**3GPP TSG RAN WG1 #109-e R1-220XXXX**

**e-Meeting, May 9th – 20th, 2022**

**Agenda Item:** 8.2.3

**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 8.2.3 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:

[109-e-R17-FR2-2-04] Email discussion under 8.2.3 for maintenance on scheduling and HARQ, for issues 4-1, 4-2, 4-3, 4-5, 4-10, 4-11, 4-12, 4-13, 4-16, 4-18, 4-21 in R1-2205124 – Seonwook (LGE)

* 1st check point: May 13 (any RRC impact by May 12)
* Final check point: May 18

# Issue#4-1: Clarification on type-1 HARQ CB that time domain bundling is applied across PDSCHs scheduled by “the same DCI”

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| Company | Views |
| [1] Huawei | Proposal 1: It should be clarified that logical AND operation is applied across all valid PDSCHs scheduled by the same DCI associated with a determined candidate PDSCH reception occasion when time bundling is applied for type 1 HARQ codebook generation. |
| [8] Fujitsu | Observation 1: According to the agreement made in RAN#107b-e meeting for type-1 HARQ-ACK codebook with time domain bundling, logical AND operation may be applied to PDSCHs scheduled by different DCIs (up to gNB’s scheduling). However, the current specification (TS 38.213 h10) seems not aligned with the agreement (the specification seems to limit logical AND operation to the case where the associated valid PDSCHs are scheduled by a single DCI).Proposal 3: For Type-1 HARQ-ACK codebook with time domain bundling, clarify the following in TS 38.213:* Logical AND operation is applied across all valid PDSCHs associated with a determined candidate PDSCH reception occasion, and the valid PDSCHs may be scheduled by one or more DCIs.
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**Agreement** (RAN1#107bis-e)

* Update the previous agreement made in RAN1#107-e, as follows:

**Agreement** (RAN1#107-e)

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~~

## [Moderator’s note#1] There could be two interpretations on the highlighted part above in the agreement made in RAN1#107bis-e.

* Interpretation 1: Logical AND operation is applied across all valid PDSCHs scheduled by the same DCI associated with a determined candidate PDSCH reception occasion when time bundling is applied for type-1 HARQ codebook generation.
* Interpretation 2: Logical AND operation is applied across all valid PDSCHs associated with a determined candidate PDSCH reception occasion, and the valid PDSCHs may be scheduled by one or more DCIs.

Companies are encouraged to express which interpretation is consistent with current specifications.

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| Company | Views |
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In addition, [8] Fujitsu brought up the following issue.

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| **Issue 2: How to support SPS PDSCH**According to discussion so far, when time domain bundling is supported, it is possible that for a determined candidate PDSCH reception occasion, the associated PDSCHs include both PDSCH scheduled by DCI and PDSCH scheduled by SPS (SPS PDSCH). For example, as shown in Figure 2, for occasion 1, one associated valid PDSCH is scheduled by a DCI, and one associated valid PDSCH is scheduled by SPS.Figure 2. example of one valid PDSCH scheduled by one DCI and one valid PDSCH scheduled by SPS for an occasionHowever, so far, there is still no discussion about how to handle the case where the PDSCHs associated with a determined candidate PDSCH reception occasion include both PDSCH scheduled by DCI and PDSCH scheduled by SPS (SPS PDSCH).In our view, for such case, the following options can be considered.* Option 1: Logical AND operation is applied across all valid PDSCHs associated with a determined candidate PDSCH reception occasion, and the valid PDSCHs may be scheduled by DCI and SPS.
* Option 2: For a determined candidate PDSCH reception occasion, if UE receives a DCI which schedule a PDSCH associated with the occasion, UE will not receive SPS PDSCH (if any) associated with the same occasion and not report HARQ-ACK information corresponding to the SPS PDSCH.

**Observation 2: For Type-1 HARQ-ACK codebook with time domain bundling, it has not been discussed how to support SPS PDSCH.** **Proposal 4: For Type-1 HARQ-ACK codebook with time domain bundling, discuss how to support SPS PDSCH and consider the following two options.*** **Option 1: Logical AND operation is applied across all valid PDSCHs associated with a determined candidate PDSCH reception occasion, and the valid PDSCHs may be scheduled by DCI and SPS.**
* **Option 2: For a determined candidate PDSCH reception occasion, if the UE receives a DCI which schedules a PDSCH associated with the occasion, the UE would not receive SPS PDSCH (if any) associated with the same occasion and not report HARQ-ACK information corresponding to the SPS PDSCH.**
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## [Moderator’s note#2] Companies are encouraged to express which option in the above Proposal 4 is to be supported.

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| Company | Views |
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# Issue#4-2: DCI-to-PDSCH OOO (case 5) and timeline of NNK1 (case 6) are based on configured SLIV vs. valid SLIV

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| Company | Views |
| [1] Huawei | Proposal 2: Support to clarify that “scheduled” PDSCH/PUSCH is the “configured” PDSCH/PUSCH in DCI-to-PDSCH OOO (case 5) and timeline of NNK1 (case 6). |
| [2] ZTE | Proposal 1: For out-of-order scheduling, the rule for OOO scheduling determined is determined based on valid SLIVs.Proposal 2: For a first DCI scheduling multiple PDSCHs and providing an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator filed, to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator filed in a second DCI, only the valid PDSCHs scheduled by the first DCI are considered for definition of the corresponding timeline requirements. |
| [3] InterDigital | Proposal 1: Out-of-order scheduling determination should be based on valid SLIVs. Proposal 2: When a first DCI schedules multiple PDSCHs and provides an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator filed to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator filed in a second DCI, only the valid SLIVs scheduled by the first DCI are considered for definition of the corresponding timeline requirements. |
| [6] vivo | Proposal 1: For multi-PDSCH/PUSCH scheduling, OoO scheduling rules are applied only to valid SLIV(s) in the TDRA row indicated by a scheduling DCI.Proposal 2: For multi-PDSCH scheduling, and for case(s) where Type-2 codebook/enhanced Type-2 codebook is configured and an inapplicable value is provided by a PDSCH-to-HARQ\_feedback timing indicator field included in a first DCI scheduling more than one PDSCH, only valid PDSCH(s) scheduled by the first DCI is considered to decide if an SPS PDSCH reception is received after the PDSCH(s) or not. |
| [8] Fujitsu | Observation 3：According to TS38.213 h10, for Type-1 HARQ-ACK codebook with time domain bundling, for a candidate PDSCH reception occasion associated with a single valid PDSCH scheduled by a DCI which indicates a TDRA row including more than one SLIV, the corresponding HARQ-ACK information bit is not correctly set.Proposal 5: For Type-1 HARQ-ACK codebook with time domain bundling, update the pseudo-code in TS 38.213 to clarify the following:* For a candidate PDSCH reception occasion associated with a single valid PDSCH scheduled by a DCI which indicates a TDRA row with more than one SLIV, the corresponding HARQ-ACK information bit is equal to the HARQ-ACK information bit for the single valid PDSCH.

Proposal 6: For a first DCI scheduling multiple PDSCHs and providing an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator filed, to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator filed in a second DCI, only the valid PDSCHs scheduled by the first DCI are considered for definition of the corresponding timeline requirements.* TP#1 can be considered.
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| [11] OPPO | Proposal 1 For OOO scheduling, the scheduled PDSCHs/PUSCHs or received PDSCHs/PUSCHs are determined based on valid SLIV.Proposal 2 For a first DCI scheduling multiple PDSCHs and providing an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator filed, to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator filed in a second DCI, only the valid PDSCHs scheduled by the first DCI are considered for definition of the corresponding timeline requirements. |
| [12] Ericsson | Proposal 1 For multi-PDSCH/multi-PUSCH scheduling in Rel-17, out-of-order scheduling is determined based on configured SLIVs.Proposal 2 For multi-PDSCH scheduling in Rel-17, the evaluation of the time-line requirement for application of NN-K1 is based on configured SLIVs. |
| [14] Apple | Proposal 1: The following table indicates our preferences on “configured” vs “valid” for the existing agreements:

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| Case | Issue | Agreement: Configured vs Valid | Apple’s Proposals |
| Case 5 | Out-of-order behavior | Pending | Valid |
| Case 6 | NN-K1 | Pending | Valid |

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| [15] NTT DOCOMO | Proposal 1: For OoO scheduling judgement, support to consider “configured SLIV”* No TP is needed
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| [16] Nokia | Proposal 1: Determination of OOO scheduling and NN-K1 timeline requirements are based on the valid SLIVs, without further modification on type-1 codebook determination. Adopt TP#1~#3 in the Appendix. |
| [17] LG Electronics | Proposal #3: Do not consider any invalid PDSCH or PUSCH (which is collided with semi-static UL or DL symbol(s)) to check out-of-order scheduling.Proposal #4: If type-1 HARQ-ACK codebook is configured with time domain bundling and OOO scheduling is determined based on valid PDSCHs,* If there are more than one scheduled PDSCH for a PDSCH reception occasion m, then bundled HARQ-ACK information is generated for the PDSCH associated with the last SLIV.
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| [18] MediaTek | Proposal 2: For out-of-order scheduling, the rule for scheduling is determined based on configured SLIVs indicated by the TDRA information field. |
| [19] Intel | Proposal 2: * Prefer to apply unified handling for Case 5 and Case 6
* Prefer to confirm Case 5 OOO handling is based on configured SLIVs
* Otherwise, if OOO handling is defined by the valid SLIVs, it is preferred to apply valid SLIVs in
	+ PUSCH preparation time
	+ PDSCH reception preparation time with cross carrier scheduling with different SCSs for PDCCH and PDSCH
	+ Activated TCI states within multi-PDSCH transmission
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| [20] Qualcomm | Proposal 3: The out-of-order rules should be applied on the valid allocations only. Proposal 4: For a first DCI scheduling multiple PDSCHs and providing an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator field, to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator field in a second DCI, only the valid PDSCHs scheduled by the first DCI are considered for definition of the corresponding timeline requirements. |

Agreement: (RAN1#106bis-e)

For two multi-PDSCH (or two multi-PUSCH) scheduling DCIs, UE does not expect any of the scheduled PDSCHs (or PUSCHs) and the scheduling DCI to lead to out-of-order scheduling.

**Conclusion** (RAN1#107bis-e)

* UE does not expect any of the scheduled PDSCHs (or PUSCHs) and the scheduling DCIs to lead to out-of-order scheduling, also for the case of one multi-PDSCH (or multi-PUSCH) scheduling DCI and one single-PDSCH (or single-PUSCH) scheduling DCI, where multi-PDSCH (or multi-PUSCH) scheduling DCI schedules more than one PDSCH (or PUSCH).
	+ This may not have specification impact.
* Note: It is separately discussed whether the scheduled PDSCHs (or PUSCHs or SLIV) is based on configured SLIV or valid SLIV.

**Agreement** (RAN1#108-e)

* The case where two multi-PDSCH (or multi-PUSCH) scheduling DCIs end in the same symbol but two multi-PDSCH (or multi-PUSCH) schedulings have overlapping spans, where the span is defined from the beginning of the first scheduled SLIV till the end of the last scheduled SLIV, is considered as out-of-order scheduling and is not expected by UE.
	+ This applies also when one of two DCIs is single-PDSCH (or single-PUSCH) scheduling DCI, including the case that one DCI schedules multi-slot PDSCH (or PUSCH repetition type A or B).
	+ Note: This doesn’t apply when each of two DCIs schedules multi-slot PDSCH (or PUSCH repetition type A or B) as in Rel-15/Rel-16
	+ Note: This doesn’t apply when each of the two DCIs schedules single PDSCH (or single PUSCH) as in Rel-15/Rel-16
* Note: It is separately discussed whether the scheduled SLIV is based on configured SLIV or valid SLIV.

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| **TS 38.214**For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start receiving a first PDSCH starting in symbol *j* by a PDCCH ending in symbol *i*, the UE is not expected to be scheduled to receive a PDSCH starting earlier than the end of the first PDSCH with a PDCCH that ends later than symbol *i*.For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol *j* by a PDCCH ending in symbol *i*, the UE is not expected to be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH that ends later than symbol *i*.If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* in which one or more rows contain multiple *SLIV*s for PDSCH on a DL BWP of a serving cell, when any two DL DCIs end in the same symbol and at least one of the DCIs schedules multiple PDSCHs, the UE does not expect that the scheduled PDSCH(s) by the two DCIs have overlapping spans, where the span associated with a DCI is defined from the beginning of the first scheduled PDSCH or up to the end of the last scheduled PDSCH.If a UE is configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17* 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.**TS 38.213**If a UE receives a first DCI format that the UE detects in a first PDCCH monitoring occasion and includes a PDSCH-to-HARQ\_feedback timing indicator field providing an inapplicable value from *dl-DataToUL-ACK-r16*, - if the UE detects a second DCI format, the UE multiplexes the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission in a slot that is indicated by a value of a PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format, where- if the UE is not provided *pdsch-HARQ-ACK-Codebook-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format.- if the UE is provided *pdsch-HARQ-ACK-Codebook-r16*, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in clause 9.1.3.3, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format. - if the UE is provided *pdsch-HARQ-ACK-Codebook-r16*, the UE receives the second DCI format later than the slot for HARQ-ACK information in response to a SPS PDSCH reception received after the PDSCH scheduled by the first DCI format, and the second DCI format indicates a HARQ-ACK information report for a same PDSCH group index as indicated by the first DCI format as described in clause 9.1.3.3.- if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the first DCI format does not have associated HARQ-ACK information without scheduling a PDSCH reception or TCI state update, the UE detects the second DCI format in any PDCCH monitoring occasion after the first one, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in clause 9.1.4, and where the slot indicated by the value of the PDSCH-to-HARQ\_feedback timing indicator field in the second DCI format is no later than a slot for HARQ-ACK information in response to a SPS PDSCH reception, if any, received after the PDSCH scheduled by the first DCI format.- if the UE is provided *pdsch-HARQ-ACK-OneShotFeedback-r16*, the first DCI format does not have associated HARQ-ACK information without scheduling a PDSCH reception or TCI state update, and the UE receives the second DCI format later than the slot for HARQ-ACK information in response to a SPS PDSCH reception received after the PDSCH scheduled by the first DCI format, and the second DCI format includes a One-shot HARQ-ACK request field with value 1, the UE includes the HARQ-ACK information in a Type-3 HARQ-ACK codebook, as described in clause 9.1.4.- otherwise, the UE does not multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH transmission.  |

Company views on the highlighted parts above in previous agreements/conclusion and specifications:

* Case 5: For out-of-order scheduling, is the rule for OOO scheduling determined based on configured SLIVs or valid SLIVs?
	+ Based on configured SLIVs: Huawei, Ericsson, NTT DOCOMO, MediaTek, Intel
	+ Based on valid SLIVs: ZTE, InterDigital, vivo, OPPO, Apple, Nokia, LG Electronics, Qualcomm
* Case 6: For a first DCI scheduling multiple PDSCHs and providing an inapplicable value of k1 in its PDSCH-to-HARQ\_feedback timing indicator filed, to multiplex the corresponding HARQ-ACK information in a PUCCH or PUSCH in a slot indicated by the PDSCH-to-HARQ\_feedback timing indicator filed in a second DCI, only the [valid] PDSCHs scheduled by the first DCI are considered for definition of the corresponding timeline requirements.
	+ Based on configured SLIVs: Huawei, Ericsson, NTT DOCOMO, Intel
	+ Based on valid SLIVs: ZTE, InterDigital, vivo, Fujitsu, OPPO, Apple, Nokia, Qualcomm

## [Moderator’s note] It can be observed that

* Most companies agree that Case 5 and Case 6 should have a common solution; and
* Slightly more companies prefer “based on valid SLIVs”; and
* For Case 5, current specification can be interpreted as “based on configured SLIVs”; and
* For Case 6, current specification requires further clarification no matter which option is chosen; and
* For Case 5, proponents of “based on configured SLIVs” have a concern on the additional impact on type-1 HARQ-ACK CB with time domain bundling configured, while proponents of “based on valid SLIVs” suggested not to further modify type-1 HARQ-ACK CB.

With those observations, it is suggested to go with one of the following two options:

* **Option 1**: Based on configured SLIVs for Case 5 and Case 6
* **Option 2**: Based on valid SLIVs for Case 5 and Case 6, without further modification on type-1 HARQ-ACK codebook generation

**Companies are encouraged to provide views on which option is preferable or is NOT acceptable.**

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| Company | Views |
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# Issue#4-3: Type-1 HARQ CB for multiple PDSCHs scheduled by single DCI 1-1 and slot-aggregated PDSCH scheduled by DCI 1-2

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| Company | Views |
| [1] Huawei | Proposal 4: Support configuring *enableTimeDomainHARQ-Bundling* for type 1 HARQ codebook feedback for multiple PDSCHs scheduled by single DCI 1-1 and *pdsch-AggregationFactor* for PDSCH scheduled by DCI 1-2 at same time. TP#1 is preferred.---------------------------start of TP#1 for TS 38.213 Clause 9.1.2.1-------------------------------------9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel\*\*\*\*Unchanged Text Omitted\*\*\*\*“elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of the PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of and for each slot from to slot , at least one symbol of the PDSCH time resource derived by row of set *R* is configured as UL if the row of set *R* belongs to time domain resource allocation table configured for DCI format 1\_2”\*\*\*\*Unchanged Text Omitted\*\*\*\*----------------------------end of TP#1 for TS 38.213 Clause 9.1.2.1-------------------------------------- |
| [5] CATT | Proposal 3：Further optimization is not preferred for type-1 HARQ-ACK generation when both are more than 1 and *enableTimeDomainHARQ-Bundling* is provided. Approve TP-1 in Appendix. ------------------------------Start of TP#1 for TS 38.213 Clause 9.1.2.1 ----------------------------------9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel======================== Unchanged Text Omitted ========================else if the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of each PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of . and for each slot from to slot, at least one symbol of the PDSCH time resource derived by row of set *R* is configured as UL-------------------------------------------------End of TP#1---------------------------------------------------- |
| [10] Samsung | Proposal 5: To support multi-PDSCH scheduling by DCI format 1\_1 and PDSCH repetition by DCI format 1\_2 in type-1 HARQ-ACK CB, a row r in the set R’ and the set R is removed when the both conditions are met* Condition 1 for multi-PDSCH scheduling) each SLIVs of the TDRA row r overlapped with a semi-static UL symbol
* Condition 2 for PDSCH repetition) the last SLIV of the TDRA row r over K slots overlapped with a semi-static UL symbol.
* Adopt TP#3 in Appendix for TS38.213

======================= Start of TP #3 for TS 38.213 ========================9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel======================== Unchanged Text Omitted =========================while if the UE is not provided *enableTimeDomainHARQ-Bundling* and is provided *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot from slot to slot , at least one symbol of the PDSCH time resource derived by row is configured as ULwhere is the *k*-th slot timing value in set , where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and the end of the PDSCH time resource for row is not within any UL slot , or if *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* is provided and HARQ-ACK information for PDSCH time resource derived by row in slot cannot be provided in slot ;elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of each PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of and for each slot from to slot , at least one symbol of the PDSCH time resource derived by row of set *R* is configured as UL;;else; end ifend while======================= End of TP #3 for TS 38.213 ========================= |
| [12] Ericsson | Proposal 4 Simultaneous configuration of time domain bundling for multi-PDSCH scheduled by DCI 1\_1 and repetition for PDSCH scheduled by DCI 1\_2 is allowed.Proposal 5 Adopt TP-1 for Type-1 HARQ-ACK codebook in physical uplink control channel (TS 38.213, Section 9.1.2.1) for multi-PDSCH scheduling.-------------------------------Start of TP-1 for TS 38.213 Clause 9.1.2.1 ----------------------------------9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel======================== Unchanged Text Omitted =========================while if the UE is not provided *enableTimeDomainHARQ-Bundling* and is provided *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot from slot to slot , at least one symbol of the PDSCH time resource derived by row is configured as UL if row *r* of set *R* belongs to time domain resource allocation table that only includes single SLIV rows, or at least one symbol of the PDSCH time resource derived by row in slot is configured as UL if row *r* of set *R* belongs to time domain resource allocation table that includes at least one row indicating multiple SLIVs,where is the *k*-th slot timing value in set , where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and the end of the PDSCH time resource for row is not within any UL slot , or if HARQ-ACK information for PDSCH time resource derived by row in slot  cannot be provided in slot ;elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of the PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of and for each slot from to slot , at least one symbol of the PDSCH time resource derived by row of set *R* is configured as UL if the row of set *R* belongs to time domain resource allocation table configured for DCI format 1\_2;;else; end ifend while-------------------------------------------------End of TP-1----------------------------------------------------- |
| [16] Nokia | Proposal 3: Type-1 codebook determination is modified to support PDSCH repetitions also when the HARQ-ACK time domain bundling is configured. Adopt the TP#4 in Appendix.**TP#4: TP#G from [4] for type-1 codebook supporting PDSCH repetitions also with HARQ-ACK time domain bundling**-----------------------------Start of TP#G for TS 38.213 Clause 9.1.2.1 ----------------------------------9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel======================== Unchanged Text Omitted =========================while if the UE is not provided *enableTimeDomainHARQ-Bundling* and is provided *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot from slot to slot , at least one symbol of the PDSCH time resource derived by row is configured as ULwhere is the *k*-th slot timing value in set , where is a DL slot with a smallest index among DL slots overlapping with UL slot , or *subslotLengthForPUCCH* is provided for the HARQ-ACK codebook and the end of the PDSCH time resource for row is not within any UL slot , or if HARQ-ACK information for PDSCH time resource derived by row in slot cannot be provided in slot ;elseif the UE is provided *enableTimeDomainHARQ-Bundling* and *tdd-UL-DL-ConfigurationCommon*, or *tdd-UL-DL-ConfigurationDedicated* and, for each slot , at least one symbol of the PDSCH time resource derived by row of set is configured as UL, where = 0,1,…,, , and is the cardinality of and for each slot from to slot , at least one symbol of the PDSCH time resource derived by row of set *R* is configured as UL;;else; end ifend while------------------------------------------End of TP#G--------------------------------------------- |

## [Moderator’s note] It seems that all companies agree to support multi-PDSCH scheduling by DCI format 1\_1 and PDSCH repetition by DCI format 1\_2 in type-1 HARQ-ACK codebook, but have slightly different views on how to implement it in the specification. Companies are encourage to provide views on which TP is preferable or is NOT acceptable.

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| Company | Views |
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# Issue#4-5: Collision handling between PUSCH and CORESET#0

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| Company | Views |
| [4] Panasonic | Proposal 1: Support to update the previous agreement with the following changeFor multiple PDSCHs (or PUSCHs) scheduled by a single DCI,* Rel-15/16 behavior that is described in TS 38.213 Clauses 11 and 11.1 for a PDSCH (or PUSCH) indicated by DCI also applies for multiple PDSCHs (or PUSCHs) schedule by a single DCI.
* If one of multiple PDSCHs (or PUSCHs) scheduled by the DCI collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*),
	+ If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* ~~[or symbol(s) indicated by~~ *~~pdcch-ConfigSIB1~~* ~~in MIB for a CORESET for Type0-PDCCH CSS set]~~, the HARQ process number increment is skipped for the PUSCH.
	+ Otherwise, the HARQ process number increment is not skipped for that PDSCH (or PUSCH).
 |
| [5] CATT | Proposal 2：If a PUSCH is collided with symbol(s) indicated by *pdcch-ConfigSIB1* in MIB for a CORESET for Type0-PDCCH CSS set, the PUSCH transmission is skipped and the HARQ process number increment is skipped. |
| [14] Apple | Proposal 2: HARQ Process Number is NOT skipped if PUSCH collides with CORESET #0. |
| [19] Intel | Proposal 1* If a PUSCH is collided with symbol(s) indicated by pdcch-ConfigSIB1 in MIB for a CORESET for Type0-PDCCH CSS set, the HARQ process number increment is not skipped for the PUSCH.
* No TP is needed for HARQ process number increment for invalid PUSCH.
 |

Agreement: (RAN1#106bis-e)

For multiple PDSCHs (or PUSCHs) scheduled by a single DCI,

* Rel-15/16 behavior that is described in TS 38.213 Clauses 11 and 11.1 for a PDSCH (or PUSCH) indicated by DCI also applies for multiple PDSCHs (or PUSCHs) schedule by a single DCI.
* If one of multiple PDSCHs (or PUSCHs) scheduled by the DCI collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*),
	+ If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* [or symbol(s) indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set], the HARQ process number increment is skipped for the PUSCH.
	+ Otherwise, the HARQ process number increment is not skipped for that PDSCH (or PUSCH).

Company views on highlighted part above:

* If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* or symbol(s) indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set, the HARQ process number increment is skipped for the PUSCH.
	+ Supported by CATT
	+ Objected by Panasonic, Apple, Intel

## [Moderator’s note] Even though the number of inputs is quite small, it is suggested to go with the direction that is supported by more companies and does not require additional specification impact.

### Proposal #4-5 (Collision btw PUSCH and CORESET#0):

* Update the previous agreement made in RAN1#106bis-e, as follows:
	+ NOTE: No spec change is needed.

Agreement: (RAN1#106bis-e)

For multiple PDSCHs (or PUSCHs) scheduled by a single DCI,

* Rel-15/16 behavior that is described in TS 38.213 Clauses 11 and 11.1 for a PDSCH (or PUSCH) indicated by DCI also applies for multiple PDSCHs (or PUSCHs) schedule by a single DCI.
* If one of multiple PDSCHs (or PUSCHs) scheduled by the DCI collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*),
	+ If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* ~~[or symbol(s) indicated by~~ *~~pdcch-ConfigSIB1~~* ~~in~~ *~~MIB~~* ~~for a CORESET for Type0-PDCCH CSS set]~~, the HARQ process number increment is skipped for the PUSCH.
	+ Otherwise, the HARQ process number increment is not skipped for that PDSCH (or PUSCH).

Companies are encouraged to provide views on Proposal #4-5.

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# Issue#4-10: Clarification on type-2 CB generation when both of spatial bundling and time domain bundling are configured

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| Company | Views |
| [6] vivo | In [1], time domain bundling operation for Type-2 codebook is divided further into two cases, i.e. the case when *harq-ACK-SpatialBundlingPUCCH* is not provided and the case when *harq-ACK-SpatialBundlingPUCCH* is provided. For the latter case, the corresponding description is referred as below.

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| If a UE is provided *numberOfHARQ-BundlingGroups* and *harq-ACK-SpatialBundlingPUCCH* for a serving cell , the UE generates HARQ-ACK information over PDSCH reception groups for PDSCH receptions scheduled by a DCI format on the serving cell where a maximum number of PDSCH reception groups, , is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for the PDSCH receptions as described in clause 9.1.1 by setting and . For a PDSCH reception group associated with at least one PDSCH that does not overlap with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE assumes that TBs provided by a PDSCH that overlaps with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, are correctly received. For a PDSCH reception group associated only with PDSCHs that overlap with UL symbols indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE generates a NACK value for the PDSCH reception group. |

Based on the above description, the UE refers to the description in clause 9.1.1 by setting and to generate HARQ-ACK information bits for the DL scheduling DCI. However, in clause 9.1.1 there is no description about spatial bundling, e.g. binary AND operation of the HARQ-ACK information bits corresponding to first and second transport blocks of all PDSCH receptions in a PDSCH reception group. Therefore, there may be ambiguity on how to perform spatial bundling when time domain bundling is configured for Type-2 codebook.**Proposal 7: For time domain bundling of Type-2 codebook, clarify the corresponding UE behaviour to generate HARQ-ACK information bits for a DL scheduling DCI when spatial bundling is also configured.** |

## [Moderator’s note] Companies are encouraged to comment for above Proposal 7 (e.g., spatial domain bundling first then time domain bundling second). In addition, please provide a TP if needed.

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# Issue#4-11: Introduce an independent formula for type-2 HARQ CB when time domain is not configured but multi-PDSCH scheduling DCI is configured

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| Company | Views |
| [6] vivo | ---------------------------------------------------Start TP2------------------------------------------------------***Reason for change:*** The defined calculation formula is not applicable for the case when the UE is not provided *numberOfHARQ-BundlingGroups* and two sub-codebooks are required.***Summary of change:*** Define a calculation formula for the case when the UE is not provided *numberOfHARQ-BundlingGroups* and two sub-codebooks are required.***Consequences if not approved:*** There is no calculation formula of applicable for the case when the UE is not provided *numberOfHARQ-BundlingGroups* and two sub-codebooks are required.9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel…If a UE is not provided *numberOfHARQ-BundlingGroups*, detects a first DCI format scheduling one PDSCH reception or having associated HARQ-ACK information without scheduling a PDSCH reception, if any, and a second DCI format scheduling more than one PDSCH reception on a serving cell from the serving cells, if any, and the UE would provide corresponding HARQ-ACK information in a same PUCCH, the UE determines the according to the previous pseudo-code with the following modifications- the UE determines a first HARQ-ACK sub-codebook based on each detected DCI format scheduling one PDSCH reception or having associated HARQ-ACK information without scheduling a PDSCH reception, or SPS PDSCH receptions, if any, and- the UE determines a second HARQ-ACK sub-codebook based on each detected DCI format scheduling more than one PDSCH reception, and- instead of generating one HARQ-ACK information bit per transport block for serving cell , the UE generates HARQ-ACK information bits where is the maximum value of across all serving cells, is a maximum number of PDSCH receptions that can be scheduled by a DCI format on serving cell as described in [6, TS 38.214], and is the value of *maxNrofCodeWordsScheduledByDCI* for serving cell if *harq-ACK-SpatialBundlingPUCCH* is not provided; else, . The UE generates the HARQ-ACK information bits in ascending order of the PDSCHs, including any PDSCH that overlaps with UL symbols indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided. If, for serving cell , the UE detects a DCI format that schedules PDSCH receptions and , the UE generates NACK for the last HARQ-ACK information bits- The pseudo-code operation when *PDSCH-CodeBlockGroupTransmission* is provided is not applicable.- The counter DAI value and the total DAI value apply separately for each HARQ-ACK sub-codebook.- The UE generates the HARQ-ACK codebook by appending the second HARQ-ACK sub-codebook to the first HARQ-ACK sub-codebook.If the UE is not provided *numberOfHARQ-BundlingGroups* and  ~~and~~ , the UE also determines for obtaining a PUCCH transmission power, as described in clause 7.2.1, with where- is the number of serving cells each of which is provided *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* in serving cells- if , is the value of the counter DAI in the last DCI format scheduling more than one PDSCH receptions for any serving cell from the serving cells ~~with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information~~ that the UE detects within the PDCCH monitoring occasions- if , is the value of the total DAI in the last DCI format scheduling more than one PDSCH receptions ~~with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information~~ for any serving cell from the serving cells that the UE detects within the PDCCH monitoring occasions- , if the UE does not detect any DCI format scheduling more than one PDSCH receptions ~~with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information~~ for any serving cell from the serving cells in any of the PDCCH monitoring occasions- is the total number of DCI formats scheduling more than one PDSCH receptions ~~with TBG-based HARQ-ACK information or with TB-based HARQ-ACK information~~ for any serving cell from the serving cells that the UE detects within the PDCCH monitoring occasions for serving cell . if the UE does not detect any DCI format scheduling more than one PDSCH receptions for serving cell in any of the PDCCH monitoring occasions- if *harq-ACK-SpatialBundlingPUCCH* is provided,~~- if~~ *~~numberOfHARQ-BundlingGroups~~* ~~is provided, is the number of PDSCH groups that include at least one PDSCH not overlapping with a UL symbol indicated by~~ *~~tdd-UL-DL-ConfigurationCommon~~*~~, or~~ *~~tdd-UL-DL-ConfigurationDedicated~~* ~~if provided, that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH~~- ~~if~~ *~~numberOfHARQ-BundlingGroups~~* ~~is not provided,~~  is the number of PDSCHs that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH- if *harq-ACK-SpatialBundlingPUCCH* is not provided,~~- if~~ *~~numberOfHARQ-BundlingGroups~~* ~~is provided, is the number of TBGs including at least one PDSCH not overlapping with an UL symbol indicated by~~ *~~tdd-UL-DL-ConfigurationCommon~~*~~, or by~~ *~~tdd-UL-DL-ConfigurationDedicated~~* ~~if provided, that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH~~- ~~if~~ *~~numberOfHARQ-BundlingGroups~~* ~~is not provided,~~  is the number of transport blocks in PDSCHs that the UE receives in serving cell from the serving cells in PDCCH monitoring occasion and the UE reports corresponding HARQ-ACK information in the PUCCH.If a UE is provided *numberOfHARQ-BundlingGroups* and is not provided *harq-ACK-SpatialBundlingPUCCH* for a serving cell , the UE generates HARQ-ACK information over transport block groups (TBGs) for PDSCH receptions where, for a maximum number of PDSCH receptions scheduled by a DCI format on the serving cell, a maximum number of TBGs is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for first TBs and, if applicable, generates HARQ-ACK information bits for second TBs in the PDSCH receptions as described in clause 9.1.1 by setting and . For a TBG associated with at least one PDSCH that does not overlap with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE assumes that TB(s) provided by a PDSCH that overlaps with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, are correctly received. For a TBG associated only with PDSCHs that overlap with UL symbols indicated by *tdd-UL-DL-ConfigurationCommon*,or by *tdd-UL-DL-ConfigurationDedicated* if provided, the UE generates a NACK value for the TBG.…--------------------------------------------------End TP2-------------------------------------------------------Proposal 8: For Type-2 codebook of multi-PDSCH scheduling, introduce an independent description for calculation formula of defined for the case when the UE is not provided *numberOfHARQ-BundlingGroups* and two sub-codebooks are required, where the corresponding variables are used; the TP2 can be considered in TS38.213 as a starting point. |

## [Moderator’s note] Companies are encouraged to comment for above Proposal 8 and TP2.

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# (E) Issue#4-12: Clarification on when it is used for the first sub-codebook out of two sub-codebooks

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| Company | Views |
| [6] vivo | ---------------------------------------------------Start TP3------------------------------------------------------***Reason for change:*** When is used as a component to calculate other (than ), identified cases applied only for the equation may not be applicable anymore.***Summary of change:*** Clarify the purpose or covered HARQ-ACK case(s) by when it is used as a component to calculate other (than ).***Consequences if not approved:*** There may be ambiguity on whether the identified cases applied for the equation is also applicable for when it is used as a component to calculate other (than ).9.1.3.1 Type-2 HARQ-ACK codebook in physical uplink control channel…If and , the UE also determines for obtaining a PUCCH transmission power, as described in clause 7.2.1, where corresponds to HARQ-ACK information contained in the first HARQ-ACK sub-codebook, and corresponds to HARQ-ACK information contained in the second HARQ-ACK sub-codebook, with where…--------------------------------------------------End TP3-------------------------------------------------------Proposal 9: Clarify the purpose or applicable case(s) of when it is used as a component to calculate other (than ) to avid ambiguity, and the TP3 can be considered in TS38.213. |

## [Moderator’s note] Do you agree on the above TP3? If not, please provide a reason or alternative TP.

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# (E) Issue#4-13: Reflect the agreement that priority indicator indicated in a multi-PXSCH scheduling DCI is applied to all of scheduled PXSCHs

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| Company | Views |
| [7] NEC | **Proposal 1:** * *Adopt following text change for clause 9 in TS 38.213.*

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| 9 UE procedure for reporting control information[….]If in an active DL BWP a UE monitors PDCCH for detection of DCI format that includes a priority indicator field, a priority index can be provided by the priority indicator field. If a UE indicates a capability to monitor, in an active DL BWP, PDCCH for detection of DCI format that includes a priority indicator field, the DCI format can schedule PUSCH transmission(s) of any priority, or PDSCH reception(s) and/or trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority, and DCI format 1\_1 or DCI format 1\_2 can indicate a TCI state update and trigger a PUCCH transmission with corresponding HARQ-ACK information of any priority. A DCI format indicating a SPS PDSCH release, or SCell dormancy without scheduling a PDSCH reception, or indicating a TCI state update without scheduling PDSCH reception, is referred to as a DCI format having associated HARQ-ACK information without scheduling a PDSCH reception. [….] |

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## [Moderator’s note] Do you agree on the above TP? If not, please provide a reason or alternative TP.

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# Issue#4-16: Restriction on the number of PDSCH receptions/PUSCH transmissions in a slot

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| Company | Views |
| [10] Samsung | We have the following agreements for 480/960 kHz SCS scenario.

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| Agreement: (RAN1#106-e)* For single TRP operation, for 480/960 kHz SCS,
	+ A UE does not expect to be scheduled with more than one unicast PDSCH in a slot, by a single DCI or multiple DCIs.
	+ A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.

**Agreement** (RAN1#107-e)* For multi-TRP operation, for 480/960 kHz SCS,
	+ A UE does not expect to be scheduled with more than one unicast PDSCH in a slot, by a single DCI or multiple DCIs, from the same TRP.
	+ A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs, from the same TRP.
	+ Note: This does not preclude a UE being scheduled with two PDSCHs (or two PUSCHs) in the same slot from two different TRPs for multi-DCI based multi-TRP mechanism.
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If there is SPS PDSCH/CG PUSCH in the slot, UE behaviour is not clear. For example, whether UE can receive a unicast PDSCH and a SPS PDSCH in a slot? The intention of the agreement is to restrict that there is up to 1 PDSCH/PUSCH per slot. Same rule should apply to SPS PDSCH/CG PUSCH. In addition, whether the scheduled PDSCH/PUSCH is a valid one should be clarified.**Proposal 1: For single TRP or multi-TRP operation, for 480/960 kHz SCS,*** + **A UE does not expect to receive more than one unicast PDSCH in a slot on a serving cell from the same TRP.**
	+ **A UE does not expect to transmit more than one PUSCH in a slot on a serving cell from the same TRP.**
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## [Moderator’s note] Companies are encouraged to express whether above Proposal 1 is agreeable or not.

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# (E) Issue#4-18: Reflect the agreement that UE does not apply *pusch-AggregationFactor* to DCI format 0\_1 if multi-PUSCH scheduling DCI is configured

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| Company | Views |
| [13] ASUSTeK | Observation 1: According to current standard, when the UE is configured with *pusch-AggregationFactor* and *pusch-TimeDomainAllocationListForMultiPUSCH-r17,* the number of repetitions *K* for PUSCH scheduled by DCI format 0\_1 is not clear.Proposal 1: RAN1 clarify that the UE does not apply *pusch-AggregationFactor* to DCI format 0\_1 is equivalent to that the number of repetitions *K* is 1. Proposal 2: Adopt the Text proposal 1 or Text proposal 2 in updating of TS38.214 section 6.1.2.1, for determining number of repetitions *K*.

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| **Text proposal 1**6.1.2 Resource allocation 6.1.2.1 Resource allocation in time domain**<Omitted>**For PUSCH repetition Type A, when transmitting PUSCH scheduled by DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1, the number of repetitions *K* is determined as- if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions K is equal to *numberOfRepetitions*;- elseif the UE is configured with *pusch-AggregationFactor* and the transmitting PUSCH is scheduled by DCI format 0\_2, the number of repetitions *K* is equal to *pusch-AggregationFactor*; - elseif the UE is configured with *pusch-AggregationFacto*r, (and the transmitting PUSCH is scheduled by DCI format 0\_1) and not configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17*, the number of repetitions *K* is equal to *puschAggregationFactor*;- otherwise *K=1*.**<Omitted>**If a UE is configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17* 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-TimeDomainAllocationListForMultiPDSCH-r17*.**<Omitted>** |

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| **Text proposal 2**6.1.2 Resource allocation 6.1.2.1 Resource allocation in time domain**<Omitted>**For PUSCH repetition Type A, when transmitting PUSCH scheduled by DCI format 0\_1 or 0\_2 in PDCCH with CRC scrambled with C-RNTI, MCS-C-RNTI, or CS-RNTI with NDI=1, the number of repetitions *K* is determined as- if *numberOfRepetitions* is present in the resource allocation table, the number of repetitions K is equal to *numberOfRepetitions*;- elseif the UE is configured with *pusch-AggregationFactor* and not configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17* for corresponding DCI format, the number of repetitions *K* is equal to *pusch-AggregationFactor*; - otherwise *K=1*.**<Omitted>**If a UE is configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17* 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-TimeDomainAllocationListForMultiPDSCH-r17*.**<Omitted>** |

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## [Moderator’s note] Companies are encouraged to express which TP between above Text proposals 1 and 2 is preferable.

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# Issue#4-21: Clarification on the applicability of K1 set extension for K1 values for DCI 1\_0

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| Company | Views |
| [19] Intel | 3.2 DCI format 1\_0 in Type-1 HARQ-ACK codebookIn the existing Type-1 HARQ-ACK transmission in NR, a DCI format 1\_0 can only be used to schedule a PDSCH transmission if the indicated K1 value belongs to the intersection of the configured set of K1 values for DCI format 1\_1/1\_2 and the predefined set of K1 values for DCI format 1\_0, i.e. {1,2,3,4,5,6,7,8}. The Type-1 HARQ-ACK transmission with time bundling for FR2-2 can be considered as generation of an extended set of K1 values then allocate occasions for candidate PDSCH reception for each of the extended K1 values. The usage of K1 in the current specification in section 9.1.2.1 in 38.213 is organized with the following structure. - in the beginning of the section, the definition of K1 is provided, e.g., by RRC configuration- Then, in the beginning of the pseudo code, the RRC configured K1 set is extended to account the multiple SLIVs of each row in TDRA table- , which replaces RRC configured K1 set with the extended K1 set- in the following pseudo code, it works based on the extended K1 set - finally, after the pseudo code, the term ‘K1’ is used again for one time, which is related to the determination of applicable slot timing values for DCI 1\_0Based on the above analysis, the current specification is already in a logic to handle DCI 1\_0 with the extended K1 set, though there is explicit discussion yet. It is worth noting that such behaviour is beneficial. That is, the applicable slot timing values for DCI 1\_0 can be from the extended K1 set instead of the RRC configured K1 set. In other words, even when the intersection of the predefined K1 values for DCI 1\_0 and the RRC configured K1 set for DCI 1\_1/1\_2 is empty, it is still possible to do schedule based on DCI 1\_0, which provides large flexibility for gNB configuration. Therefore, we prefer to clarify that the intersection of predefined K1 values for DCI 1\_0 and the extended K1 set for DCI 1\_1/1\_2 is applicable to DCI 1\_0. With the clarification, no change to the current specification is needed. Otherwise, the update to the specification is necessary.

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| 9.1.2.1 Type-1 HARQ-ACK codebook in physical uplink control channel… [Intel: definition of K1 and other parameters]set while set to the set of entries for row set to the set of values of entries for row set set to the cardinality of set to the cardinality of set – index of element in set – index of element in while *;*;end whilewhile ;;end while;end while;… [Intel: other pseudo code for Type-1 HARQ-ACK codebook generation]If a UE is provided *dl-DataToUL-ACK* or *dl-DataToUL-ACK-DCI-1-2*, the UE does not expect to be indicated by DCI format 1\_0 a slot timing value for transmission of HARQ-ACK information that does not belong to the intersection of the set of slot timing values {1, 2, 3, 4, 5, 6, 7, 8} for SCS configuration of PUCCH transmission , {7, 8, 12, 16, 20, 24, 28, 32} for , and {13, 16, 24, 32, 40, 48, 56, 64} for , and the set of slot timing values provided by for the active DL BWP of a corresponding serving cell.**…** |

**Proposal 4*** The intersection of predefined K1 values for DCI 1\_0 and the extended K1 set for DCI 1\_1/1\_2 is applicable to DCI 1\_0.
* The current specification already covers the behavior. Hence no specification change is necessary
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## [Moderator’s note] Companies are encouraged to express whether above Proposal 4 is agreeable or not.

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| Company | Views |
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# Reference

1. R1-2203081 Remaining issues of PDSCH/PUSCH enhancement for 52-71GHz spectrum Huawei, HiSilicon
2. R1-2203292 Remaining issues on data channel enhancements for 52.6 to 71GHz ZTE, Sanechips
3. R1-2203371 Remaining issues for PDSCH/PUSCH enhancements to supporting 52.6-71 GHz band in NR InterDigital, Inc.
4. R1-2203401 Discussion on PDSCH/PUSCH enhancements for NR 52.6-71 GHz Panasonic
5. R1-2203432 Remaining issues on PDSCH/PUSCH enhancements for up to 71GHz operation CATT
6. R1-2203510 Maintenance on PDSCH/PUSCH enhancements for NR operation from 52.6GHz to 71GHz vivo
7. R1-2203678 Remaining issues of PDSCH/PUSCH enhancements for 52.6 to 71GHz NEC
8. R1-2203708 Remaining issues of multi-PDSCH/PUSCH scheduling via a single DCI Fujitsu Limited
9. R1-2203784 Remaining issues on PDSCH and PUSCH enhancements for NR 52.6-71GHz xiaomi
10. R1-2203860 Maintenance on PDSCH/PUSCH enhancements for NR from 52.6 GHz to 71 GHz Samsung
11. R1-2203988 Discussion on remaining issue for PDSCH/PUSCH enhancements OPPO
12. R1-2204112 PDSCH-PUSCH Enhancements Ericsson
13. R1-2204190 Discussion on multi-PXSCH scheduling ASUSTeK
14. R1-2204203 On remaining issues for PDSCH PUSCH Enhancements Apple
15. R1-2204340 Remaining issues on PDSCH/PUSCH enhancements for NR in FR2-2 NTT DOCOMO, INC.
16. R1-2204601 Remaining issues on PDSCH/PUSCH enhancements Nokia, Nokia Shanghai Bell
17. R1-2204613 Remaining issues of PDSCH/PUSCH enhancements to support NR above 52.6 GHz LG Electronics
18. R1-2204707 Remaining discussion on multi-PDSCH scheduling design for 52.6-71 GHz NR operation MediaTek Inc.
19. R1-2204768 Discussion on PDSCH/PUSCH enhancements for extending NR up to 71 GHz Intel Corporation
20. R1-2204980 PDSCH and PUSCH enhancements Qualcomm Incorporated

# Appendix: Previous agreements

### RAN1#104-e

Agreement:

* For a UE and for a serving cell, scheduling multiple PDSCHs by single DL DCI and scheduling multiple PUSCHs by single UL DCI are supported.
	+ Each PDSCH or PUSCH has individual/separate TB(s) and each PDSCH/PUSCH is confined within a slot.
	+ FFS: The maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI
	+ FFS: Whether multiple PDSCH scheduling applies to 120 kHz in addition to 480 and 960 kHz
	+ At least for 120 kHz SCS, single-slot scheduling with slot-based monitoring will still be supported as specified in Rel-15/Rel-16
* The followings will not be considered in this WI.
	+ Single DCI to schedule both PDSCH(s) and PUSCH(s)
	+ Single DCI to schedule one or multiple TBs where any single TB can be mapped over multiple slots, where mapping is not by repetition
	+ Single DCI to schedule N TBs (N>1) where a TB can be repeated over multiple slots (or mini-slots)
* Note: This does not imply that existing slot aggregation and/or repetition for PDSCH and PUSCH by single DCI is precluded for the serving cell.

Agreement:

* For a DCI scheduling multiple PDSCHs, HARQ-ACK information corresponding to PDSCHs scheduled by the DCI is multiplexed with a single PUCCH in a slot that is determined based on K1,
	+ where K1 (indicated by the PDSCH-to-HARQ\_feedback timing indicator field in the DCI or provided by *dl-DataToUL-ACK* if the PDSCH-to-HARQ\_feedback timing indicator field is not present in the DCI) indicates the slot offset between the slot of the last PDSCH scheduled by the DCI and the slot carrying the HARQ-ACK information corresponding to the scheduled PDSCHs.
		- It is noted that granularity of K1 can be separately discussed.
* FFS: If needed, further discuss whether or not HARQ-ACK information corresponding to different PDSCHs scheduled by the DCI can be carried by different PUCCH(s)

Agreement:

For generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the following alternatives can be considered to DAI counting and will be down-selected in RAN1#104bis-e.

* Alt 1: C-DAI/T-DAI is counted per DCI.
* Alt 2: C-DAI/T-DAI is counted per PDSCH.
* Alt 3: C-DAI/T-DAI is counted per M scheduled PDSCH(s), where M is configurable (e.g., 1, 2, 4, …).
* FFS: Codebook generation details
* FFS: How to signal DAI values (e.g., increase of DAI bits for Alt 2 and Alt 3)
* FFS: Whether to apply time domain bundling of HARQ-ACK feedback

Agreement:

The multi-PUSCH scheduling defined in Rel-16 NR-U is the baseline for multi-PUSCH scheduling in Rel-17.

* FFS: Applicability to multi-PDSCH scheduling.

Agreement:

* For the multi-PUSCH scheduling in Rel-17, study the enhancement of the following in addition to Rel-16 multi-PUSCH scheduling.
	+ CBGTI: Whether or not CBG (re)transmission is supported when more than one PUSCHs are scheduled (Already supported when only one PUSCH is scheduled).
	+ CSI-request: Whether to apply same or different rule compared to Rel-16 (e.g., the PUSCH that carries the AP-CSI feedback is the first PUSCH that satisfies the multiplexing timeline).
	+ TDRA: Down-select among
		- Alt 1: TDRA table is extended such that each row indicates up to [X, FFS for X] multiple PUSCHs (continuous in time-domain). 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 TDRA table signalled in DCI.
		- Alt 2: TDRA table is extended such that each row indicates up to [X, FFS for X] multiple PUSCHs (that can be non-continuous in time-domain). 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 TDRA table signalled in DCI.
		- Alt 3: TDRA table is extended such that each row indicates up to 8 multiple PUSCH groups (that can be non-continuous between PUSCH groups). Each PUSCH group has a separate SLIV, mapping type and number of slots/PUSCHs N. Within each PUSCH group, N PUSCHs occupy the same OFDM symbols indicated by the SLIV and mapping type. The number of scheduled PUSCHs is the sum of number of PUSCHs in all PUSCH groups in the row of the TDRA table signalled in DCI.
	+ FDRA: Whether/how to enhance FDRA e.g., by increasing RBG size or changing allocation granularity
	+ Frequency hopping: Whether/how to support frequency hopping for scheduled PUSCHs, e.g., inter-PUSCH/intra-PUSCH hopping
	+ URLLC related fields such as priority indicator and open-loop power control parameter set indication: Whether/how to apply URLLC related fields for scheduled PUSCHs
	+ Applicability to multi-PDSCH scheduling in Rel-17.
	+ Note: Other enhancements are not precluded.

### RAN1#104bis-e

Agreement:

* The maximum number of PDSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 480 and 960 kHz.
	+ FFS: Further restrictions for 480 kHz to 4
	+ FFS: A UE capability to select between 4 and 8 for 480 kHz SCS
	+ Note: Multi-PDSCH scheduling for the case of 120 kHz SCS is still FFS as per prior agreement. This case can be addressed after this FFS has been decided.
* The maximum number of PUSCHs that can be scheduled with a single DCI in Rel-17 is 8.
	+ FFS: Further restrictions for 120 kHz and 480 kHz SCS
	+ FFS: A UE capability to select between different values for 120 kHz and 480 kHz SCS

Agreement:

For a DCI that can schedule multiple PDSCHs,

* MCS for the 1st TB: This appears only once in the DCI and applies commonly to the first TB of each PDSCH
* NDI for the 1st TB: This is signaled per PDSCH and applies to the first TB of each PDSCH
* RV for the 1st TB: This is signaled per PDSCH, with 2 bits if only a single PDSCH is scheduled or 1 bit for each PDSCH otherwise and applies to the first TB of each PDSCH
* HARQ process number: This applies to the first scheduled PDSCH and is incremented by 1 for subsequent PDSCHs (with modulo operation, if needed)
* FFS:
	+ MCS/NDI/RV for the 2nd TB for each PDSCH, including whether scheduling of the 2nd TB for each PDSCH can be supported or not
	+ Details of resource allocation related fields such as VRB-to-PRB mapping, PRB bundling size indicator, rate matching indicator, and ZP CSI-RS trigger
	+ Whether/how to signal CBGFI/CBGTI if CBGFI/CBGTI is supported for multi-PDSCH scheduling
	+ Details of fields that are common with multi-PUSCH scheduling, e.g., TDRA, FDRA, priority indicator, including potential enhancements

Agreement:

* For a DCI that can schedule multiple PUSCHs,
	+ TDRA: Alt 2 (TDRA table is extended such that each row indicates up to 8 multiple PUSCHs (that can be non-continuous in time-domain). Each PUSCH has a separate SLIV and mapping type. The number of scheduled PUSCHs is implicitly indicated by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.), as per agreement made in RAN1#104-e
		- FFS: signaling details
	+ Note: Alt 2 does not preclude continuous resource allocation in time-domain.
* For a DCI that can schedule multiple PDSCHs,
	+ TDRA: TDRA table is extended such that each row indicates up to 8 multiple PDSCHs (that can be non-continuous in time-domain). Each PDSCH has a separate SLIV and mapping type. The number of scheduled PDSCHs is implicitly indicated by the number of indicated valid SLIVs in the row of the TDRA table signalled in DCI.
		- FFS: signaling details
	+ Note: This does not preclude continuous resource allocation in time-domain.
	+ Note: Multi-PDSCH scheduling for the case of 120 kHz SCS is still FFS as per prior agreement. This case can be addressed after this FFS has been decided.

Agreement:

For enhancements of generating type-1 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the following options can be considered,

* Option 1: The set of candidate PDSCH reception occasions is determined according to each SLIV of each row in the TDRA table and based on extension of K1 set
* Option 1a: The set of candidate PDSCH reception occasions is determined according to each SLIV of each row in the TDRA table
* Option 2: The set of candidate PDSCH reception occasions is determined according to the last SLIV of each row in the TDRA table
* FFS: Codebook generation details, including how to handle the collision with TDD DL/UL configuration and whether/how to extend K1 set based on K1 and slot offset between last PDSCH and other PDSCHs in a row in the TDRA table

Conclusion:

The following is observed for alternative 1 from prior agreement.

* For Alt 1 (C-DAI/T-DAI is counted per DCI) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ C-DAI/T-DAI in DL DCI: Same DAI overhead with Rel-16 single-PDSCH DCI
	+ T-DAI in UL DCI:
		- In case of single codebook handling feedback for both single and multi-PDSCH scheduling, same DAI overhead with Rel-16 UL DCI
		- In case of separate sub-codebooks, need additional DAI field (with same bit-width of DAI with Rel-16 UL DCI), in UL DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
			* Note that DAI field increment for this case is similar for the case in Rel-15 where CBG is configured
	+ HARQ-ACK codebook generation:
		- A separate sub-codebook can be generated when multi-PDSCH DCI is configured for a serving cell, similar to the way as 2nd sub-codebook is defined to handle CBG-based scheduling
			* FFS: whether single codebook or separate sub-codebooks is(are) generated when multi-PDSCH DCI is configured for a serving cell
			* FFS: how many sub-codebooks are generated when multi-PDSCH DCI is configured for a serving cell and CBG is configured for the serving cell and/or the other serving cell(s)
		- HARQ-ACK payload size is increased compared to single PDSCH scheduling only, since the number of HARQ-ACK bits corresponding to each DAI of the (sub-)codebook for multi-PDSCH DCI in case of separate sub-codebooks (or for all DL DCIs in case of single codebook) depends on the maximum configured number of PDSCHs for multi-PDSCH DCI across serving cells belonging to the same PUCCH cell group.
		- The number of HARQ-ACK bits for multi-PDSCH DCI in case of separate sub-codebooks, or for all DL DCIs in case of single codebook, does not depend on the number of actually scheduled PDSCHs, rather, it is fixed as the maximum configured number of PDSCHs.
		- FFS: time domain bundling of HARQ-ACK feedback, as per agreement in RAN1#104-e
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

Conclusion:

The following is observed for alternative 2 from prior agreement.

* For Alt 2a (C-DAI/T-DAI is counted per PDSCH with a single codebook) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ C-DAI/T-DAI in DL DCI: Bit-width can be increased (FFS: by how much), in DL DCI not only for multi-PDSCH DCI but also for single-PDSCH DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
	+ T-DAI in UL DCI: Bit-width can be increased (FFS: by how much), in UL DCI for all serving cells including a serving cell not configured with multi-PDSCH DCI
	+ C-DAI/T-DAI in DL DCI and T-DAI in UL DCI shall be designed such that at most 3 consecutive DCI missing can be resolved, same as in Rel-15/16 NR.
		- FFS: details on increment of DAI field size
		- FFS: whether/how to handle the case where different DCI formats (e.g., DCI format 1\_0 and DCI format 1\_1) have different field sizes for C-DAI/T-DAI
	+ HARQ-ACK codebook generation:
		- The number of HARQ-ACK bits depends on the number of scheduled PDSCHs.
		- FFS: ordering of the PDSCHs for DAI counting
		- FFS: time domain bundling of HARQ-ACK feedback, as per agreement in RAN1#104-e
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

Conclusion:

The following is observed for alternative 3 from prior agreement.

* For Alt 3 (C-DAI/T-DAI is counted per M scheduled PDSCH(s), where M is configurable) of generating type-2 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs,
	+ If M equals to the maximum configured number of PDSCHs, Alt 3 is the same with Alt 1, if the same number of codebooks is assumed.
	+ Else if M equals to 1, Alt 3 is the same with Alt 2.
	+ Otherwise (i.e., 1<M<the maximum configured number of PDSCHs), Alt 3 is similar to Alt 2, except that
		- The number of HARQ-ACK bits corresponding to each DAI increases by M times.
		- NACK bits may be padded if the number of scheduled PDSCHs is not an integer multiple of M.
		- FFS: details on DAI field size
		- FFS: whether single codebook or separate sub-codebooks is(are) generated when multi-PDSCH DCI is configured for a serving cell
	+ In addition, new RRC parameter to configure M needs to be introduced.
	+ Note that multi-PDSCH DCI refers to a DL DCI where at least one entry of the TDRA table allows scheduling more than one PDSCH

### RAN1#105-e

Agreement:

* Do not use fallback DCI (i.e., DCI formats 0\_0 and 1\_0) for multi-PDSCH/PUSCH scheduling.
* Use DCI format 0\_1 to schedule multiple PUSCHs with a single DCI.
* Use DCI format 1\_1 to schedule multiple PDSCHs with a single DCI.

Conclusion:

For a DCI that can schedule multiple PUSCHs,

* CSI-request: When the DCI schedules M PUSCHs, the PUSCH that carries the aperiodic CSI feedback is M-th scheduled PUSCH for M <= 2, or (M-1)-th scheduled PUSCH for M > 2.

Agreement:

* If a PDSCH among multiple PDSCHs that are scheduled by a single DCI is collided with uplink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, the UE does not receive the PDSCH.
	+ FFS on how to handle HARQ-related issue for the PDSCH (e.g., HARQ process numbering)
* The UE does not expect to be scheduled with multiple PDSCHs by a single DCI, where every PDSCH is collided with uplink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*.
* If a PUSCH among multiple PUSCHs that are scheduled by a single DCI is collided with downlink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, the UE does not transmit the PUSCH.
	+ FFS on how to handle HARQ-related issue for the PUSCH (e.g., HARQ process numbering)
* The UE does not expect to be scheduled with multiple PUSCHs by a single DCI, where every PUSCH is collided with downlink symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*.

Agreement:

For TDRA in a DCI that can schedule multiple PDSCHs (or PUSCHs),

* A row of the TDRA table can indicate PDSCHs (or PUSCHs) that are in consecutive or non-consecutive slots.
	+ FFS: The maximum value of the gap between two consecutively scheduled PDSCHs or between two consecutively scheduled PUSCHs
	+ FFS: The maximum value of the gap between the first scheduled PDSCH and the last scheduled PDSCH or between the first scheduled PUSCH and the last scheduled PUSCH
	+ FFS: Details to introduce the gap between PDSCHs or between PUSCHs

Agreement:

For enhancements of generating type-1 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the set of candidate PDSCH reception occasions corresponding to a UL slot with HARQ-ACK transmission is determined based on a set of DL slots and a set of SLIVs corresponding to each DL slot belonging to the set of DL slots.

* The set of DL slots includes all the unique DL slots that can be scheduled by any row index r of TDRA table in DCI indicating the UL slot as HARQ-ACK feedback timing.
* The set of SLIVs corresponding to a DL slot (belonging to the set of DL slots) at least include all the SLIVs that can be scheduled within the DL slot by any row index r of TDRA table in DCI indicating the UL slot as HARQ-ACK feedback timing.
	+ FFS: details of further pruning of the set of SLIVs
	+ FFS: impact if receiving more than one PDSCH in a slot is allowed, e.g., handling of overlapped SLIVs from different rows in the same and different DL slot
	+ FFS impact of time domain bundling, if supported

Agreement:

* At least for 120 kHz SCS, for a DCI that can schedule multiple PUSCHs and is configured with the TDRA table containing at least one row with multiple SLIVs,
	+ If CBG-based (re)transmission is configured, CBGTI field is not present when more than one PUSCHs are scheduled, but is present when a single PUSCH is scheduled, as in Rel-16.
* FFS:
	+ For 480/960 kHz SCS, whether to apply the same behavior with 120 kHz SCS or not to support CBGTI field configuration in the DCI that can schedule multiple PUSCHs
	+ For a DCI that can schedule multiple PDSCHs and is configured with the TDRA table containing at least one row with multiple SLIVs, whether/how to configure CBGTI/CBGFI fields

Agreement:

If Alt 1 (C-DAI/T-DAI is counted per DCI) is adopted for generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* At least two sub-codebooks are generated for a PUCCH cell group where
	+ The first sub-codebook is for the following cases:
		- Any DCI that is not configured with CBG-based scheduling and is configured with TDRA table containing rows each with a single SLIV
		- Any DCI that is not configured with CBG-based scheduling and is configured with TDRA table containing at least one row with multiple SLIVs and schedules only a single PDSCH
	+ The second sub-codebook is for the following case:
		- Any DCI that is configured with TDRA table containing at least one row with multiple SLIVs and schedules multiple PDSCHs
			* FFS: Methods (if needed) to align the size of HARQ-ACK feedback corresponding to different DCIs
			* FFS: Whether HARQ-ACK bits for 2 PDSCHs scheduled by this DCI can be included in the first sub-codebook in some cases
	+ FFS: SPS PDSCH release, SCell dormancy indication without scheduled PDSCH
* FFS: 2 or 3 sub-codebooks if CBG is configured for a serving cell in the PUCCH cell group
* FFS: impact of time domain bundling, if supported, e.g., the number of sub-codebooks including single codebook if all A/N bits are bundled into a single bit per DCI

Agreement:

If Alt 2 (C-DAI/T-DAI is counted per PDSCH) is adopted for generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* PDSCH(s) scheduled by a single DCI is counted firstly, serving cell(s) in the same PUCCH cell group and same PDCCH monitoring occasion is counted secondly, and PDCCH monitoring occasion(s) is counted thirdly.
* The bit width of counter DAI field in fallback DCI (i.e., DCI formats 0\_0 and 1\_0) remains the same as in Rel-15 NR.
* Note: The DAI bit width and number of sub-codebooks shall ensure that at most 3 consecutive missed DCIs can be resolved, same as in Rel-15/16 NR
	+ This shall not impose additional gNB’s scheduling restriction.
* In case where CBG retransmission is not configured for any serving cell in a same PUCCH cell group, the number of bits for each of counter DAI and total DAI in non-fallback DCI is extended (if needed) at least based on
	+ The number of SLIVs associated with the row indexes in TDRA table
		- FFS: details
* FFS: the case with configuration of CBG retransmission
* FFS: the number of sub-codebooks
* FFS: for the UE indicating by *type2-HARQ-ACK-Codebook* support for more than one PDSCH reception on a serving cell that are scheduled from a same PDCCH monitoring occasion

### RAN1#106-e

Working assumption:

Scheduling multiple PDSCHs by single DL DCI applies to 120 kHz in addition to 480 and 960 kHz at least in FR2-2.

* FFS: Further limitations on maximum number of PDSCHs

Agreement:

Adopt Alt 1 (C-DAI/T-DAI is counted per DCI) for generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs.

Agreement:

* The maximum number of PDSCHs/PUSCHs that can be scheduled with a single DCI in Rel-17 is 8 for SCS of 120, 480 and 960 kHz.
* FFS: Whether UE capability is introduced for restricting the maximum number of PDSCHs or PUSCHs that can be scheduled with a single DCI

Agreement:

If a scheduled PDSCH/PUSCH is dropped due to collision with UL/DL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, HARQ process number increment is skipped for the PDSCH/PUSCH and applied only for valid PDSCH(s)/PUSCH(s).

* FFS: HARQ process number determination for the case where a scheduled PDSCH/PUSCH collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*) if the UE is configured to monitor DCI format 2\_0.

Agreement:

* For a DCI that can schedule multiple PUSCHs,
	+ Priority indicator and open loop power control parameter set indication fields are applied to all of scheduled PUSCHs.
* For a DCI that can schedule multiple PDSCHs,
	+ Priority indicator field is applied to all of scheduled PDSCHs.

Agreement:

For TDRA in a DCI that can schedule multiple PDSCHs (or PUSCHs),

* A row of the TDRA table can indicate PDSCHs (or PUSCHs) that are in consecutive or non-consecutive slots, by configuring {SLIV, mapping type, scheduling offset K0 (or K2)} for each PDSCH (or PUSCH) in the row of TDRA table.
* Note: Whether and how to reduce RRC overhead is left to RAN2.

Agreement:

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.

Working assumption:

For NR FR2-2, two codeword transmission is supported, subject to UE capability.

* RRC parameter configures whether two codeword transmission is enabled or disabled.
	+ FFS: Details on signaling of MCS/NDI/RV for the second TB in a DCI that can schedule multiple PDSCHs when two codeword transmission is enabled
	+ FFS: Whether unified or separate parameter to enable/disable 2-TB for single and for multiple PDSCH scheduling
	+ Strive to minimize the increase in the number of bits in the DCI needed to support this feature

Agreement:

* For single TRP operation, for 480/960 kHz SCS,
	+ FFS: A UE does not expect to be scheduled with more than one PDSCH in a slot, by a single DCI or multiple DCIs.
	+ FFS: A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.
* For single TRP operation, for 120 kHz SCS (same as current specification for FR2-1 for PUSCH),
	+ Subject to UE capability, a UE can be scheduled with more than one PDSCH in a slot, by a single DCI or multiple DCIs.
	+ Subject to UE capability, a UE can be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.
* FFS for multi-TRP operation
* Note: The optimization of HARQ codebook size for Type 1 or Type 2 codebook design is considered as a low priority in Rel-17 (this does not preclude HARQ ACK bundling in time domain).
* The agreement made in RAN1#105-e is revised as follows.

|  |
| --- |
| Agreement: (RAN1#105-e)For enhancements of generating type-1 HARQ-ACK codebook corresponding to DCI that can schedule multiple PDSCHs, the set of candidate PDSCH reception occasions corresponding to a UL slot with HARQ-ACK transmission is determined based on a set of DL slots and a set of SLIVs corresponding to each DL slot belonging to the set of DL slots.* The set of DL slots contains all the unique DL slots determined by considering all combinations of the configured K1 values and the configured rows of the TDRA table.
* The set of SLIVs corresponding to a DL slot (belonging to the set of DL slots) contains all the SLIVs for that slot determined by considering all combinations of the configured K1 values and the configured rows of the TDRA table.
* The Rel-16 procedure is reused for determining the candidate PDSCH reception occasions for the set of SLIVs corresponding to each DL slot belonging to the set of DL slots
	+ Note: The Rel-16 procedure already handles pruning of multiple SLIVs corresponding to a DL slot, for both UEs that are and are not capable of receiving multiple PDSCHs per slot
	+ FFS impact of time domain bundling, if supported
 |

Agreement:

Consider the following options to construct type-2 HARQ-ACK codebook when CBG operation is configured, and down-select to one of the following options in RAN1#106bis-e.

* Option 1: HARQ-ACK bits corresponding to CBG-based PDSCH reception and multi-PDSCH reception are merged into the same sub-codebook.
* Option 2: HARQ-ACK bits corresponding to CBG-based PDSCH reception and HARQ-ACK bits corresponding to multi-PDSCH reception are contained in separate sub-codebooks.
* Option 3: UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the same PUCCH cell group.
* Note: Multi-PDSCH reception refers to the case where multiple PDSCHs are scheduled by a DCI that is configured with TDRA table containing at least one row with multiple SLIVs.

Agreement:

For NR FR2-2 at least for 480/960 kHz SCS, support 32 as the maximum number of HARQ processes for DL and UL, subject to UE capability.

* Note: Up to 32 maximal supported HARQ process number is already agreed in Rel-17 NTN WI.
* Working assumption: The same solution to support up to 32 HARQ process number in Rel-17 NTN WI is reused for NR FR2-2.

### RAN1#106bis-e

Agreement:

Confirm the working assumption from RAN1#106-e with the following modification.

Working assumption: (RAN1#106-e)

Scheduling multiple PDSCHs by single DL DCI applies to 120 kHz in addition to 480 and 960 kHz at least in FR2-2.

* ~~FFS: Further limitations on maximum number of PDSCHs~~
* Note: Further limitations (in addition to what was agreed earlier) on the maximum number of PDSCHs or PUSCHs can be separately discussed for all SCSs.

Working assumption:

UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the same PUCCH cell group with a Type 2 codebook.

* If time bundling operation is supported, this working assumption can be revisited

Agreement:

For a PDSCH that is scheduled by multi-PDSCH scheduling DCI and is skipped due to collision with semi-static UL symbol(s),

* For Type-1 HARQ-ACK codebook generation, the PDSCH is not considered and the HARQ-ACK bit corresponding to the PDSCH is not reported by UE.
	+ Note: Rel-16 procedure can be reused to handle this case.
* For Type-2 HARQ-ACK codebook generation, UE reports NACK for the PDSCH.
	+ FFS on HARQ-ACK bit ordering
* Note: Codebook generation in case time domain bundling is enabled can be separately discussed if time domain bundling is supported.

Agreement:

For generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs,

* HARQ-ACK bit corresponding to SPS PDSCH release or SCell dormancy indication without scheduled PDSCH, belongs to the first sub-codebook (which is defined in the previous agreement made in RAN1#105-e)

Agreement:

For two multi-PDSCH (or two multi-PUSCH) scheduling DCIs, UE does not expect any of the scheduled PDSCHs (or PUSCHs) and the scheduling DCI to lead to out-of-order scheduling.

* FFS: whether to allow OOO scheduling for the following two cases:
	+ for the case of one multi-PDSCH (or multi-PUSCH) scheduling DCI and one single-PDSCH (or single-PUSCH) scheduling DCI, where multi-PDSCH (or multi-PUSCH) scheduling DCI schedules more than one PDSCH (or PUSCH)
	+ for the case where two multi-PDSCH (or multi-PUSCH) scheduling DCIs end in the same symbol but two multi-PDSCH (or multi-PUSCH) scheduling DCIs have overlapping spans, where the span is defined from the beginning of the first scheduled SLIV till the end of the last scheduled SLIV
* Note: The above FFS aspect applies only to multi-PDSCH and multi-PUSCH scheduling with single DCI

Agreement:

For multiple PDSCHs (or PUSCHs) scheduled by a single DCI,

* Rel-15/16 behavior that is described in TS 38.213 Clauses 11 and 11.1 for a PDSCH (or PUSCH) indicated by DCI also applies for multiple PDSCHs (or PUSCHs) schedule by a single DCI.
* If one of multiple PDSCHs (or PUSCHs) scheduled by the DCI collides with a flexible symbol (indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*),
	+ If that PUSCH is collided with SSB symbols indicated by *ssb-PositionsInBurst* [or symbol(s) indicated by *pdcch-ConfigSIB1* in *MIB* for a CORESET for Type0-PDCCH CSS set], the HARQ process number increment is skipped for the PUSCH.
	+ Otherwise, the HARQ process number increment is not skipped for that PDSCH (or PUSCH).

Conclusion:

For a DCI that can scheduled multiple PDSCHs (or PUSCHs), HARQ process number indicated in the DCI is applied to the first valid PDSCH (or PUSCH).

* Note: This is the consequence of previous agreements.

Agreement:

For single TRP operation, for 480/960 kHz SCS,

* A UE does not expect to be scheduled with more than one unicast PDSCH in a slot, by a single DCI or multiple DCIs.
* A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs.

Agreement:

For a DCI that can schedule multiple PDSCHs, and if RRC parameter configures that two codeword transmission is enabled,

* MCS for the 2nd TB: This appears only once in the DCI and applies commonly to the 2nd TB of each PDSCH
* NDI for the 2nd TB: This is signaled per PDSCH and applies to the 2nd TB of each PDSCH
* RV for the 2nd TB: This is signaled per PDSCH, with 2 bits if only a single PDSCH is scheduled or 1 bit for each PDSCH otherwise and applies to the 2nd TB of each PDSCH
* FFS: the maximum number of PDSCHs when 2 TB is enabled or when 2 TB is scheduled

### RAN1#107-e

**Agreement**

* For multi-PDSCH or multi-PUSCH scheduling DCI, FDRA enhancement is deprioritized in Rel-17.

**Agreement**

* For multi-TRP operation, for 480/960 kHz SCS,
	+ A UE does not expect to be scheduled with more than one unicast PDSCH in a slot, by a single DCI or multiple DCIs, from the same TRP.
	+ A UE does not expect to be scheduled with more than one PUSCH in a slot, by a single DCI or multiple DCIs, from the same TRP.
	+ Note: This does not preclude a UE being scheduled with two PDSCHs (or two PUSCHs) in the same slot from two different TRPs for multi-DCI based multi-TRP mechanism.

**Agreement**

* For a DCI that can schedule multiple PDSCHs, CBGTI and CBGFI fields are not present in the DCI.
* UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the serving cell with a Type 1 codebook.
* Confirm the working assumption from RAN1#106bis-e with the following modification.

Working assumption: (RAN1#106bis-e)

* UE does not expect to be configured with both of CBG operation and multi-PDSCH scheduling in the same PUCCH cell group with a Type 2 codebook.
	+ ~~If time bundling operation is supported, this working assumption can be revisited~~

**Agreement**

For 480/960 kHz SCS, CBG-based HARQ cannot be configured for uplink and downlink.

**Agreement**

* The maximum number of PDSCHs that can be scheduled with a single DCI in Rel-17 is also 8 when 2 TB is enabled or when 2 TB is scheduled, for SCS of 120, 480 and 960 kHz.
	+ Note: This is to handle FFS (the maximum number of PDSCHs when 2 TB is enabled or when 2 TB is scheduled) in previous agreement in RAN1#106bis-e.

**Agreement**

For multi-PUSCH scheduling DCI in Rel-17, support intra-slot frequency hopping which is applicable to each of multiple PUSCH transmissions scheduled by the DCI, and do not support inter-slot frequency hopping.

**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

**Agreement**

* If a UE is configured with a TDRA table in which one or more rows contain multiple SLIVs for PDSCH for DCI format 1\_1, the UE does not expect to be configured with *repetitionNumber* for the TDRA table, and if *pdsch-AggregationFactor* is configued in *PDSCH-config*, it does not apply to DCI format 1\_1.
	+ Note: *repetitionNumber* cannot be configured with *pdsch-TimeDomainAllocationListDCI-1-2* as in Rel-16.
	+ Note: Under agenda item 8.2.4, in RAN1#106-bis, it was already agreed that within the TDRA table for multi-PDSCH scheduling, the UE does not expect to be configured with the higher layer parameter *repetitionNumber*.
	+ Note: These does not preclude *pdsch-AggregationFactor* can be configured and applies to DCI format 1\_2
* If a UE is configured with a TDRA table in which one or more rows contain multiple SLIVs for PUSCH for DCI format 0\_1, the UE does not expect to be configured with *numberOfRepetitions* for the TDRA table, and if *pusch-AggregationFactor* is configued in *PUSCH-config*, it does not apply to DCI format 0\_1.
	+ Note: These does not preclude *numberOfRepetitions* is configured for TDRA table corresponding to DCI format 0\_2
	+ Note: These does not preclude *pusch-AggregationFactor* can be configured and applies to DCI format 0\_2

**Agreement**

* For type-2 HARQ-ACK codebook generation, HARQ-ACK bit ordering is based on configured SLIV position in the indicated TDRA row index, regardless of the validity of each scheduled PDSCH.

**Agreement**

* There is no consensus in RAN1 to support that HARQ-ACK information corresponding to different PDSCHs scheduled by a single DCI is carried over multiple PUCCHs in Rel-17.

**Agreement**

For multi-PDSCH scheduling with a single DCI

* Introduce a new RRC parameter, e.g., *numberOfHARQ-BundlingGroups*, to configure the number of HARQ bundling groups with value range {1, 2, 4} for type-2 HARQ-ACK codebook per serving cell.
	+ If the RRC parameter is not configured for a serving cell, time domain bundling for type-2 HARQ-ACK codebook is not enabled for the serving cell.
	+ The maximum number of PDSCHs allocated to each bundling group is ceil(NPDSCH,MAX/NHBG) where NHBG is the number of bundling groups configured by *numberOfHARQ-BundlingGroups* for a serving cell and NPDSCH,MAX is the maximum configured number of PDSCHs for the serving cell.
	+ The PDSCHs corresponding to [configured or valid] SLIVs in a TDRA row index indicated by multi-PDSCH scheduling DCI are allocated to the bundling groups, e.g., if NHBG =4, NPDSCH,MAX =8, and 5 PDSCHs are scheduled, then 2/1/1/1 PDSCHs are assigned to each group, by reusing CBG grouping method.
		- For a group that is empty or is filled with only invalid PDSCH(s), HARQ-ACK bits for the bundling group is set to NACK (same principle as when no time bundling configured)
		- Logical AND operation is applied to across all valid PDSCHs within the same bundling group to generate 1 HARQ-ACK bit per group, at least for 1-TB case
	+ If the number of HARQ bundling groups is configured as 1 for a serving cell, HARQ-ACK bits corresponding to any DCI for the serving cell belong to the first sub-codebook.
	+ At least for 1-TB case, if the number of HARQ bundling groups is configured as larger than 1 for a serving cell, HARQ-ACK bits corresponding to multi-PDSCH scheduling case (which implies a multi-PDSCH DCI schedules more than one PDSCH) for the serving cell belong to the second sub-codebook,
		- Where the number of HARQ-ACK bits corresponding to a multi-PDSCH DCI is determined based on the maximum of Q value across all serving cells within the same PUCCH cell group, and Q=maximum configured number of PDSCHs for a cell without *numberOfHARQ-BundlingGroups* configured or Q=number of configured HARQ bundling groups for a cell with *numberOfHARQ-BundlingGroups* configured

### RAN1#107bis-e

**Agreement**

* In NR FR2-2, a UE supporting 32 maximum number of HARQ processes for 480/960 kHz SCS for DL (or for UL) shall support 32 as the maximum number of HARQ processes for 120 kHz SCS for DL (or UL), subject to UE capability.

**Agreement**

* If the higher layer parameter *maxNrofCodeWordsScheduledByDCI* indicates that two codeword transmission is enabled and more than one PDSCH is scheduled by a multi-PDSCH scheduling DCI,
	+ Either the first or the second transport block of all scheduled PDSCHs is disabled by the DCI if *IMCS* = 26 and if RV bits are set to ‘1’ for the corresponding transport block of all scheduled PDSCHs (i.e. irrespective of whether this is a valid PDSCH).

**Conclusion**

For multi-PDSCH or multi-PUSCH scheduling DCI, the following maximum value of a gap is not specified in Rel-17 and up to gNB scheduler.

* The maximum value of the gap between two consecutively scheduled PDSCHs or between two consecutively scheduled PUSCHs
* The maximum value of the gap between the first scheduled PDSCH and the last scheduled PDSCH or between the first scheduled PUSCH and the last scheduled PUSCH

**Conclusion**

HARQ process number configured for SPS PDSCH (or CG PUSCH) can be allocated to a PDSCH (or PUSCH) of multi-PDSCH (or multi-PUSCH) scheduling, as long as the timeline condition defined in Rel-15/16 is met.

* Note: It is up to gNB implementation whether/how to avoid UL data retransmission due to HARQ process index collision and flushed HARQ transmit buffer.

**Agreement**

* Update the previous agreement made in RAN1#107-e, as follows:

**Agreement** (RAN1#107-e)

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~~

**Agreement**

For multi-PDSCH scheduling with a single DCI and for type-2 HARQ-ACK codebook generation,

* Time domain bundling and spatial bundling can be independently configured.

**Conclusion**

* UE does not expect any of the scheduled PDSCHs (or PUSCHs) and the scheduling DCIs to lead to out-of-order scheduling, also for the case of one multi-PDSCH (or multi-PUSCH) scheduling DCI and one single-PDSCH (or single-PUSCH) scheduling DCI, where multi-PDSCH (or multi-PUSCH) scheduling DCI schedules more than one PDSCH (or PUSCH).
	+ This may not have specification impact.
* Note: It is separately discussed whether the scheduled PDSCHs (or PUSCHs or SLIV) is based on configured SLIV or valid SLIV.

**Conclusion**

UE does not expect any of the received PDSCHs (including SPS PDSCH) and the resource for the HARQ-ACK transmission to lead to out-of-order scheduling, for any scheduling DCIs (including multi-PDSCH scheduling DCI).

**Agreement**

For a DCI that can schedule multiple PDSCHs or multiple PUSCHs,

* It is clarified that NDI/RV fields in the following previous agreements correspond to scheduled PDSCHs indicated by the TDRA information field.

|  |
| --- |
| Agreement: (RAN1#104-bis)For a DCI that can schedule multiple PDSCHs,* NDI for the 1st TB: This is signaled per PDSCH and applies to the first TB of each PDSCH
* RV for the 1st TB: This is signaled per PDSCH, with 2 bits if only a single PDSCH is scheduled or 1 bit for each PDSCH otherwise and applies to the first TB of each PDSCH

Agreement: (RAN1#106bis-e)For a DCI that can schedule multiple PDSCHs, and if RRC parameter configures that two codeword transmission is enabled,* NDI for the 2nd TB: This is signalled per PDSCH and applies to the 2nd TB of each PDSCH
* RV for the 2nd TB: This is signalled per PDSCH, with 2 bits if only a single PDSCH is scheduled or 1 bit for each PDSCH otherwise and applies to the 2nd TB of each PDSCH
 |

* Above clarification also applies to the DCI scheduling multiple PUSCHs, i.e., NDI/RV fields in the DCI correspond to scheduled PUSCHs indicated by the TDRA information field.
* The following example change to 38.214 Sections 5.1.3 and 6.1.4 can be recommended to the editor of 38.214 to use at the editor’s discretion

---------------------------Start of TP for TS 38.214 Clause 5.1.3 -----------------------------------------------

5.1.3 Modulation order, target code rate, redundancy version and transport block size determination

================ Unchanged Text Omitted =======================

When the UE is scheduled with multiple PDSCHs by a DCI, as described in clause 5.1.2.1, the bits of *rv* field and NDI field, respectively, in the DCI are one-to-one mapped to the scheduled PDSCH(s) indicated by the TDRA information field with the corresponding transport block(s) in the scheduled order, where the LSB bits of the *rv* field and NDI field, respectively, correspond to the last scheduled PDSCH indicated by the TDRA information field.

---------------------------------------------- End of TP --------------------------------------------------------------

---------------------------Start of TP for TS 38.214 Clause 6.1.4 -----------------------------------------------

6.1.4 Modulation order, redundancy version and transport block size determination

================ Unchanged Text Omitted =======================

When the UE is scheduled with multiple PUSCHs by a DCI, as described in clause 6.1.2.1, the bits of *rv* field and NDI field, respectively, in the DCI are one to one mapped to the scheduled PUSCH(s) indicated by the TDRA information field with the corresponding transport block(s) in the scheduled order where the LSB bits of the *rv* field and NDI field, respectively, correspond to the last scheduled PUSCH indicated by the TDRA information field.

---------------------------------------------- End of TP --------------------------------------------------------------

**Conclusion**

It is clarified that the absence or presence of CBGTI field in the following previous agreement is determined based on scheduled PUSCHs indicated by the TDRA information field (i.e. irrespective of whether this is a valid PUSCH).

|  |
| --- |
| Agreement: (RAN1#105-e)* At least for 120 kHz SCS, for a DCI that can schedule multiple PUSCHs and is configured with the TDRA table containing at least one row with multiple SLIVs,
	+ If CBG-based (re)transmission is configured, CBGTI field is not present when more than one PUSCHs are scheduled, but is present when a single PUSCH is scheduled, as in Rel-16.
 |

**Agreement**

A UE validates, for scheduling activation or scheduling release, a DL SPS assignment PDCCH or a configured UL grant Type 2 PDCCH if the PDCCH indicates a TDRA row index including only one SLIV.

**Agreement**

For type-1 HARQ-ACK codebook, if , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, as follows.

* For a serving cell *c* configured with *enableTimeDomainHARQ-Bundling*, and for a DCI format indicating a TDRA row that includes more than one SLIV entry on the serving cell *c*, the UE considers a PDSCH (which carries one or two transport blocks enabled by the DCI format irrespective of whether the PDSCH is valid or not) only associated with the last SLIV as received, to determine .

### RAN1#108-e

**Agreement**

* The case where two multi-PDSCH (or multi-PUSCH) scheduling DCIs end in the same symbol but two multi-PDSCH (or multi-PUSCH) schedulings have overlapping spans, where the span is defined from the beginning of the first scheduled SLIV till the end of the last scheduled SLIV, is considered as out-of-order scheduling and is not expected by UE.
	+ This applies also when one of two DCIs is single-PDSCH (or single-PUSCH) scheduling DCI, including the case that one DCI schedules multi-slot PDSCH (or PUSCH repetition type A or B).
	+ Note: This doesn’t apply when each of two DCIs schedules multi-slot PDSCH (or PUSCH repetition type A or B) as in Rel-15/Rel-16
	+ Note: This doesn’t apply when each of the two DCIs schedules single PDSCH (or single PUSCH) as in Rel-15/Rel-16
* Note: It is separately discussed whether the scheduled SLIV is based on configured SLIV or valid SLIV.

Working assumption

The TP#1 below for TS 38.213 section 9.1.3.1 is endorsed.

* TP#1 (Construction of bundling group based on “configured” SLIVs)

|  |
| --- |
| If a UE is provided *numberOfHARQ-BundlingGroups* and is not provided *harq-ACK-SpatialBundlingPUCCH* for a serving cell , the UE generates HARQ-ACK information over transport block groups (TBGs) for PDSCH receptions where, for a maximum number of PDSCH receptions scheduled by a DCI format on the serving cell, a maximum number of TBGs is provided by *numberOfHARQ-BundlingGroups*. If the UE detects a DCI format scheduling PDSCH receptions on the serving cell , the UE generates HARQ-ACK information bits for first TBs and, if applicable, generates HARQ-ACK information bits for second TBs in the PDSCH receptions as described in clause 9.1.1 by setting and . For a TBG with at least one PDSCH not overlapping with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*,if provided, the UE assumes that a PDSCH in the TBG is correctly received if the PDSCH overlaps with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*. For a TBG that includes only PDSCH(s) overlapping with UL symbol(s) indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, if provided, NACK is generated for the TBG. |

**Agreement**

* When re-transmission of DL SPS is indicated by DCI format 1\_1, the PDCCH indicates a TDRA row index including only one SLIV.
* When re-transmission of UL CG is indicated by DCI format 0\_1, the PDCCH indicates a TDRA row index including only one SLIV.

Text Proposal TP#B (for 38.213, Clause 9.1.2.1) in section 4.2 of R1-2202679 is endorsed.

Text Proposal TP#C (for 38.214, Clause 6.1) in section 4.3 of R1-2202679 is endorsed.

Text Proposal TP#E (for 38.213, Clause 10.3) in section 4.5 of R1-2202679 is endorsed.

Text Proposal TP#H (for 38.214, Clauses 5.1 and 6.1) in section 4.8 of R1-2202679 is endorsed.

**Conclusion**

For a DCI that can schedule multiple PUSCHs, it is clarified that the following M is counted based on scheduled PUSCHs indicated by the TDRA information field.

* CSI-request: When the DCI schedules M PUSCHs, the PUSCH that carries the aperiodic CSI feedback is M-th scheduled PUSCH for M <= 2, or (M-1)-th scheduled PUSCH for M > 2.

Note: Aperiodic CSI feedback will be dropped if M-th scheduled PUSCH for M <= 2 (or (M-1)-th scheduled PUSCH for M > 2) is collided with semi-static DL or SSB symbols.

**Agreement**

TP#F1 below for TS 38.214 Clause 6.1.2.1 is endorsed

-------------------------------------------Start of TP#F1 for TS 38.214 Clause 6.1.2.1-----------------------------------------------

6.1.2.1 Resource allocation in time domain

If a UE is configured with *pusch-TimeDomainAllocationListForMultiPUSCH-r17* 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-r17*.

------------------------------------------------------------End of TP#F1----------------------------------------------------------------

**Agreement**

TP#J1 below for TS 38.214 Clause 5.1.3.2 is endorsed

-------------------------------------------Start of TP#J1 for TS 38.214 Clause 5.1.3.2 -----------------------------------------------

5.1.3.2 Transport block size determination

In case the higher layer parameter *maxNrofCodeWordsScheduledByDCI* indicates that two codeword transmission is enabled, then one of the two transport blocks is disabled by DCI format 1\_1 if *IMCS* = 26 and if *rvid* = 1 for the corresponding transport block. When the UE is configured with higher layer parameter [*pdsch-TimeDomainAllocationListForMultiPDSCH-r17*], either the first or the second transport block of all scheduled PDSCHs is disabled by the DCI format 1\_1 if *IMCS* = 26 and if *rvid* = 2 for the corresponding transport block of all scheduled PDSCHs. If both transport blocks are enabled, transport block 1 and 2 are mapped to codeword 0 and 1 respectively. If only one transport block is enabled, then the enabled transport block is always mapped to the first codeword.

------------------------------------------------------------End of TP#J1----------------------------------------------------------------

**Agreement**

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.

**Agreement**

When a DCI format indicates TCI state update without scheduling PDSCH reception, the PDCCH indicates a TDRA row index including only one SLIV.

**Agreement**

For generating type-2 HARQ-ACK codebook corresponding to a DCI that can schedule multiple PDSCHs, if , the UE determines a number of HARQ-ACK information bits for obtaining a transmission power for a PUCCH, considering at least the followings.

* For a serving cell *c* configured with *numberOfHARQ-BundlingGroups* with , (in formula) corresponding to the DCI in PDCCH monitoring occasion is given by 2 if *harq-ACK-SpatialBundlingPUCCH* is not provided and the DCI schedules two codewords, or given by 1 otherwise.
* If the UE is configured with *numberOfHARQ-BundlingGroups* with for a serving cell or not configured with *numberOfHARQ-BundlingGroups* but configured with *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH* for a serving cell, .
	+ For a serving cell *c* configured with *numberOfHARQ-BundlingGroups* with , (in formula) corresponding to the DCI in PDCCH monitoring occasion is given by 2\*X(X= the number of TBGs, each including at least one valid PDSCH which are constructed based on the PDSCH(s) scheduled by the DCI) if *harq-ACK-SpatialBundlingPUCCH* is not provided and the DCI schedules two codewords, or given by X otherwise.
	+ For a serving cell *c* not configured with *numberOfHARQ-BundlingGroups* but configured with *PDSCH-TimeDomainResourceAllocationListForMultiPDSCH*, (in formula) corresponding to the DCI in PDCCH monitoring occasion is given by 2\*Y(Y= the number of valid PDSCH receptions scheduled by the DCI) if *harq-ACK-SpatialBundlingPUCCH* is not provided and the DCI schedules two codewords, or given by Y otherwise.
	+ Note: “valid PDSCH” implies a PDSCH not overlapping with an UL symbol indicated by *tdd-UL-DL-ConfigurationCommon* or *tdd-UL-DL-ConfigurationDedicated*, if provided