**3GPP TSG RAN WG1 #110bis-e R1-220XXXX**

**e-Meeting, October 10th – 19th, 2022**

**Agenda Item:** 8.2

**Source:** Moderator (LG Electronics)

**Title:** Summary #1 of PDSCH/PUSCH enhancements (Scheduling/HARQ)

**Document for:** Discussion and decision

# Introduction

This is the summary document for 8.2 on PDSCH/PUSCH enhancements (especially for scheduling and HARQ) for NR above 52.6 GHz, based on the contributions listed in reference section.

# Issue#1-1: Type-1 HARQ CB generation

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| Company | Views |
| [1], [13] Huawei | **Proposal 1**: The pruning condition based on the slot from$n\_{0,k}+n\_{D}-N\_{PDSCH}^{repeat,max}+1$to slot$n\_{0,k}+n\_{D}$applies if the row *r* does not only belong to time domain resource allocation table configured for DCI format 1\_1 or *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is not provided.**Proposal 2**: The row *r* is pruned if at least one symbol of the PDSCH time resource derived by row $r$in slot$n\_{0,k}+n\_{D}$is configured as UL by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* and the row r only belongs to TDRA table of DCI 1-1 which can schedule multiple PDSCHs. |

## [Moderator’s note] One company suggested two proposals to modify type-1 HARQ-ACK codebook generation when multi-PDSCH scheduling is configured. Proposal 1 seems to be a problem to be addressed, as $N\_{PDSCH}^{repeat,max}$ should be differently interpreted depending on either DCI format 1\_1 or DCI format 1\_2, when pdsch-AggregationFactor is configured. On the other hand, Proposal 2 doesn’t seems to be an issue since the corresponding if condition is necessary to prune the row r that cannot be scheduled with a given (extended) K1 value.

Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | This issue does not need to be discussed.For proposal 1, it is not an essential issue but just an enhancement to reduce redundancy for Type-1 HARQ-ACK codebook, so it should not be discussed at current stage. The relevant agreement (in RAN1#107) on pdsch-AggregationFactor for DCI format 1\_1 and 1\_2 has already been reflected in TS 38.214. For proposal 2, we share the same view with FL. |
| Samsung | No need to be discussed.The current spec may result in a larger size of Type-1 HARQ-ACK codebook, but it is fine. No need further optimization for the CR phase. |
| Nokia/NSB | We share view |
| Ericsson | Similar views as above |
| Huawei, HiSilicon | The CR is trying to align the spec with the agreement. For the 1st issue, the CB size is impacted due to the slot aggregation factor which should not be applied on the PDSCH schedule by DC1-1 with multiple PDSCH scheduling. Although the agreement is captured in 214 for the scheduling, the HARQ procedure should be consistent with scheduling behavior. For 2nd issue, the current spec language “can not be provided” is not clear. Whether it is due to some values in extendK1 set is not meet the UE processing timeline, or it is due to the collision with UL. We hope it can be clarified and have unified expression as in other places.  |
| Apple | Agree with emerging consensus |

# Issue#1-2: Type-1 HARQ CB when time bundling is configured

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| Company | Views |
| [2] vivo | **Reason for change:**1. During RAN1#110 meeting, regarding Type-1 HARQ-ACK codebook generation with time domain bundling two interpretations were discussed, and Interpretation 2 seemed to be the common understanding that “a PDSCH associated with occasion m” is a PDSCH of which the corresponding HARQ-ACK information is mapping to occasion m. Therefore, a corresponding CR should be provided to TS38.213 based on Interpretation 2.
2. Besides, the case when there is only one valid PDSCH scheduled by a DCI indicating multiple SLIVs is not covered by the pseudo code of Type-1 HARQ-ACK codebook generation with time domain bundling.
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| [5], [6] Fujitsu | **Observation 1**: The current pseudo-code for Type-1 HARQ-ACK codebook generation with time domain bundling fails to capture the case of single valid PDSCH among multiple PDSCHs scheduled by a single DCI.**Observation 2**: There are two possible interpretations on the “a PDSCH associated with occasion m”. How to update the pseudo-code to capture the case of single valid PDSCH among multiple scheduled PDSCHs depends on which interpretation we assume.* + Interpretation 1: “a PDSCH associated with occasion $m$”is a PDSCH scheduled in the corresponding DL slot of occasion $m$, and the corresponding DL slot of occasion $m$ is the DL slot where the last SLIV locates for determining occasion $m.$

* + Interpretation 2: “a PDSCH associated with occasion $m$”is a PDSCH of which the corresponding HARQ-ACK information is mapping to occasion $m.$

**Observation 3**: Interpretation 2 is the common understanding according to the discussions in RAN1#110 meeting.**Proposal 1**: For Type-1 HARQ-ACK codebook generation with time domain bundling, to capture the case of single valid PDSCH among multiple PDSCHs scheduled by a single DCI, adopt the CR in [1] which is based on Interpretation 2. |
| [7], [8] LG Electronics | **Reason for change**:For type-1 HARQ-ACK CB pseudo code when time domain bundling is configured,1. To follow the interpretation that “a PDSCH associated with occasion m” implies PDSCH(s) of which the corresponding HARQ-ACK information maps to occasion m
2. To clarify binary AND operation when some of scheduled PDSCHs are collided with semi-static UL symbol(s)
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| [10] Samsung | **Observation 1**: The pseudo-code of Type-1 HARQ-ACK codebook is clear for time domain bundling operation. |

## [Moderator’s note] Three companies proposed TPs to reflect Interpretation 2 in [6] and to clarify binary AND operation. On the other hand, one company observed no issue in current specification.

Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | We believe this issue should be discussed and the specification needs to be changed. As per the discussion in RAN1#110 meeting, it is almost a common understanding that changes for “single valid PDSCH” case are needed and it should be based on Interpretation 2, so we think RAN1 does not need to repeat the discussion on whether the specification is clear or not and should focus on how to make the specification clear. |
| Samsung | We think the current UE behavior is clear. But fine to discuss if the majority prefer to. |
| Nokia/NSB | We are fine to discuss this issue in this meeting. We are fine with the interpretation 2 & related spec changes. |
| Apple | Open to the discussion. Fine with interpretation 2. |

# Issue#2: Maximum number of entries in TDRA table for multi-PDSCH scheduling

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| Company | Views |
| [10] Samsung | **Proposal 1**: RAN1 to take one option among the following two options - Option 1) Remove the text to support up to 64 entries in TDRA table when multi-PDSCH scheduling is configured. i.e., take text proposal 1 and Draft CR1 in Appendix for TS38.212- Option 2) Send LS to RAN2 to support up to 64 entries in TDRA table when multi-PDSCH scheduling is configured. |

## [Moderator’s note] One company brought up the misalignment issue between 38.212 (where up to 64 entries can be configured in TDRA field for a DCI) and 38.331 (where only 16 entries can be configured in TDRA table) specifications and suggested two options to figure this issue out.

Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | It can be deprioritized. Though there is a misalignment, it seems still workable.  |
| Samsung | The misalignment issue can be decided in the meeting since it may affect RAN1/RAN2 specification. To correct RRC parameter, it is not proper to defer this issue to the future meeting.  |
| Nokia, NSB | We can discuss in this meeting. We slightly prefer option 2 for multi-PDSCH scheduling flexibility.  |
| Ericsson | Prefer Option 2 to correct misalignment issue, and it should be done this meeting (as commented by Samsung). Preserving 64 rows is beneficial for flexibility; 16 seems overly restrictive. |
| Huawei, HiSilicon | Prefer option 2. Considering the multiple PDSCH scheduling, at most 16 entries are not sufficient to cover variable SLIV combination  |
| Apple | Option 2 |

# Issue#3: Indication of 32 HARQ processes in CG-DFI and CG-UCI

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| Company | Views |
| [11] Samsung | **Reason for change**:1. Rel-17 introduced up to 32 HARQ process numbers for DL and UL. RAN2 introduced *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* IE to support up to 32 HARQ process numbers for CG-PUSCH transmission.
2. 4-bit HARQ process number field in CG-UCI to indicate used HARQ process number of CG-PUSCH and 16-bit bitmap in CG-DFI to indicate successful reception of CG-PUSCHs only support up to 16 HARQ process numbers.
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## [Moderator’s note] One company suggested to increase bit-width of HARQ process number field in CG-UCI and that of bitmap in CG-DFI, considering 32 HARQ processes can be configured for FR2-2.

Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | Yes, it needs to be discussed. |
| Samsung | We support to discuss this issue as proponent.  |
| Nokia, NSB | Yes, this should be addressed. We are ok with the changes proposed by Samsung. |
| Apple | Should be discussed. |

# Issue#4: ZP CSI-RS rate-matching

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| Company | Views |
| [12] Samsung | **Reason for change**:1. Rel-17 introduced multi-PDSCH scheduling by a single DCI. If the DCI format trigger ZP CSI-RS, it is unclear whether or not the scheduled PDSCHs are rate-matched around the triggered ZP CSI-RS in all slot(s) where the PDSCHs are scheduled.
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## [Moderator’s note] One company suggested TP to reflect the following agreement.

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| Agreement: (RAN1#106-e)For a DCI that can schedule multiple PDSCHs,* Each of VRB-to-PRB mapping, PRB bundling size indicator, ZP-CSI-RS trigger, and rate matching indicator fields appears only once in the DCI.
* VRB-to-PRB mapping and PRB bundling size indicator fields are applied to all the PDSCHs scheduled by the DCI.
* For ZP-CSI-RS trigger field, the triggered aperiodic ZP CSI-RS is applied to all the slot(s) in which the PDSCH(s) scheduled by the DCI are contained.
* When receiving a PDSCH scheduled by the DCI, the REs corresponding to configured resources in *rateMatchPatternGroup1* or *rateMatchPatternGroup2* (according to indication of rate matching indicator field) are not available for the scheduled PDSCH.
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Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu  | It may not need to be discussed and can be deprioritized. It seems the description in TS 38.214 as below can cover the case of multi-PDSCH scheduling. That is, all scheduled PDSCHs should apply the triggered AP CSI-RS. Even without further clarification in spec., there should be no other interpretations.The REs indicated by sp-ZP-CSI-RS-ResourceSetsToAddModList and aperiodic-ZP-CSI-RS-ResourceSetsToAddModList are declared as not available for PDSCH when their triggering and activation are applied, respectively. |
| Samsung | @Fujitsu, The text does not cover the multi-PDSCH scheduling by a single DCI.The text is only cover a rate-matching rule for one slot where including the REs indicated by *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList*. The text proposal deals with other slots where no REs for AP-ZP-CSI-RS but PDSCH(s) are scheduled by the same DCI format. |
| Nokia, NSB | We are fine to discuss. We think Samsung’s understanding is correct.  |
| Ericsson | Okay to discuss. Good to clarify as per the RAN1#106-e agreement. |
| Apple | OK to discuss. |

# Issue#5: Validity of PDSCH scheduled by multi-PDSCH scheduling DCI with mTRP operation

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| Company | Views |
| [14], [15] NTT DOCOMO | **Summary of change**:Clarify that for multi-PDSCH scheduling via single DCI mTRP with ‘tdmSchemeA’, a PDSCH is invalid if any PDSCH occasion of the PDSCH overlaps with UL symbol. |

## [Moderator’s note] One company suggested TP to reflect the following agreement.

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| **Agreement (RAN1#108-e)**For multi-PDSCH scheduling via a single DCI with ‘tdmSchemeA’ for single DCI based multi-TRP mechanism,* If at least one of the repetitions of the PDSCH collides with semi-static UL symbols, the corresponding PDSCH (i.e., both repetitions) is considered as invalid.
	+ Note: No specification impact on Type-1 HARQ-ACK codebook construction is expected, as a consequence of this agreement.
	+ Note: This is not applied for the case when the multi-PDSCH DCI schedules only a single PDSCH.
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Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | Yes, it needs to be discussed. |
| Samsung | OK to discuss. |
| Nokia/NSB | Fine to discuss.  |
| Apple | OK to discuss |

# Issue#6: RRC parameter to configure multi-PXSCH scheduling

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| Company | Views |
| [16] Huawei | **Reason for change**:According to TS38.331, the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH-r17* is removed. The TDRA for multiple PUSCH scheduling by single DCI in Rel-16 and Rel-17 are differentiated by whether *k2-r16* in *PUSCH-TimeDomainResourceAllocation-r16* or *extendedK2-r17* in *PUSCH-Allocation-r16* is configured in the *pusch-TimeDomainAllocationListForMultiPUSCH*-*r16*. |

## [Moderator’s note] One company suggested TP to reflect that the higher layer parameter pusch-TimeDomainAllocationListForMultiPUSCH-r17 is removed in current TS 38.331 specification.

Companies are encouraged to express whether this issue needs to be discussed in RAN1#110bis-e.

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| Company | Views |
| Fujitsu | Yes, it needs to be discussed. |
| Samsung | OK to discuss. |
| Nokia/NSB | Fine to discuss.  |
| Apple | OK to discuss |

# (E) Issue#7: RRC parameter alignment

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| Company | Views |
| [3] vivo | **Summary of change**:Align the following RRC parameter names in TS38.213 with the RRC specification in TS38.331: * Rel-17 enhanced Type-3 HARQ-ACK codebook in Sec. 9.1.2.1 & 9.1.3.1
	+ *enableTimeDomainHARQ-Bundling*  *timeDomainHARQ-BundlingType1*
	+ *numberOfHARQ-BundlingGroups*  *nrofHARQ-BundlingGroups*
	+ *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH*  *pdsch-TimeDomainAllocationListForMultiPDSCH*
 |
| [4] vivo | **Summary of change**:Align the following RRC parameter names in TS38.212 with the RRC specification in TS38.331: * Rel-17 enhanced Type-3 HARQ-ACK codebook in Sec. 7.3.1.2.2 & 7.3.1.2.3
	+ *pdsch-HARQ-ACK-EnhType3List*  *pdsch-HARQ-ACK-EnhType3ToAddModList*
	+ *pdsch-HARQ-ACK-EnhType3SecondaryList*  *pdsch-HARQ-ACK-EnhType3SecondaryToAddModList*
 |
| [9] LG Electronics | **Summary of change**:*enableTimeDomainHARQ-Bundling* and *numberOfHARQ-BundlingGroups* in TS 38.213 are changed to *timeDomainHARQ-BundlingType1* and *nrofHARQ-BundlingGroups*, respectively. |
| [10] Samsung | Based on TS38.331, the correct name of *pusch-TimeDomainResourceAllocationListForMultiPUSCH-r17, and pdsch-TimeDomainResourceAllocationListForMultiPDSCH* should be *pusch-TimeDomainAllocationListForMultiPUSCH-r17 and pdsch-TimeDomainAllocationListForMultiPDSCH*, respectively*.* **Proposal 2**: RAN1 to take text proposal 2-1 and Draft CR2-1 in Appendix for TS38.212 and text proposal 2-2 and Draft CR2-2 in Appendix for TS38.213.Based on TS38.331, RAN2 introduce new RRC parameters *nrofHARQ-ProcessesForPDSCH-v1700* and *nrofHARQ-ProcessesForPUSCH-r17* to indicate 32 HARQ process numbers for PDSCH reception and PUSCH, respectively. **Proposal 3**: RAN1 to take text proposal 3 and Draft CR3 in Appendix for TS38.214. |
| [17] Huawei | **Summary of change**:Delete *pusch-TimeDomainAllocationListForMultiPUSCH*-*r17*. |

## [Moderator’s note] Above TPs can be treated with alignment CR. Companies are encouraged to express the concern about those TPs. By the way, TP from [4] vivo does not fall into this FR2-2 agenda item but into URLLC agenda item.

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| Company | Views |
| Samsung | Generally find to add the TPs in alignment CR. The TP from HW can be discussed under Issue#6.  |
| Nokia/NSB | We are fine with the proposed TPs as editorial.  |
| Ericsson | Can be handled in alignment CR |
| Huawei, HiSilicon | Fine to discuss the issue in [17] in issue #6 as they are from the same change in RAN2. |
| Apple | OK |

# Reference

1. R1-2208464 Discussion on the type 1 HARQ codebook generation for multiple PDSCH scheduling Huawei, HiSilicon
2. R1-2208597 Correction on generation of Type-1 codebook with time domain bundling vivo
3. R1-2208598 Correction on RRC parameters for time domain bundling of HARQ-ACK for multi-PDSCH scheduling in TS38.213 vivo
4. R1-2208599 Correction on RRC parameters for enhanced Type-3 codebook in TS38.212 vivo
5. R1-2209006 Correction on Type-1 HARQ-ACK codebook determination in TS 38.213 Fujitsu
6. R1-2209007 Discussion on Type-1 HARQ-ACK codebook Fujitsu
7. R1-2209441 Draft CR for type-1 HARQ-ACK codebook when time domain bundling is configured LG Electronics
8. R1-2209442 Discussion on type-1 HARQ-ACK codebook when time domain bundling is configured LG Electronics
9. R1-2209443 Draft CR on RRC parameters for HARQ-ACK time domain bundling LG Electronics
10. R1-2209694 Discussion on multi-PDSCH/PUSCH scheduling by a single DCI Samsung
11. R1-2209695 Draft CR to support up to 32 HARQ process numbers Samsung
12. R1-2209696 Draft CR for ZP CSI-RS rate-matching Samsung
13. R1-2209818 Corrections on Type 1 HARQ codebook generation in TS38.213 Huawei, HiSilicon
14. R1-2209870 Draft CR on DL PDSCH validity for multi-PDSCH scheduling via single DCI mTRP in FR2-2 NTT DOCOMO, INC.
15. R1-2209871 Discussion on remaining issues for NR in FR2-2 NTT DOCOMO, INC.
16. R1-2210220 Corrections on TDRA for multiple PUSCH scheduling in TS38.214 Huawei, HiSilicon
17. R1-2210221 Corrections on TDRA for multiple PUSCH scheduling in TS38.212 Huawei, HiSilicon

# TPs

## TP#A (TBA)