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

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

**Agenda Item:** 8.2

**Source:** Moderator (LG Electronics)

**Title:** Summary #3 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.

The following email thread is assigned for discussion of this topic:

[110bis -e-R17-FR2-2-07] Email discussion for maintenance on scheduling/HARQ for FR2-2 for issues HARQ-1-1, HARQ-1-2, HARQ-2, HARQ-3, HARQ-4, HARQ-5, HARQ-6, and HARQ-7 (as recommendation for editor’s alignment CR) in R1-2210392 - Seonwook (LGE)

* Check points: October 14, October 19

# 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 fromto slotapplies 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 in slotis 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. |

## [Closed][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 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 |
| Moderator | Let’s discuss Issue#1-1 this meeting. |

## [Active][Moderator’s note] It is observed that at least 5 companies (Fujitsu, Samsung, Nokia, Ericsson, and Apple) don’t support two proposals under Issue#1-1.

Companies are encouraged to provide more views on Proposals 1 and 2 in [1].

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| Company | Views |
| vivo | Agree with other companies that this issue is not essential but a kind of optimization for reducing redundancy for Type-1 codebook. |
| ZTE, Sanechips | Regarding proposal 1, we share the same view with Fujitsu, Samsung, Nokia, Ericsson, Apple and vivo. While for proposal 2, we have the same understanding with FL. |
| Samsung | As we commented in the preparation phase, it is optimization, which should be avoided in maintenance phase |
| Fujitsu | Still, we think the issue is not critical. |
| Huawei, HiSilicon | As we mentioned in the preparation phase, the issue 1 is trying to align the behavior between 213 and 214, as well as the agreement. Meanwhile, it will bring benefit to reduce feedback overhead as committed by companies. It should not be regarded as optimization only because the existing spec can work.  As for issue 2, there might be two interpretations. One is to prune the (SLIV, K1) pairs only according to the collision with UL. Another is to prune the (SLIV, K1) pairs according to collision with UL and UE processing timeline. The former one is clearly agreed in RAN1#106 but may be not known to people just reading the spec. The ambiguity of current spec language may cause interoperability issue during the implementation. |
| Intel | We are OK with keeping existing spec without further optimization. |

# 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. |
| [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 ”is a PDSCH scheduled in the corresponding DL slot of occasion , and the corresponding DL slot of occasion is the DL slot where the last SLIV locates for determining occasion      * + Interpretation 2: “a PDSCH associated with occasion ”is a PDSCH of which the corresponding HARQ-ACK information is mapping to occasion     **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) |
| [10] Samsung | **Observation 1**: The pseudo-code of Type-1 HARQ-ACK codebook is clear for time domain bundling operation. |

## [Closed][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. |
| Moderator | Let’s discuss Issue#1-2 this meeting. |

## [Closed][Moderator’s note] Based on the discussion in RAN1#110, majority companies supported Interpretation 2 in [6]. So, we can take TP#A (in Section 11.1) as the baseline, in which Interpretation 2 is reflected and binary AND operation issue is resolved.

Companies are encouraged to provide views on whether TP#A is acceptable.

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| Company | Views |
| vivo | We support Interpretation 2 and revise for the binary AND operation issue. However, in TP#A assumption of ACK for invalid PDSCH in newly introduced, which is not desired in maintenance phase. The TP provided in our contribution [4] is preferred to avoid much spec change. Besides, the TP provided by Fujitsu in [5] are also acceptable. |
| ZTE, Sanechips | We support interpretation 2 and corresponding TP #A is acceptable for us. |
| Samsung | We don’t think the TP is necessary and the UE behavior is pretty clear.  Besides the single valid PDSCH case, the TP is not needed. As pointed out by Fujitsu Interpretation 1 does not need a TP.  For the single valid PDSCH case, hopefully, the proponents can clarify a bit about the unclear of UE behavior, if any. To make progress we are fine with a conclusion to clarify that UE generates HARQ-ACK for this single valid PDSCH. No spec change is expected. |
| Fujitsu | We support Interpretation 2 and share the same view with vivo on TP#A.  Our first preference is the TP in our contribution [5]. And the TP provided by vivo [4] is acceptable. |
| Huawei, HiSilicon | We can go with interpretation 2. We think the version by vivo has less spec change and no confusion. |
| ZTE, Sanechips2 | After double-check other TPs, we want to update our view, that is, we still support interpretation 2, but on corresponding TP, we think that TP from Fujitsu or vivo seems to be more aligned with the previous conclusion and interpretation 2. For TP#A, a new assumption is introduced and also is not supported and reached any consensus in previous meetings. So we cannot accept it at this stage. |

### Proposal #1-2 (type-1 CB when time bundling is configured):

For pseudo code of type-1 HARQ-ACK codebook generation when time domain bundling is configured, down-select between the following two interpretations.

* Interpretation 1: “a PDSCH associated with occasion ”is a PDSCH scheduled in the corresponding DL slot of occasion , and the corresponding DL slot of occasion is the DL slot where the last SLIV locates for determining occasion
  + Note: No spec change is expected.



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



## [Active][Moderator’s note] The following agreement was made during GTW session.

**Agreement**

For pseudo code of type-1 HARQ-ACK codebook generation when time domain bundling is configured, adopt interpretation 2:

* Interpretation 2: “a PDSCH associated with occasion ”is a PDSCH of which the corresponding HARQ-ACK information is mapping to occasion
* Further discuss whether there is specification impact, if so discuss the corresponding TP.

Companies are encouraged to provide views on whether TP is needed or not, if needed, which TP out of TP#A, TP in [2] (from vivo), and TP in [5] (from Fujitsu). Additionally, it should be clarified that assuming ACK for invalid PDSCH (as suggested in TP#A) is not the new one, rather it is already applied to type-2 HARQ-ACK codebook.

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| Company | Views |
| Intel | We support the FL proposal. Regarding the specification impact, we tend to agree with Samsung view that the current specification is clear.  Fine with update if majority companies want to do it. More discussion on wording is needed. For example, the update ‘more than one PDSCH associated with occasion is scheduled by a DCI format indicating a TDRA row that includes more than one SLIV entry’ seems redundant, since “a TDRA row that includes more than one SLIV entry” already indicate multiple PDSCHs are scheduled though some PDSCHs may be invalid. |
| Fujitsu | We believe TP is needed. If the current specification is clear, why some companies, e.g. Samsung, took Interpretation 1 before?  And as discussed in the last meeting, it is due to “a PDSCH associated with occasion , “if the PDSCH is associated with the last SLIV in the TDRA row” and the paired “else” in the pseudo code that some companies were misled to Interpretation 1.  For “assuming ACK”, we agree it is applied to Type-2 codebook. However, RAN1 did not agreed to apply it to Type-1 codebook. As per agreement in RAN1#107 meeting (as below), the logical AND operation is applied to all valid PDSCHs. Nothing to do with invalid PDSCHs. So we insist “assuming ACK” is a new thing for Type-1 codebook.  **Agreement**  For multi-PDSCH scheduling with a single DCI   * Introduce a new RRC parameter, e.g., *enableTimeDomainHARQ-Bundling*, to enable time domain bundling operation for type-1 HARQ-ACK codebook per serving cell.   + If the RRC parameter enables time domain bundling operation,     - To determine the set of candidate PDSCH reception occasions,       * A row index is removed if at least one symbol of every PDSCH associated with the row index is configured as semi-static UL. (NOTE: This is similar to the case of slot aggregated PDSCH in Rel-16)       * Pruning procedure in Rel-16 is performed based on the last configured SLIV of each row index.     - Logical AND operation is applied across all valid PDSCHs associated with a determined candidate PDSCH reception occasion, at least for 1-TB case.     - FFS: UE does not expect the last scheduled SLIV overlaps with a semi-static UL symbol when parameter *enableTimeDomainHARQ-Bundling* is configured   For “more than one”, we agree that it is a little bit redundant, but it should has no harm and may help to aovid confusion for some companies. And actually, our original TP in previous meetings is without “more than one”. “more than one” is to address Samsung’s concorn in the last meeting. And those may be why all submitted TPs have “more than one”. Consider the situation, we prefer to keep “more than one” in the TP.  To summarize, still, our first preference is the TP in our contribution [5], since it is clearer. And the TP provided by vivo [2] is acceptable. |

# [Closed] 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 |
| Moderator | Let’s discuss Issue#2 this meeting. |

## [Moderator’s note] Summary of company views so far, between two options in [10].

* 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
  + Supported by
* Option 2) Send LS to RAN2 to support up to 64 entries in TDRA table when multi-PDSCH scheduling is configured.
  + Supported by Nokia, Ericsson, Huawei, Apple, vivo, ZTE, Samsung, Fujitsu, Huawei

Companies are encouraged to provide more views on which option is preferred. Please note that if Option 2 is taken, we need to send an LS to RAN2 to inform RAN1’s decision.

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| Company | Views |
| vivo | Option 2 is preferred for more flexibility. |
| ZTE, Sanechips | Considering misalignment issue on the maximum number of entry in TDRA table between TS 38.331 and TS 38.212, we tend to support Option2 for the sake of flexibility. |
| Samsung | To provide enough flexibility for multi-PDSCH scheduling, we are ok to take option 2. |
| Fujitsu | We are OK with Option 2. |
| Huawei, HiSilicon | Support option 2 |
| Moderator | During GTW session, Proposal #2 was agreed. So this issue can be closed. |

### Proposal #2 (# of TDRA entries):

For multi-PDSCH scheduling DCI,

* Increase the value of higher layer parameter *maxNrofDL-Allocations* from 16 to 64.
  + Note: According to TS 38.212 specification, if the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is configured, up to 6 bits can be allocated to time domain resource allocation field in DCI format 1\_1. The bitwidth for that field is determined as bits, where *I* is the number of entries in the higher layer parameter *TimeDomainAllocationListForMultiPDSCH*.
  + Send an LS to RAN2

# 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. |

## [Closed][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. |
| Moderator | Let’s discuss Issue#3 this meeting. |

## [Active][Moderator’s note] TP#B (from [11]) is provided in Section 11.2 to address Issue#3.

Companies are encouraged to provide views on whether TP#B is acceptable.

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| Company | Views |
| vivo | Support TP#B. |
| Samsung | We support the TP#B as a proponent. |
| Huawei, HiSilicon | Support TP#B |
| Ericsson | Support TP#B |
| Intel | Support TP#B. |
| Fujitsu | Support TP#B |

# 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. |

## [Closed][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. |

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. |
| Moderator | Let’s discuss Issue#4 this meeting. |

## [Active][Moderator’s note] TP#C (from [12]) is provided in Section 11.3 to address Issue#4.

Companies are encouraged to provide views on whether TP#C is acceptable.

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| Company | Views |
| vivo | Support TP#C. |
| Samsung | We support the TP#C as a proponent. |
| Huawei, HiSilicon | Support TP#C |
| Ericsson | Support TP#C |
| Intel | We are fine with TP#C |
| Fujitsu | We can accept TP#C. |

# 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. |

## [Closed][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. |

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 |
| Moderator | Let’s discuss Issue#5 this meeting. |

## [Active][Moderator’s note] TP#D (from [14]) is provided in Section 11.4 to address Issue#5.

Companies are encouraged to provide views on whether TP#D is acceptable.

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| Company | Views |
| vivo | Support TP#D |
| Samsung | We agree with the intention of TP#D, but we would like to share our understanding and potential TP.  First, the section 5.1.2.1 is not a proper place to describe HARQ process ID increment, all HARQ process ID increment rules are specified in Clause 5.1.  Second, our understanding is that PDSCH in the text below includes two PDSCH transmission occasion if ‘tdmSchemeA’ is configured.  When the UE is scheduled with multiple PDSCHs by a DCI, HARQ process ID indicated by this DCI applies to the first PDSCH not overlapping with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, HARQ process ID is then incremented by 1 for each subsequent PDSCH(s) in the scheduled order, with modulo operation of *nrofHARQ-ProcessesForPDSCH* applied if *nrofHARQ-ProcessesForPDSCH* is provided, or with modulo operation of 8 applied, otherwise. HARQ process ID is not incremented for PDSCH(s) not received if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided.  The minimal change is to clarify the PDSCH includes two PDSCH transmission occasions in Clause 5.1 if ‘tdmSchemeA’ is configured, i.e.,  When the UE is scheduled with multiple PDSCHs by a DCI, HARQ process ID indicated by this DCI applies to the first PDSCH, not overlapping with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided, HARQ process ID is then incremented by 1 for each subsequent PDSCH(s) in the scheduled order, with modulo operation of *nrofHARQ-ProcessesForPDSCH* applied if *nrofHARQ-ProcessesForPDSCH* is provided, or with modulo operation of 8 applied, otherwise. HARQ process ID is not incremented for PDSCH(s) not received if at least one of the symbols indicated by the indexed row of the used resource allocation table in the slot overlaps with a UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated* if provided. When a UE is configured by the higher layer parameter *repetitionScheme* set to 'tdmSchemeA’, the PDSCH includes two PDSCH transmission occasions. |
| Huawei, HiSilicon | either TP#D or Samsung’s change are fine |
| Moderator | **@ Samsung,**  Just to understand the TP proposed by Samsung, is the following highlighted part captured in that TP?  **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. |
| Intel | We slightly prefer Samsung’s TP. Our understanding is that HARQ incremental issue for valid PDSCH needs to be captured in 5.1 |
| Fujitsu | Agree with Samsung and Intel that it should be captured in clause 5.1. However, the TP from Sansung may not be complete. Maybe we can combine the new sentences in Samsung’s TP and TP#D, like:  When a UE is configured by the higher layer parameter *repetitionScheme* set to ‘tdmSchemeA’, the PDSCH includes two PDSCH transmission occasions.  ~~When the UE is scheduled with multiple PDSCHs by a DCI, resource allocation of two PDSCH occasions for each PDSCH can be determined.~~ For each PDSCH, if either PDSCH occasion overlaps with a UL symbol indicated by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigurationDedicated if provided, the PDSCH is not received. ~~HARQ process ID is not incremented for the PDSCH.~~ |

# 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*. |
| [17] Huawei | **Summary of change**:  Delete *pusch-TimeDomainAllocationListForMultiPUSCH*-*r17*. |

## [Closed][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 |
| Moderator | Let’s discuss Issue#6 this meeting. |

## [Active][Moderator’s note] It is noted that issue brought up in [17] is moved into Issue#6 as per request of the proponent. TP#E (from [16]) and TP#F (from [17]) are provided in Section 11.5 and Section 11.6, respectively, to address Issue#5.

Companies are encouraged to provide views on whether TP#E and TP#F are acceptable.

|  |  |
| --- | --- |
| Company | Views |
| vivo | Support TP#E and TP#F. |
| Samsung | Support both TPs. |
| Huawei, HiSilicon | Support TP#E and TP#F |
| Ericsson | Support TP#E and TP#F |
| Intel | We are fine with both TPs |
| Fujitsu | OK with the TPs |

# (E) Issue#7: RRC parameter alignment

|  |  |
| --- | --- |
| 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. |

## [Closed][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.

|  |  |
| --- | --- |
| 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 |
| Moderator | Let’s discuss Issue#7 this meeting. |

## [Active][Moderator’s note] As commented by companies, TPs under Issue#7 can be directly forwarded to editor as alignment CR. It is noted that TP in [3] (from vivo) is the superset of TP in [9] (from LG Electronics) and Draft CR2-2 in [10] (from Samsung).

### Proposal #7:

**For alignment CRs**

* For 38.212:
  + The identified RRC parameter corrections by Samsung in Draft CR2-1 in R1-2209694 are referred to the 38.212 editor alignment CR.
  + The identified RRC parameter corrections by vivo in R1-2208599 are referred to the 38.212 editor alignment CR.
* For 38.213:
  + The identified RRC parameter corrections by vivo in R1-2208598 are referred to the 38.212 editor alignment CR.
* For 38.214:
  + The identified RRC parameter corrections by Samsung in Draft CR3 in R1-2209694 are referred to the 38.214 editor alignment CR.

Companies are encouraged to provide views on Proposal #7.

|  |  |
| --- | --- |
| Company | Views |
| Moderator | As I indicated during preparation phase, TP (from [4] **vivo**) does not fall into this FR2-2 agenda item but into URLLC agenda item, as also highlighted in Proposal #7. If companies are all OK, we can treat it as well, but I’m not sure if this is the right direction… |
| vivo | Sorry that we have wrongly submitted R1-2208599 under agenda 8.2 by a mistake. We already inform this to moderator of agenda 8.3 and R1-2208599 has been handled under agenda 8.3. Therefore, the highlighted part in Proposal #7 can be removed.  In addition, we support Proposal #7 after removing the highlighted part. |
| Samsung | 1) For Draft CR2-1 in R1-2209694, we don’t need to adopt the changes in 7.3.1.1.2 since the RRC parameter, *pusch-TimeDomainResourceAllocationListForMultiPUSCH-r17*, will be removed by TP#E. The following can be added in alignment CR.  7.3.1.2.2 Format 1\_1  \*\*\* Unchanged text is omitted \*\*\*  - Time domain resource assignment – 0, 1, 2, 3, 4, 5 or 6 bits  - If the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is not configured and if the higher layer parameter *pdsch-TimeDomainAllocationList* is configured, 0, 1, 2, 3 or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter is configured;  - if the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is configured, 0, 1, 2, 3, 4, 5 or 6 bits as defined in Clause 5.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*;  - otherwise *I* is the number of entries in the default table.  \*\*\* Unchanged text is omitted \*\*\*  2) FL missed our TP in draft CR2-2, which is also added in alignment CR on TS38.213. So, we proposw   * For 38.213:   + The identified RRC parameter corrections by vivo in R1-2208598 are referred to the 38.212 editor alignment CR.   + The identified RRC parameter corrections by Samsung in Draft CR2-2 in R1-2209694 are referred to the 38.213 editor alignment CR. |

### Proposal #7a:

**For alignment CRs**

* For 38.212:
  + The identified RRC parameter corrections in TP#G in R1-221xxxx are referred to the 38.212 editor alignment CR.
* For 38.213:
  + The identified RRC parameter corrections by vivo in R1-2208598 are referred to the 38.212 editor alignment CR.
* For 38.214:
  + The identified RRC parameter corrections by Samsung in Draft CR3 in R1-2209694 are referred to the 38.214 editor alignment CR.

Companies are encouraged to provide views on Proposal #7a.

|  |  |
| --- | --- |
| Company | Views |
| Moderator | **@ vivo,**  Thanks for the clarification. The corresponding bullet is now removed.  **@ Samsung,**  For the first comment, TP#G is added.  For the second comment, Draft CR2-2 in R1-2209694 seems to be covered by R1-2208598 (from vivo). Please let me know if I’m mistaken. |
| Ericsson | Support Proposal #7a |
| Fujitsu | OK with the proposal. |

# 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 (from LG Electronics [7])

* Reason for change
  + For type-1 HARQ-ACK CB pseudo code when time domain bundling is configured,
    - 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
    - To clarify binary AND operation when some of scheduled PDSCHs are collided with semi-static UL symbol(s)
* Summary of change
  + For type-1 HARQ-ACK CB pseudo code when time domain bundling is configured,
    - “a PDSCH associated with occasion m” is changed to “more than one PDSCH associated with occasion m” and if statement to check whether or not the PDSCH is associated with the last SLIV is removed.
    - Scheduled PDSCHs that are collided with semi-static UL symbol(s) are assumed as correctly received for binary AND operation.
* Consequences if not approved
  + Unclear UE behaviour for type-1 HARQ-ACK codebook generation when time domain bundling is configured

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

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

Set – serving cell index: lower indexes correspond to lower RRC indexes of corresponding cells including, when applicable, cells in the set and the set

Set - HARQ-ACK information bit index

Set to the number of serving cells configured by higher layers for the UE

while

Set – index of occasion for candidate PDSCH reception, or SPS PDSCH release, or TCI state update

while

if *enableTimeDomainHARQ-Bundling* is provided for serving cell and more than one PDSCH associated with occasion is scheduled by a DCI format indicating a TDRA row that includes more than one SLIV entry

if *harq-ACK-SpatialBundlingPUCCH* is not provided and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell

= binary AND operation of the HARQ-ACK information bits corresponding to first transport blocks in PDSCH receptions scheduled by the DCI format on serving cell , by assuming ACK for first transport blocks in PDSCH receptions that overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*;

;

= binary AND operation of the HARQ-ACK information bits corresponding to second transport blocks in PDSCH receptions scheduled by the DCI format on serving cell , by assuming ACK for second transport blocks in PDSCH receptions that overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*;

;

elseif *harq-ACK-SpatialBundlingPUCCH* is provided and the UE is configured by *maxNrofCodeWordsScheduledByDCI* with reception of two transport blocks for the active DL BWP of serving cell

= binary AND operation of the HARQ-ACK information bits corresponding to all transport blocks in PDSCHs scheduled by the DCI format of serving cell , by assuming ACK for all transport blocks in PDSCHs that overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*

if the UE receives one transport block, the UE assumes ACK for the second transport block;

;

else

=binary AND operation of the HARQ-ACK information bits corresponding to all transport blocks in PDSCHs scheduled by the DCI format of serving cell , by assuming ACK for all transport blocks in PDSCHs that overlap with an uplink symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*

;

end if

## TP#B (from Samsung [11])

* Reason for change
  + 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.
  + 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.
* Summary of change
  + For CG-UCI, the bitwidth of the HARQ process number field is extended to 5 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is configured
  + For CG-DFI, the bitwidth of the bitmap is extended to 32 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is *configuredConsequences* if not approved
* Consequences if not approved
  + Up to 32 HARQ process numbers for CG PUSCH cannot be supported

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

6.3.2.1.3 CG-UCI

For CG-UCI bits transmitted on a CG PUSCH when the higher layer parameter *cg-RetransmissionTimer* is configured, the CG-UCI bit sequence is determined as follows:

- set for and , where the CG-UCI bit sequence is given by Table 6.3.2.1.3-1, mapped in the order from upper part to lower part.

**Table 6.3.2.1.3-1: Mapping order of CG-UCI fields**

|  |  |
| --- | --- |
| **Field** | **Bitwidth** |
| HARQ process number | 5 if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is configured;  4 otherwise*;* |
| Redundancy version | 2 |
| New data indicator | 1 |
| Channel Occupancy Time (COT) sharing information | if both higher layer parameter *ul-toDL-COT-SharingED-Threshold* and higher layer parameter *cg-COT-SharingList* are configured, or if both higher layer parameter *ue-SemiStaticChannelAccessConfig* and higher layer parameter *cg-COT-SharingList* are configured, or if higher layer parameter *cg-COT-SharingList* is configured in frequency range 2-2, where *C* is the number of combinations configured in *cg-COT-SharingList;*  1 if higher layer parameter *ul-toDL-COT-SharingED-Threshold* is not configured, and if higher layer parameter *ue-SemiStaticChannelAccessConfig* is not configured, and if higher layer parameter *cg-COT-SharingOffset* is configured;  0 otherwise;  If a UE indicates COT sharing other than "no sharing" in a CG PUSCH within the UE's initiated COT, the UE should provide consistent COT sharing information in all the subsequent CG PUSCHs, if any, occurring within the same UE's initiated COT such that the same DL starting point and duration are maintained. |

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

7.3.1.1.2 Format 0\_1

DCI format 0\_1 is used for the scheduling of one or multiple PUSCH in one cell, or indicating CG downlink feedback information (CG-DFI) to a UE.

The following information is transmitted by means of the DCI format 0\_1 with CRC scrambled by C-RNTI or CS-RNTI or SP-CSI-RNTI or MCS-C-RNTI:

- Identifier for DCI formats – 1 bit

- The value of this bit field is always set to 0, indicating an UL DCI format

- Carrier indicator – 0 or 3 bits, as defined in Clause 10.1 of [5, TS38.213]. This field is reserved when this format is carried by PDCCH on the primary cell and the UE is configured for scheduling on the primary cell from an SCell, with the same number of bits as that in this format carried by PDCCH on the SCell for scheduling on the primary cell.

- DFI flag – 0 or 1 bit

- 1 bit if the UE is configured to monitor DCI format 0\_1 with CRC scrambled by CS-RNTI and for operation in a cell with shared spectrum channel access when the higher layer parameter *cg-RetransmissionTimer* is configured. For a DCI format 0\_1 with CRC scrambled by CS-RNTI, the bit value of 0 indicates activating or releasing type 2 CG transmission and the bit value of 1 indicates CG-DFI. For a DCI format 0\_1 with CRC scrambled by C-RNTI/SP-CSI-RNTI/MCS-C-RNTI and for operation in a cell with shared spectrum channel access, the bit is reserved.

- 0 bit otherwise;

If DCI format 0\_1 is used for indicating CG-DFI, all the remaining fields are set as follows:

- HARQ-ACK bitmap – 16 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is not configured or 32 bits if *nrofHARQ-Processes-v1700* in *ConfiguredGrantConfig* is configured where the order of the bitmap to HARQ process index mapping is such that HARQ process indices are mapped in ascending order from MSB to LSB of the bitmap. For each bit of the bitmap, value 1 indicates ACK, and value 0 indicates NACK.

- TPC command for scheduled PUSCH – 2 bits as defined in Clause 7.1.1 of [5, TS38.213]

- All the remaining bits in format 0\_1 are set to zero.

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

## TP#C (from Samsung [12])

* Reason for change
  + 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.
* Summary of change
  + Include the multi-PDSCH scheduling by a single DCI description for ZP CSI-RS rate-matching, i.e., “or *pdsch-TimeDomainAllocationListForMultiPDSCH-r17*”
* Consequences if not approved
  + Unclear how to rate-match multi-PDSCHs if ZP CSI-RS is triggered when multi-PDSCH scheduling is configured

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

5.1.4.2 PDSCH resource mapping with RE level granularity

The procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 1\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList*.

The procedures for PDSCH scheduled by PDCCH with DCI format 1\_0 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_1 and the procedures for PDSCH scheduled by PDCCH with DCI format 1\_1 described in this clause equally apply to PDSCH scheduled by PDCCH with DCI format 4\_2, by applying the parameters of *aperiodicZP-CSI-RS-ResourceSetsToAddModList in PDSCH-Config-Multicast* instead of *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList in PDSCH-Config*.

A UE may be configured with any of the following higher layer parameters:

*-* REs indicated by the '*RateMatchPatternLTE-CRS*'in *lte-CRS-ToMatchAround* in *ServingCellConfig* or *ServingCellConfigCommon* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

*-* REs indicated by *'RateMatchPatternLTE-CRS'* in *lte-CRS-PatternList1-r16* in *ServingCellConfig* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

- For the UE for broadcast reception, REs indicated by *'RateMatchPatternLTE-CRS'* in *PDSCH-Config-MCCH* or *PDSCH-Config-MCCH* configuring cell-specific RS, in 15 kHz subcarrier spacing applicable only to 15 kHz subcarrier spacing PDSCH, of one LTE carrier in a serving cell are declared as not available for PDSCH.

- Each *RateMatchPatternLTE-CRS* configuration contains *v-Shift* consisting of LTE-CRS-vshift(s), *nrofCRS-Ports* consisting of LTE-CRS antenna ports 1, 2 or 4 ports, *carrierFreqDL* representing the offset in units of 15 kHz subcarriers from (reference) point A to the LTE carrier centre subcarrier location, *carrierBandwidthDL* representing the LTE carrier bandwidth, and may also configure *mbsfn-SubframeConfigList* representing MBSFN subframe configuration. A UE determines the CRS position within the slot according to Clause 6.10.1.2 in [15, TS 36.211], where slot corresponds to LTE subframe.

- If the UE is configured by higher layer parameter *PDCCH-Config* with two different values of *coresetPoolIndex* in *ControlResourceSet* and is also configured by the higher layer parameter *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16* in *ServingCellConfig*, the following REs are declared as not available for PDSCH:

- if the UE is configured with *crs-RateMatch-PerCoresetPoolIndex*, REs indicated by the CRS pattern(s) in *lte-CRS-PatternList1-r16* if the PDSCH is associated with *coresetPoolIndex* set to '0', or the CRS pattern(s) in *lte-CRS-PatternList2-r16* if PDSCH is associated with *coresetPoolIndex* set to '1';

- otherwise, REs indicated by *lte-CRS-PatternList1-r16* and *lte-CRS-PatternList2-r16,* in *ServingCellConfig*.

- Within a BWP, the UE can be configured with one or more ZP CSI-RS resource set configuration(s) for aperiodic, semi-persistent and periodic time-domain behaviours (higher layer parameters *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList,*  *sp-ZP-CSI-RS-ResourceSetsToAddModList* and *p-ZP-CSI-RS-ResourceSet* respectively comprised in *PDSCH-Config*), with each ZP CSI-RS resource set consisting of at most 16 ZP CSI-RS resources (higher layer parameter *ZP-CSI-RS-Resource*) in numerology of the BWP. The REs indicated by *p-ZP-CSI-RS-ResourceSet* are declared as not available for PDSCH. 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. The following parameters are configured via higher layer signaling for each ZP CSI-RS resource configuration:

- *zp-CSI-RS-ResourceId* in *ZP-CSI-RS-Resource* determines ZP CSI-RS resource configuration identity.

- *nrofPorts* in *CSI-RS-ResourceMapping* defines the number of CSI-RS ports, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *cdm-Type* in *CSI-RS-ResourceMapping* defines CDM values and pattern, where the allowable values are given in Clause 7.4.1.5 of [4, TS 38.211].

- *resourceMapping* in *ZP-CSI-RS-Resource* defines the OFDM symbol and subcarrier occupancy of the ZP CSI-RS resource within a slot that are given in Clause 7.4.1.5 of [4, TS 38.211].

- *periodicityAndOffset* in*ZP-CSI-RS-Resource* defines the ZP-CSI-RS periodicity and slot offset for periodic/semi-persistent ZP CSI-RS.

- For the UE in RRC\_CONNECTED mode for multicast reception, *p-ZP-CSI-RS-ResourceSet* can be configuredin *PDSCH-Config-Multicast* for GC-PDSCH rate matching, subject to UE capability. The REs indicated by *p-ZP-CSI-RS-ResourceSet* are declared as not available for GC-PDSCH. The REs indicated by *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config* for unicast do not apply for GC-PDSCH and the REs indicated by *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config-Multicast* for multicast do not apply for unicast PDSCH. The total number of periodic *ZP-CSI-RS-Resources* that a UE can be configured with is the same as for unicast in Rel-16. If *p-ZP-CSI-RS-ResourceSet* is configured in both *PDSCH-Config* and *PDSCH-Config-Multicast*, it is subject to UE capability whether the *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config-Multicast* can be different from the *p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config*.

- For the UE in RRC\_CONNECTED mode for multicast reception, s*p-ZP-CSI-RS-ResourceSet* can be configuredin *PDSCH-Config-Multicast* for GC-PDSCH rate matching, subject to UE capability. The REs indicated by s*p-ZP-CSI-RS-ResourceSet* are declared as not available for GC-PDSCH when their triggering and activation delivered by unicast PDSCH are applied. The REs indicated by s*p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config* for unicast do not apply for GC-PDSCH and the REs indicated by s*p-ZP-CSI-RS-ResourceSet* configured in *PDSCH-Config-Multicast* for multicast do not apply for unicast PDSCH. The total number of semi-persistent *ZP-CSI-RS-Resources* that a UE can be configured with is the same as for unicast.

The UE may be configured with a DCI field for triggering the aperiodic ZP CSI-RS. A list of *ZP-CSI-RS-ResourceSet(s)*, provided by higher layer parameter *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* in*PDSCH-Config*, is configured for aperiodic triggering. The maximum number of aperiodic *ZP-CSI-RS-ResourceSet(s)* configured per BWP is 3. The bit-length of DCI field *ZP CSI-RS trigger* depends on the number of aperiodic *ZP-CSI-RS-ResourceSet(s)*configured (up to 2 bits). Each non-zero codepoint of '*ZP CSI-RS' trigger* in DCI format 1\_1 triggers one aperiodic 'ZP-CSI-RS-ResourceSet' in the list *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* by indicating the aperiodic ZP CSI-RS resource set ID. The DCI codepoint '01' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '1', the DCI codepoint '10' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '2', and the DCI codepoint '11' triggers the resource set with 'ZP-CSI-RS-ResourceSetId' set to '3'. Codepoint '00' is reserved for not triggering aperiodic ZP CSI-RS. When receiving PDSCH scheduled by DCI format 1\_0 or PDSCHs with SPS activated by DCI format 1\_0, the REs corresponding to configured resources in *aperiodic-ZP-CSI-RS-ResourceSetsToAddModList* or in *aperiodicZP-CSI-RS-ResourceSetsToAddModListDCI-1-2* are available for PDSCH.

When the UE is configured with multi-slot and single-slot PDSCH scheduling or *pdsch-TimeDomainAllocationListForMultiPDSCH-r17*, the triggered aperiodic ZP CSI-RS is applied to all the slot(s) of the PDSCH(s) scheduled or the PDSCHs with SPS activated by the PDCCH containing the trigger.

For a UE configured with a list of semi-persistent *ZP-CSI-RS-ResourceSet(s)* provided by higher layer parameter *sp-ZP-CSI-RS-ResourceSetsToAddModList*:

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the activation command, as described in clause 6.1.3.19 of [10, TS 38.321], for ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on the PDSCH RE mapping corresponding to the activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1, and is provided by *K-Mac* or if *K-Mac* is not provided.

- when the UE would transmit a PUCCH with HARQ-ACK information in slot *n* corresponding to the PDSCH carrying the deactivation command, as described in clause 6.1.3.19 of [10, TS 38.321], for activated ZP CSI-RS resource(s), the corresponding action in [10, TS 38.321] and the UE assumption on cessation of the PDSCH RE mapping corresponding to the de-activated ZP CSI-RS resource(s) shall be applied starting from the first slot that is after slot where ** is the SCS configuration for the PUCCH and is the subcarrier spacing configuration for with a value of 0 for frequency range 1, and is provided by *K-Mac* or if *K-Mac* is not provided.

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

## TP#D (from NTT DOCOMO [14])

* Reason for change
  + Correction on DL PDSCH validity for multi-PDSCH scheduling via single DCI mTRP in FR2-2.
* 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.
* Consequences if not approved
  + Incomplete support for NR in FR2-2

5.1.2.1 Resource allocation in time domain

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*unrelated part omitted\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

When a UE is configured by the higher layer parameter *repetitionScheme* set to 'tdmSchemeA*'* and indicated DM-RS port(s) within one CDM group in the DCI field '*Antenna Port(s)'*, the number of PDSCH transmission occasions is derived by the number of TCI states indicated by the DCI field *'Transmission Configuration Indication'* of the scheduling DCI*.*

- If two TCI states are indicated by the DCI field '*Transmission Configuration Indication*', the UE is expected to receive two PDSCH transmission occasions, where the first TCI state is applied to the first PDSCH transmission occasion and resource allocation in time domain for the first PDSCH transmission occasion follows Clause 5.1.2.1. The second TCI state is applied to the second PDSCH transmission occasion, and the second PDSCH transmission occasion shall have the same number of symbols as the first PDSCH transmission occasion. If the UE is configured by the higher layers with a value in *StartingSymbolOffsetK*, it shall determine that the first symbol of the second PDSCH transmission occasion starts after symbols from the last symbol of the first PDSCH transmission occasion. If the value is not configured via the higher layer parameter *StartingSymbolOffsetK*, = 0 shall be assumed by the UE. The UE is not expected to receive more than two PDSCH transmission layers for each PDSCH transmission occasion. For two PDSCH transmission occasions, the redundancy version to be applied is derived according to Table 5.1.2.1-2, where applied respectively to the first and second TCI state. The UE expects the PDSCH mapping type indicated by DCI field '*Time domain resource assignment*' to be mapping type B, and the indicated PDSCH mapping type is applied to both PDSCH transmission occasions. When the UE is scheduled with multiple PDSCHs by a DCI, resource allocation of two PDSCH occasions for each PDSCH can be determined. For each PDSCH, if either PDSCH occasion overlaps with a UL symbol indicated by tdd-UL-DL-ConfigurationCommon or tdd-UL-DL-ConfigurationDedicated if provided, the PDSCH is not received. HARQ process ID is not incremented for the PDSCH.

- Otherwise, the UE is expected to receive a single PDSCH transmission occasion, and the resource allocation in the time domain follows Clause 5.1.2.1.

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*unrelated part omitted\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## TP#E (from Huawei [16])

* 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*.
* Summary of change
  + Remove suffix “-r17” in the RRC parameter of *TimeDomainAllocationListForMultiPUSCH-r17* and add “*k2-r16*” or “*extendedK2-r17*” to differentiate between r16 and r17 procedure.
* Consequences if not approved
  + Wrong RRC parameter to configure multiple PUSCH scheduling by single DCI in Rel-17

6.1.2.1 Resource allocation in time domain

**<Unchanged parts omitted>**

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple SLIVs for PUSCH on a UL BWP of a serving cell, the UE does not apply *pusch-AggregationFactor,* if configured, to DCI format 0\_1 on the UL BWP of the serving cell and the UE does not expect to be configured with *numberOfRepetitions* in *pusch-TimeDomainAllocationListForMultiPUSCH*.

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple *SLIV*s for PUSCH on a UL BWP of a serving cell, when any two UL DCIs end in the same symbol and at least one of the DCIs scheduling multiple PUSCHs, the UE does not expect that the any scheduled multiple PUSCHs have overlapping spans, where the span associated with a DCI is defined from the beginning of the first scheduled PUSCH till the end of the last scheduled PUSCH.

**<Unchanged parts omitted>**

If *pusch-TimeDomainAllocationListForMultiPUSCH* in *pusch-Config* contains row indicating resource allocation for two to eight contiguous PUSCHs, *K2* given by *k2-r16* indicates the slot where UE shall transmit the first PUSCH of the multiple PUSCHs. Each PUSCH has a separate SLIV and mapping type. The number of scheduled PUSCHs is signalled by the number of indicated valid SLIVs in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* signalled in DCI format 0\_1.

For *pusch-TimeDomainAllocationListForMultiPUSCH* in *pusch-Config,* each PUSCH has a separate SLIV, mapping type and *K2* given by *extendedK2*. The number of scheduled PUSCHs is signalled by the number of indicated SLIVs in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* signalled in DCI format 0\_1.

If a UE is configured with *extendedK2* in *pusch-TimeDomainAllocationListForMultiPUSCH* in which one or more rows contain multiple *SLIV*s for PUSCH on a UL BWP of a serving cell, and the UE is indicated re-transmission of PUSCH by DCI format 0\_1, where the PUSCH is correspond to a configured grant Type 1 or Type 2, the UE does not expect that the number of indicated *SLIV*s in the row of the *pusch-TimeDomainAllocationListForMultiPUSCH* by the DCI is more than one.

**<Unchanged parts omitted>**

## TP#F (from Huawei [17])

* Reason for change
  + According to TS38.331, the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH-r17* is removed.
* Summary of change
  + Delete *pusch-TimeDomainAllocationListForMultiPUSCH*-*r17*.
* Consequences if not approved
  + Wrong RRC parameter to configure multiple PUSCH scheduling by single DCI in Rel-17

7.3.1.1.2 Format 0\_1

**<Unchanged parts omitted>**

- Time domain resource assignment – 0, 1, 2, 3, 4, 5, or 6 bits

If the higher layer parameter *pusch-TimeDomainAllocationListDCI-0-1* is not configured and if the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH* is not configured and if the higher layer parameter *pusch-TimeDomainAllocationList* is configured, 0, 1, 2, 3, or 4 bits as defined in Clause 6.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pusch-TimeDomainAllocationList*;

If the higher layer parameter *pusch-TimeDomainAllocationListDCI-0-1* is configured or if the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH* is configured , 0, 1, 2, 3, 4, 5 or 6 bits as defined in Clause 6.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pusch-TimeDomainAllocationListDCI-0-1* or *pusch-TimeDomainAllocationListForMultiPUSCH*;

- otherwise the bitwidth for this field is determined as bits, where *I* is the number of entries in the default table*.*

- Frequency hopping flag – 0 or 1 bit:

- 0 bit if only resource allocation type 0 is configured, or if the higher layer parameter *frequencyHopping* is not configured and the higher layer parameter *pusch-RepTypeIndicatorDCI-0-1* is not configured to *pusch-RepTypeB*, or if the higher layer parameter *frequencyHoppingDCI-0-1* is not configured and *pusch-RepTypeIndicatorDCI-0-1* is configured to *pusch-RepTypeB*, or if only resource allocation type 2 is configured;

- 1 bit according to Table 7.3.1.1.1-3 otherwise, only applicable to resource allocation type 1, as defined in Clause 6.3 of [6, TS 38.214].

- Modulation and coding scheme – 5 bits as defined in Clause 6.1.4.1 of [6, TS 38.214]

- New data indicator – 1 bit if the number of scheduled PUSCH indicated by the Time domain resource assignment field is 1; otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined based on the maximum number of schedulable PUSCH among all entries in the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH*, where each bit corresponds to one scheduled PUSCH as defined in clause 6.1.4 in [6, TS 38.214].

- Redundancy version – – number of bits determined by the following:

- 2 bits as defined in Table 7.3.1.1.1-2 if the number of scheduled PUSCH indicated by the Time domain resource assignment field is 1;

- otherwise 2, 3, 4, 5, 6, 7 or 8 bits determined by the maximum number of schedulable PUSCHs among all entries in the higher layer parameter *pusch-TimeDomainAllocationListForMultiPUSCH*, where each bit corresponds to one scheduled PUSCH as defined in clause 6.1.4 in [6, TS 38.214] and redundancy version is determined according to Table 7.3.1.1.2-34.

**<Unchanged parts omitted>**

## TP#G (from Samsung [10])

7.3.1.2.2 Format 1\_1

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

- Time domain resource assignment – 0, 1, 2, 3, 4, 5 or 6 bits

- If the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is not configured and if the higher layer parameter *pdsch-TimeDomainAllocationList* is configured, 0, 1, 2, 3 or 4 bits as defined in Clause 5.1.2.1 of [6, TS 38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationList* if the higher layer parameter is configured;

- if the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH* is configured, 0, 1, 2, 3, 4, 5 or 6 bits as defined in Clause 5.1.2.1 of [6, TS38.214]. The bitwidth for this field is determined as bits, where *I* is the number of entries in the higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*;

- otherwise *I* is the number of entries in the default table.

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