning different multi-TB PDSCHs (see Section 2.3.3 in ZTE’s contribution and Issue #3 in Qualcomm’s contribution for further discussion).

1. Discuss and decide on potential changes to allow TDD HARQ-ACK bundling.

# Issue #6: Realization of UL early termination

ZTE’s contribution [18] proposes to define RRC configurable explicit unicast scheduling gaps to allow UL early termination, and also proposes to consider indicating the HARQ process ID indices to be terminated using a bitmap in the DCI (see Sections 2.2.1 and 2.2.2 in ZTE’s contribution for further discussion).

Ericsson’s contribution [21] argues that the UL gaps needed for UL early termination can be realized using the UL resource reservation feature and proposes to check if something is missing in 36.213 to ensure the UE monitors DL during UL gaps (see Issue #1 in Ericsson’s contribution for further discussion).

1. Discuss and decide on potential changes to allow UL early termination.

# Issue #7: Clarification of sub-PRB symbol counter reset

RAN1#100e agreed on a 36.211 clarification regarding symbol counter reset for NB-IoT. Huawei’s contribution [17] and Nokia’s contribution [22] propose a similar clarification for LTE-MTC (see Section 2.5 in Huawei’s contribution and Section 2.4 in Nokia’s contribution for further discussion).

1. Postpone any clarification of sub-PRB symbol counter reset till the next meeting.

# Issue #8: Clarification of CSI reporting

ZTE’s contribution [18] proposes that the CSI report is carried in the first TB and that other details are the same as in legacy operation (see Section 2.2.6 in ZTE’s contribution for further discussion).

1. Postpone any clarification of CSI reporting till the next meeting.

# Issue #9: No scheduling gap after last SC-MTCH TB

RAN1#100e agreed a 36.213 TP to eliminate the scheduling gap insertion after the last TB in a SC-MTCH multi-TB transmission. ZTE’s contribution [18] proposes a similar change for LTE-MTC (see Section 2.1 in ZTE’s contribution for further discussion).

1. Postpone any modification of SC-MTCH scheduling gaps till the next meeting.

# Issue #10: Editorial clean-up for FDD HARQ-ACK timing

RAN1#100e agreed a TP for 36.213 clause 10.2 on HARQ-ACK timing in TDD. Ericsson’s contribution [21] proposes to align the HARQ-ACK timing description for FDD with the one for TDD to make it more compact by describing the bundling and non-bundling for FDD in the same paragraph in the same way as for TDD (see Issue #6 in Ericsson’s contribution for further discussion).

1. Postpone any editorial clean-up for FDD HARQ-ACK timing till the next meeting.

# Issue #11: Editorial clean-up for TB interleaving equations

Ericsson’s contribution [21] proposes to eliminate the redundant variable “g” in the TB interleaving equations in 36.213 clauses 7.1.11 and 8.0 as proposed in Sierra’s RAN1#100e contribution [24] (see Issue #5 in Ericsson’s contribution and Section 3.1 in Sierra’s contribution for further discussion).

1. Postpone any editorial clean-up for TB interleaving equations till the next meeting.

# References

1. [RP-192875](https://www.3gpp.org/ftp/tsg_ran/TSG_RAN/TSGR_86/Docs/RP-192875.zip), “Revised WID: Additional MTC enhancements for LTE”

1. [R1-1913594](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_99/Docs/R1-1913594.zip), “RAN1 agreements for Rel-16 Additional MTC Enhancements for LTE”

1. [R2-2001886](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_109_e/Docs/R2-2001886.zip), “RAN2 agreements for Rel-16 additional enhancements for NB-IoT and MTC”

1. [R1-2001477](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001477.zip), “Updated consolidated parameter list for Rel-16 LTE”

1. [R1-2001485](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001485.zip), “RAN1 UE features list for Rel-16 LTE after RAN1#100-E”

1. [R1-1913610](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913610.zip), Addition of feature for 36.211
2. [R1-1913611](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913611.zip), Addition of feature for 36.212
3. [R1-1913612](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913612.zip), Addition of feature for 36.213 (s00-s05)
4. [R1-1913613](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913613.zip), Addition of feature for 36.213 (s06-s07)
5. [R1-1913614](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913614.zip), Addition of feature for 36.213 (s08-s09)
6. [R1-1913684](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913684.zip), Addition of feature for 36.213 (s10-s13)
7. [R1-1913615](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913615.zip), Addition of feature for 36.213 (s14-sxx)

1. [R1-1913683](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_99/Docs/R1-1913683.zip), Addition of feature for 36.214
2. [R1-2001427](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001427.zip), Corrections for 36.211
3. [R1-2001431](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001431.zip), Corrections for 36.212

1. [R1-2001433](https://www.3gpp.org/ftp/tsg_ran/WG1_RL1/TSGR1_100_e/Docs/R1-2001433.zip), Corrections for 36.213

1. [R1-2001568](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2001568.zip), “Corrections on scheduling of multiple transport blocks”, Huawei, HiSilicon

1. [R1-2001852](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2001852.zip), “Remaining issues on scheduling enhancement for MTC”, ZTE

1. [R1-2001928](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2001928.zip), “Remaining issues on multiple transport blocks scheduling in MTC”, LG Electronics

1. [R1-2002174](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2002174.zip), “Scheduling of multiple DL/UL transport blocks”, Qualcomm Incorporated

1. [R1-2002504](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2002504.zip), “Corrections for Multi-TB scheduling for LTE-MTC”, Ericsson

1. [R1-2002642](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2002642.zip), “Remaining issues for scheduling of multiple TBs”, Nokia, Nokia Shanghai Bell

1. [R1-2002654](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100b_e/Docs/R1-2002654.zip), “HARQ-ACK bundling for Multi-TB scheduling”, Futurewei

1. [R1-2000507](http://www.3gpp.org/ftp/TSG_RAN/WG1_RL1/TSGR1_100_e/Docs/R1-2000507.zip), “LTE-M Multiple Transport Block Grant Design Considerations”, Sierra Wireless