**3GPP TSG RAN WG1 #112bis-e R1-230XXXX**

**e-Meeting, April 17th – April 26th, 2023**

**Agenda Item:** 7.2

**Source:** Moderator (LG Electronics)

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

**Document for:** Discussion and decision

# Introduction

This is the summary document for 7.2 on PDSCH/PUSCH enhancements (especially for scheduling and HARQ) for NR above 52.6 GHz, based on the contributions listed in reference section.

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

[112bis-e-R17-FR2\_2-03] Email discussion on Rel-17 FR2\_2 maintenance (HARQ scheduling) by April 20 – Seonwook (LGE)

# [Closed] (E) Issue#1: ‘-r17’ suffix for the parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*

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| Company | Views |
| [1] CATT | **Reason for change**: To support multiple PDSCHs scheduling via one DCI format 1\_1, the parameter of *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* is defined in TS 38.331.In the current version of TS 38.213, the parameter is described as *pdsch-TimeDomainAllocationListForMultiPDSCH*, it is not aligned as definition in TS 38.331.**Summary of change**: Change *pdsch-TimeDomainAllocationListForMultiPDSCH* to *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* |

## [Moderator’s note] The suffix ‘-r17’ for a higher layer parameter is necessary if the parameter had been introduced from the previous release. However, this parameter ‘pdsch-TimeDomainAllocationListForMultiPDSCH’ was introduced first in Rel-17. With this understanding, the suffix ‘-r17’ doesn’t seems to be needed in RAN1 specifications.

Companies are encouraged to provide views on the CR from CATT [1] and above Moderator’s note.

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| Company | Views |
| Samsung | Agree with Moderator. This is the general rule when a new RRC paramenter is added.No need to add the suffix ‘-r17’ in TS38.213.In fact, there is a discrepancy between 213 and 214 (TS38.214 used the suffix). To align, it would be better to inform 214 Editor of this discrepancy.  |
| Huawei, HiSilicon | Agree with Moderator’s note and with Samsung’s suggestion. |
| vivo | Agree with Moderator’s note |
| ASUSTeK | Agree with Moderator’s note |
| ZTE, Sanechips | Agree with Moderator’s note and Samsung’s comments. |
| Ericsson | Agree with Moderator’s note and Samsung’s comments |
| Nokia, NSB | Agree with Moderator’s note and Samsung’s comments |
| DOCOMO | Agree with Moderator’s note and Samsung’s comments. |
| Fujitsu | Agree with Moderator’s note and Samsung’s comments. |
| Moderator | According to Samsung’s comments, I prepared TP#A to remove the suffix from *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* in 214 specification. |

### Proposal #1 (‘-r17’ suffix):

For alignment TS38.214 CR:

* TP#A provided in R1-2304037 is endorsed for the editorial corrections.

Please provide comments only if there is an issue for Proposal #1. It is noted that the Tdoc number will be updated once assigned.

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| Company | Views |
| Huawei, HiSilicon | Support Proposal#1 |
| Samsung | Support the proposal |
| Ericsson  | Support Proposal #1 |
| Qualcomm | Support |
| CATT | OK |
| vivo | OK |
| ZTE, Sanechips | Support. |
| Moderator | Proposal#1 was agreed and Issue#1 can be closed. |

# [Closed] Issue#2: TDRA configuration for multi-PDSCH scheduling DCI

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| Company | Views |
| [2], [3] CATT | **Observation 1**: gNB may configure *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* in which no row contains multiple *SLIV*s for PDSCH**Observation 2**: if gNB configures *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* in which no row contains multiple SLIVs for PDSCH,$ R\_{T}$ will be NULL set, there will be an error case from for UE implementation during candidate PDSCH reception determination.**Proposal 1**: To resolve the error case during candidate PDSCH reception determination, there are two possible schemes can be downtown selected by RAN1. * **Alt-1**: (No CR) Clarify in RAN1 that if *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* if configured , there is at least one row contains multiple SLIVs; otherwise, if gNB configures TDMA in with each row only include one SLIV, parameter *TimeDomainAllocationList* shall be used .
* **Alt-2**: Modify the spec to align the limitation condition $R\_{T}$generation and candidate PDSCH reception determination as is used in TS 38.214.
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## [Moderator’s note] Companies are encouraged to provide views or preference between two alternatives in [3] CATT. If Alt-1 will be chosen, no CR is needed (Conclusion can be captured in Chairman’s note if proponents request), otherwise, we can consider the CR from CATT [2].

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| Company | Views |
| Xiaomi | Alt-1 is supported, it is nature that if *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* if configured , there is at least one row contains multiple SLIVs |
| Samsung | We prefer Alt-1. If all rows contain only one SLIV, it can be configured by Rel-15/16 RRC structure. So, *pdsch-TimeDomainAllocationListForMultiPDSCH* can be configued only if at least one row contains more than one SLIVs.  |
| Huawei, HiSilicon | We support Alt-1.  |
| CATT | We are ok both alternatives. If RAN1 choose alt1 after the discussion, then this should be clarified in the chairman’s note to remove any misunderstanding. |
| vivo | We support Alt-1. There is no need to configure *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* in which no row contains multiple SLIVs for PDSCH |
| ASUSTeK | We prefer Alt-1. |
| ZTE, Sanechips | We tend to support Alt-1. |
| Ericsson | Support Alt-1 |
| Nokia, NSB | Support Alt-1 |
| DOCOMO | Support Alt-1. |
| Fujitsu | Support Alt-1.  |
| Moderator | All companies support Alt-1. As requested by CATT, we can capture Alt-1 in the chairman’s note. |

### Proposed Conclusion #2 (TDRA config):

* It is RAN1’s understanding that *pdsch-TimeDomainAllocationListForMultiPDSCH* can be configured only if at least one row contains multiple SLIVs for PDSCH.

Companies are encouraged to provide views on Proposed Conclusion #2.

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| Company | Views |
| Huawei, HiSilicon | Support Conclusion #2  |
| Samsung | We support the proposal. |
| Ericsson | Support Conclusion #2 |
| Qualcomm | Support conclusion #2 |
| CATT | OK |
| vivo | OK |
| ZTE, Sanechips | Support. |
| Moderator | Proposed Conclusion #2 was made as conclusion and Issue#2 can be closed. |

# [Closed] Issue#3: 32-HPN support for e-type3 HARQ-ACK codebook

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| Company | Views |
| [4] CATT | **Proposal 1:** In order to support 32 HARQ processes, there is a need to update the above corresponding text in TS38.331. It is suggested to send RAN2 LS indicating such correction, which is marked in green as in the following:PDSCH-HARQ-ACK-EnhType3-r17 ::= SEQUENCE {pdsch-HARQ-ACK-EnhType3Index-r17 PDSCH-HARQ-ACK-EnhType3Index-r17,applicable-r17 CHOICE { perCC SEQUENCE (SIZE (1..maxNrofServingCells)) OF INTEGER (0..1), perHARQ SEQUENCE (SIZE (1..maxNrofServingCells)) OF BIT STRING (SIZE (32))},pdsch-HARQ-ACK-EnhType3NDI-r17 ENUMERATED {true} OPTIONAL, -- Need Rpdsch-HARQ-ACK-EnhType3CBG-r17 ENUMERATED {true} OPTIONAL, -- Need S |

## [Moderator’s note] If nrofHARQ-ProcessesForPDSCH-v1700 is provided, a maximum of 32 HARQ processes per cell can be used for the downlink. However, as CATT [4] pointed out, only 16 HARQ processes are being considered for enhanced type-3 HARQ-ACK codebook configuration and it is uncertain how enhanced type-3 HARQ-ACK codebook can work in case 32 HARQ processes are configured for a serving cell.

Companies are encouraged to provide **views on above Proposal 1** in CATT [4]. From my observation, if the proposal is agreeable, we may need not only **to send an LS to RAN2** but also **to consider the following CR for 213 specification**.

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| 9.1.4 Type-3 HARQ-ACK codebook determination If a UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the UE determines $\tilde{o}\_{0}^{ACK},\tilde{o}\_{1}^{ACK},…,\tilde{o}\_{O\_{ACK}-1}^{ACK}$ HARQ-ACK information bits, for a total number of $O\_{ACK}$ HARQ-ACK information bits, of a Type-3 HARQ-ACK codebook according to the following procedure. If the UE is provided *pdsch-HARQ-ACK-EnhType3ToAddModList* and a DCI format scheduling PDSCH reception and triggering the Type-3 HARQ-ACK codebook includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-EnhType3Index*, the UE determines a size of a set of indicated serving cells $N\_{cells}^{DL,ind}$ and a size of a set of indicated numbers of HARQ processes $N\_{HARQ,c}^{DL,ind}$ for each indicated serving cell and each indicated HARQ process number from the entry in *pdsch-HARQ-ACK-EnhType3ToAddModList* corresponding to the *pdsch-HARQ-ACK-EnhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-EnhType3Index* value is zero.Set $N\_{cells}^{DL}$ to the number of configured serving cells or, when applicable, to $N\_{cells}^{DL,ind}$Set $N\_{HARQ,c}^{DL}$ to the value of *nrofHARQ-ProcessesForPDSCH* or *nrofHARQ-ProcessesForPDSCH-v1700* for serving cell $c$, if provided; else, set $N\_{HARQ,c}^{DL}=8$ . When applicable, set $N\_{HARQ,c}^{DL}$ to $N\_{HARQ,c}^{DL,ind}$ |

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| Company | Views |
| Xiaomi | Support CATT’s proposal and also Moderator’s suggestion about the above CR in 9.1.4 |
| Samsung | We support the proposal from CATT. Also, we support the text proposal suggested by Moderator.  |
| Huawei, HiSilicon | We can support Moderator’s TP. RAN2 would take care of the bitmap size accordingly.  |
| CATT | Support TP and the LS to ran2. |
| vivo | Support the proposal and Moderator’s TP. |
| ASUSTeK | Support |
| ZTE, Sanechips | We support proposal 1 and suggested TP from Moderator. |
| Ericsson | Support Proposal 1 and suggested TP from Moderator |
| Nokia, NSB | Support Proposal 1 and suggested TP from Moderator |
| DOCOMO | Support Proposal 1 and suggested TP from Moderator |
| Fujitsu | Support the TP and LS |
| Moderator | All companies support Proposal 1 from CATT Tdoc and the corresponding TP for 213 specificaiton. |

### Proposal #3-1 (RAN1 spec for 32-HPN support):

* Adopt TP#B for TS 38.213 Section 9.1.4 in R1-2304037.

Please provide comments only if there is an issue for Proposal #3-1. It is noted that the Tdoc number will be updated once assigned.

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| Company | Views |
| Huawei, HiSilicon | Support Proposal #3-1  |
| Samsung | Support the proposal. |
| Ericsson | Support Proposal #3-1 |
| Qualcomm | Support the proposal |
| CATT | Support |
| vivo | Support |
| ZTE, Sanechips | Support. |
| Moderator | Proposal #3-1 was agreed and Issue#3 can be closed. |

### Proposal #3-2 (RAN2 LS for 32-HPN support):

* Send an LS to RAN2 with the following contents.

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| RAN1 observed that according to current TS 38.331 specification, enhanced type 3 HARQ-ACK codebook supports up to 16 HARQ process numbers per serving cell since bitmap size allocated for a serving cell equals to 16 as highlighted below.PDSCH-HARQ-ACK-EnhType3-r17 ::= SEQUENCE { pdsch-HARQ-ACK-EnhType3Index-r17 PDSCH-HARQ-ACK-EnhType3Index-r17, applicable-r17 CHOICE { perCC SEQUENCE (SIZE (1..maxNrofServingCells)) OF INTEGER (0..1), perHARQ SEQUENCE (SIZE (1..maxNrofServingCells)) OF BIT STRING (SIZE (16)) }, pdsch-HARQ-ACK-EnhType3NDI-r17 ENUMERATED {true} OPTIONAL, -- Need R pdsch-HARQ-ACK-EnhType3CBG-r17 ENUMERATED {true} OPTIONAL, -- Need S ...}However, if a UE is provided with *nrofHARQ-ProcessesForPDSCH-v1700* for a serving cell, a maximum of 32 HARQ processes for the serving cell can be used for the downlink. Therefore, RAN1 respectfully request RAN2 to update 331 specification for enhanced type 3 HARQ-ACK codebook, taking into account that up to 32 HARQ processes can be configured for a serving cell. |

Companies are encouraged to provide views on Proposal #3-2.

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| Company | Views |
| Huawei, HiSilicon | We are not sure if an LS is necessary. We think RAN2 can make necessary corrections based agreement. |
| Moderator | **@ Huawei,**Just to understand, what agreement are you referring to? |
| Samsung | We are ok to send LS to inform RAN1’s correction in Proposal#3-1 |
| Ericsson | Support sending LS |
| Qualcomm | Fine with sending the LS |
| CATT | Support sending LS |
| vivo | Support |
| Huawei, HiSilicon | @Moderator, I was referring to the agreement to Proposal #3-1Nonetheless, if all companies prefer to send an LS to RAN2, we are fine with that too. |
| ZTE, Sanechips | Support sending an LS to RAN2. |
| Fujitsu | OK with the LS. |
| Moderator | Proposal #3-2 was agreed and Issue#3 can be closed. |

# [Closed] Issue#4: Clarification on CBG configuration

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| Company | Views |
| [5] Samsung | **Issue 1: Ambiguity on the text “the SCS is 480 or 960kHz” in TS38.331**From RAN1’s agreement and TS38.331, it is unclear whether CBG-based transmission is allowed in a BWP with 120kHz SCS in a cell when another BWP in the cell is configured with 480kHz or 960kHz SCS. RAN1 agreements said that CBG-based transmission can be allowed for 120kHz, while CBG-based transmission cannot be configured for 480/960kHz SCS. This was captured in TS38.331. **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** For 480/960 kHz SCS, CBG-based HARQ cannot be configured for uplink and downlink.

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| *PUSCH-ServingCellConfig* field descriptions |
| ***codeBlockGroupTransmission***Enables and configures code-block-group (CBG) based transmission (see TS 38.214 [19], clause 5.1.5).The network does not configure this field if the SCS is 480 or 960 kHz. |

Since *codeBlockGroupTransmssion* field is configured in a cell-common RRC parameter, *PDSCH-ServingCellConfig* orPUSCH-ServingCellConfig*.* That is, all BWPs in a cell share the same CBG configuration. “the SCS is 480 or 960 kHz” in the field decription of *codeBlockGroupTransmssion* is unclear since a cell may have multiple BWPs, each of which has different subcarrier spacings. For example, suppose that a cell has two BWPs, the first BWP has 120kHz SCS and the second BWP has 480 or 960kHz SCS. If “the SCS is 480 or 960kHz” is interpreted as “at least one BWP configured in a cell has 480 or 960kHz”, then CBG-based transmission is not allowed in a BWP with 120kHz SCS. That is, gNB cannot configure *codeBlockGroupTransmssion* field in the cell. However, if “the SCS is 480 or 960kHz” is interpreted as “all BWPs configured in a cell has 480 or 960kHz”, then CBG-based transmission is allowed in a BWP with 120kHz SCS. **Observation 1***. From TS38.331, it is unclear which interpretation of the field description of codeBlockGroupTransmssion is correct between the following two interpretations* *Interpretation 1: “the SCS is 480 or 960kHz” is interpreted as “at least one BWP configured in a cell has 480 or 960kHz”**Interpretation 2: “the SCS is 480 or 960kHz” is interpreted as “all BWPs configured in a cell has 480 or 960kHz”* |

## [Moderator’s note] Samsung [5] pointed out an ambiguity issue on CBG configuration if a UE configured with the first BWP with 120 kHz SCS and the second BWP with 480/960 kHz SCS, for a serving cell.

Companies are encouraged to provide **views or preference between two interpretations from the above Observation 1** in Samsung [5]. Detailed TP can be dependent on which interpretation is supported. It is noted that there seems to be the same issue for DL case, as follows.

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| *PDSCH-ServingCellConfig* field descriptions |
| ***codeBlockGroupTransmission***Enables and configures code-block-group (CBG) based transmission (see TS 38.213 [13], clause 9.1.1). Network does not configure for a UE both spatial bundling of HARQ ACKs and *codeBlockGroupTransmission* within the same cell group.The network does not configure this field if - the SCS is 480 or 960 kHz - Type-1 HARQ-ACK codebook is configured and *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* for this serving cell contains pdsch-AllocationList with multiple entries (multiple PDSCH) - Type-2 HARQ-ACK codebook is configured and *pdsch-TimeDomainAllocationListForMultiPDSCH-r17* for any cell in the same PUCCH cell group associated with this serving cell contains pdsch-AllocationList with multiple entries (multiple PDSCH) |

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| Company | Views |
| Samsung | We support interpretation 2. We don’t see any motivations to limit CBG-based operation in a BWP with 120kHz SCS by other BWP configurations with 480/960kHz SCS.  |
| Huawei, HiSilicon | We agree with Samsung’s intention.However, we understand that ‘interpretation 1’ in Samsung’s view above does not achieve that intention. The correct interpretation that should be supported is rather ‘interpretation 2’ as Samsung initially proposed in R1-2303104 |
| CATT | *Interpretation 1: “the SCS is 480 or 960kHz” is interpreted as “at least one BWP configured in a cell has 480 or 960kHz”*We support the above interpretation 1. This is the intention of the original agreement. Also, with this interpretation, there will be no need for any changes in the CR , and it will not complicate #issue5. |
| vivo | We support interpretation 2. From our perspective, the network can configure *codeBlockGroupTransmission* if at least one BWP is not of 480 or 960kHz SCS, and the configured *codeBlockGroupTransmission* can be applied to the at least one BWP, while it is not applicable to any BWP of 480 or 960kHz SCS.Besides, we don’t think Issue#5 depends on the decision of Issue#4 (see reason below) |
| Samsung2 | Sorry for the confusion. We support Interpretation 2 as we wrote in our proposal **Proposal 1** *Adopt Interpreation 2 and send LS to RAN2 to inform the potential ambiguity on the text “the SCS is 480 or 960kHz” in TS38.331*  |
| ASUSTeK | Share view with CATT, and we support interpretation 1. |
| ZTE, Sanechips | We tend to support interpretation 1. |
| Ericsson | Support interpretation 1. We don’t think CBG’s are useful for large subcarrier spacings (including 120 kHz). |
| Nokia, NSB | Support interpretation 1 |
| DOCOMO | Support interpretation 1. |
| Fujitsu | We support interpretation 1 which is simpler and looks more like the original intention of the agreement. If we go with interpretation 2, how to interpret DCIs for the case of mixed SCS would be more complicated. |
| Moderator | Interpretation 1: “the SCS is 480 or 960kHz” is interpreted as “at least one BWP configured in a cell has 480 or 960kHz”* Supported by (7) CATT, ASUSTeK, ZTE, Ericsson, Nokia, NTT DOCOMO, Fujitsu

Interpretation 2: “the SCS is 480 or 960kHz” is interpreted as “all BWPs configured in a cell has 480 or 960kHz”* Supported by (3) Samsung, Huawei, vivo

Some observations from my side:* With Interpretation 2, gNB can configure CBG for a serving cell with more probability.
* However, CBG configuration is originally per-cell configuration (not per-BWP configuration). If we allow per-SCS CBG configuration at this later stage (i.e., Interpretation 2), it could be risky since we may have follow-up issues including multi-PUSCH scheduling issue raised up by Samsung.

**Considering the above observations and majority view, can we go with Interpretation 1? With Interpretation 1, I don’t see any TP needed for 213 and 331 specifications. Please let me know if you have different understanding.** |
| Huawei, HiSilicon | We are also open to interpretation 1 it is the majority view |
| Samsung | We are not object to take interpretation 1 as RAN1’s understanding. But, to make sure, we want to understand the technical metrit of Interpretation 1. First, in the original agreement, we cannot see the case with more than one BWPs with different SCS. Atually, the agreement said that CBG-based transmission is supported at least for 120kHz SCS. To us interpretation 2 is well aligned with this agreement. Second, RAN1 agreed to support CBG-based transmission with 120kHz in FR2-2, but now RAN1 is trying to limit the configuration possibility by **other BWP configurations with 480/960kHz**. We didn’t mention per-SCS CBG configuration. The CBG configuarion is per-cell. But, its applicability is determined by the active BWP’s SCS. And we already provide a viable way to resolve potential issue.In any cases, I think RAN1 should inform RAN2 of the interpretation and the interpretation is needed to be clarified in RAN2 specification. |
| Qualcomm | Interpretation 1 is simpler |
| CATT | Support Interpretation 1 |
| Moderator | **@ Huawei and Samsung,**Thanks a lot for being flexible!**@ Samsung,**As other companies stated, the benefit of Interpretation 1 is simpler and doesn’t require any additional work in RAN1. Although I understood the technical merit of Interpretation 2 and Samsung already proposed a method to handle an issue as a consequence of Interpretation 2, to minimize RAN1’s work at this later maintenance stage, it would be better to go with simpler way and majority view. |
| vivo | We are fine with Interpretation 1 to follow majority view. |

### Proposal #5 (CBG configuration):

* It is RAN1’s understanding that if at least one DL (or UL) BWP configured in a cell has 480 or 960kHz, the network does not configure the higher layer parameter *codeBlockGroupTransmission* for DL (or UL).
* Send an LS to RAN2 to inform this RAN1’s understanding and to request to update 331 specification accordingly, if needed.

Companies are encouraged to provide views on Proposal #5.

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| Company | Views |
| vivo | Support |
| Huawei, HiSilicon | Support Proposal#5 |
| ZTE, Sanechips | Support. |
| Fujitsu | Support. |
| Moderator | Proposal #5 was agreed and Issue#4 can be closed. |

# [Active] Issue#5: BWP switching with CBG-based PUSCH transmission

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| Company | Views |
| [5], [6] Samsung | **Issue 2: BWP switching with CBG-based PUSCH transmission**It has been agreed that CBG-based PUSCH transmission is allowed only if the indicated TDRA include single PUSCH scheduling. Otherwise, TB-based PUSCH transmission is applied. This UE behaviour was captured in TS38.212 v17.5.0 **Clause 7.3.1.1.2 of TS38.212**7.3.1.1.2 Format 0\_1[…]- CBG transmission information (CBGTI) – 0 bit if higher layer parameter *codeBlockGroupTransmission* for PUSCH is not configured or if the number of scheduled PUSCH indicated by the Time domain resource assignment field is larger than 1; otherwise, 2, 4, 6, or 8 bits determined by higher layer parameter *maxCodeBlockGroupsPerTransportBlock* for PUSCH. […]**Figure 1.BWP switching with CBG-based transmission**It is observed that if a UE is configured with two UL BWPs, the first BWP may have a TDRA table with more than one PUSCHs while the second BWP may have a TDRA table with one PUSCH only. This configuration is possible since the UE can be configured with different dedicated TDRA table in different BWP based on the RRC structure. That is, *BWP-UplinkDedicated* IE includes *pusch-Config, a*nd *pusch-Config* includes *pusch-TimeDomainAllocationList* or *pusch-TimeDomainAllocationListDCI-0-1-r16* or *pusch-TimeDomainAllocationListForMultiPUSCH-r16*.If the active BWP is the first BWP, the DCI format 0\_1 has 0 bit CBGTI. Suppose that the DCI format 0\_1 indicate the second BWP. The second BWP requires 2, 4, 6, or 8 bits CBGTI fieid as defined in the DCI format 0\_1 above. For this case, the defined UE behaviour from TS38.213 (see below) is that zeros are prepended to the CBGTI field until its size is equal to the one required for the interfertation. After the zero padding to CBGTI, all bits in CBGTI is equal to ‘0’ so that the UE’s interpretation of the CBGTI is that the scheduled PUSCH contains no CBGs. This is not the intended UE behaviour. **Clause 12 of TS38.213**If a bandwidth part indicator field is configured in a DCI format, the bandwidth part indicator field value indicates the active DL BWP, from the configured DL BWP set, for DL receptions as described in [5, TS 38.212]. If a bandwidth part indicator field is configured in a DCI format, the bandwidth part indicator field value indicates the active UL BWP, from the configured UL BWP set, for UL transmissions as described in [5, TS 38.212]. If a bandwidth part indicator field is configured in a DCI format and indicates an UL BWP or a DL BWP different from the active UL BWP or DL BWP, respectively, the UE shall- for each information field in the DCI format - if the size of the information field is smaller than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE prepends zeros to the information field until its size is the one required for the interpretation of the information field for the UL BWP or DL BWP prior to interpreting the DCI format information fields, respectively- if the size of the information field is larger than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE uses a number of least significant bits of the DCI format equal to the one required for the UL BWP or DL BWP indicated by bandwidth part indicator prior to interpreting the DCI format information fields, respectively- set the active UL BWP or DL BWP to the UL BWP or DL BWP indicated by the bandwidth part indicator in the DCI format It is worth noting that the similar problem occurs when the first BWP does not support CBG-based transmission (e.g., 480kHz/960kHz SCS) and the second BWP supports CBG-based transmission (e.g., 120kHz and single PUSCH scheduled in the indicated TDRA entry). That is, the detected DCI include 0bit CBGTI field while the indicated BWP requires more than 0 bits CBGTI field.Observation 2. *No CBGs are scheduled if the indicated BWP requires 2, 4, 6, or 8 bits CBGTI field but the detected DCI format 0\_1 includes 0 bit CBGTI field.*The scheduled PUSCH should include at least one CBGs in this case. The scheduled PUSCH may be used to confirm the UL BWP change is successfully completed. Also, PUSCH transmission with no CBGs is specified in the specification. The one way to address this issue is to not apply zero-padding as defined in TS38.213 and to interprete all CBGs contained in PUSCH are scheduled. The corresponding text proposal for TS38.212 is shown below:  |

## [Moderator’s note] The above issue doesn’t seem to be a problem since there will be more than 1 bit allocated to CBGTI field if DCI format 0\_1 (that can schedule multiple PUSCHs in the first BWP and is detected in the first BWP) schedules a single PUSCH in the second BWP, according to the above excerpt from Clause 7.3.1.1.2 of TS38.212 (i.e., the presence of CBGTI field is determined not based on TDRA configuration but based on the number of actually scheduled PUSCHs).However, if Interpretation 1 in Issue #4 will be chosen, we may need to handle this issue as Samsung [5] pointed out. With this understanding, we can put this Issue #5 on hold until Issue #4 is resolved.

Companies are encouraged to provide views on the Moderator’s note.

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| Company | Views |
| Samsung | Regarding the Moderator’s note, we have different understanding. The problem still occurs when the presence of CBGTI field is determined by the number of actually scheduled PUSCHs.Consider that following case. * A cell has two BWPs and CBG based transmission is configured on the cell.
* TDRA table in active BWP has more than one SLIVs. That is, the actually scheduled row in the active BWP has more than one SLIVs
* TDRA table in indicated BWP has one SLIV. That is, the actually scheduled row in the indicated BWP has only one SLIV.
* DCI format 0\_1 monitored in the active BWP has 0-bit CBGTI field (since the actually scheduled TDRA row in the active BWP has more than one SLIVs)

In this case, what is UE behavior intended? |
| Moderator | **@ Samsung,**Thanks for the further clarification. Now I can understood more details. It seems that we have different interpretations on the following yellow part.**Clause 7.3.1.1.2 of TS38.212**7.3.1.1.2 Format 0\_1[…]- CBG transmission information (CBGTI) – 0 bit if higher layer parameter *codeBlockGroupTransmission* for PUSCH is not configured or if the number of scheduled PUSCH indicated by the Time domain resource assignment field is larger than 1; otherwise, 2, 4, 6, or 8 bits determined by higher layer parameter *maxCodeBlockGroupsPerTransportBlock* for PUSCH. […]If the DCI format 0\_1 indicates a bandwidth part other than the active bandwidth part,* Interpretation 1: PUSCH (indicated by the Time domain resource assignment field) above implies PUSCH in **the active bandwidth part**
* Interpretation 2: PUSCH (indicated by the Time domain resource assignment field) above implies PUSCH in **the indicated bandwidth part**

What I thought was Interpretation 2, but Samsung seems to think Interpretation 1 is right. Is this correct?Even if Interpretation 1 holds as Samsung claimed, gNB can indicate TDRA row index configured with a single PUSCH both in the active bandwidth part and in the indicated bandwidth part, for which case there is no issue brought up by Samsung.Also, if this is the problem, we may consider to fix Rel-16 specification as well. |
| Huawei, HiSilicon | We agree with Moderator’s understanding. Nonetheless, we prefer to put this issue on hold until a decision is made on Issue #4 |
| CATT | Agree with Moderator. Put this on hold after Issue#4, for which if interpretation #1 is chosen, there is no need. |
| vivo | We don’t think this issue depends on decision of Issue#4. Even for NRU Rel-16 case or R17 case without 480/960KHz BWP, this issue also exists, e.g. two BWPs both with 30K/120KHz where one is multi-PUSCH and the other is single-PUSCH. Agree with Moderator’s understanding. We support Interpretation 2 which follows current spec. There is no need to change current spec. |
| Samsung | Thank you Moderator for the detail discussion. Regarding two interpretations, we believe interpretation 1 is correct. If interpretation 2 is correct, how a UE decide DCI payload size before detecting the DCI? The DCI size and field should be determined based on the active BWP size, not the indicated BWP size. This is why we made “zero padding” or “truncation” rule in Clause 12 of TS38.213.

|  |
| --- |
| If a bandwidth part indicator field is configured in a DCI format and indicates an UL BWP or a DL BWP different from the active UL BWP or DL BWP, respectively, the UE shall- for each information field in the DCI format - if the size of the information field is smaller than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE prepends zeros to the information field until its size is the one required for the interpretation of the information field for the UL BWP or DL BWP prior to interpreting the DCI format information fields, respectively- if the size of the information field is larger than the one required for the DCI format interpretation for the UL BWP or DL BWP that is indicated by the bandwidth part indicator, the UE uses a number of least significant bits of the DCI format equal to the one required for the UL BWP or DL BWP indicated by bandwidth part indicator prior to interpreting the DCI format information fields, respectively- set the active UL BWP or DL BWP to the UL BWP or DL BWP indicated by the bandwidth part indicator in the DCI format  |

Also, please check the following RAN1 agreement. The size should be determined by the active BWP, not the indicated BWP.Agreements: (RAN1#92bis)* DCI formats 0-0/1-0, 0-1, and 1-1 can have different sizes.
* DCI formats 0-1 and 1-1 can be received in USS only. The size is determined by the active BWP.

We are okay to defer this issue till Issue#4 is addressed. |
| ZTE, Sanechips | Agree with Moderator. This issue can be further discussed after Issue 4 . |
| Ericsson | Fine to hold |
| Nokia, NSB | Ok to postpone. |
| DOCOMO | Agree with moderator. |
| Fujitsu | OK to defer the discussion. |
| Moderator | **@ All,**Now that Issue#4 was finalized with Interpretation #1, we can focus on Issue#5 only for the case where a UL grant indicates BWP switching and TDRA field indicates multi-PUSCH in the active UL BWP while it indicates single PUSCH in the indicated UL BWP.After further thoughts, I think that Samsung’s interpretation is correct in that for this case, there is no CBGTI field in the UL grant. At the same time, this issue holds not only for Rel-17 multi-PUSCH scheduling DCI but also for Rel-16 multi-PUSCH scheduling DCI.With this observation, we may need to be careful not to have an NBC issue for Rel-16. One conservative way would be that NW ensures that CBGTI field is always present when BWP switching is indicated and CBG is configured.Having said that, I would like to collect companies’ views between two alternatives as the followings, in oder to resolve Issue#5.* **Alt 1 (No CR):** If a UE is configured with CBG transmission for a serving cell, the UE expects that CBGTI field in multi-PUSCH scheduling DCI is always present when BWP switching is indicated for the serving cell and the number of scheduled PUSCH indicated by TDRA field for the indicated bandwidth part is equal to 1.
* **Alt 2 (Samsung’s proposal):** If a UE is configured with CBG transmission for a serving cell, the UE assumes all CBGs in the scheduled PUSCH are scheduled when BWP switching is indicated for the serving cell, CBGTI field in multi-PUSCH scheduling DCI is 0 bit, and the number of scheduled PUSCH indicated by TDRA field for the indicated bandwidth part is equal to 1.
 |

## [Moderator’s note2] Companies are encouraged to provide views or preference between two alternatives in the above Moderator’s comment, considering that this issue affects not only Rel-17 but also Rel-16 specifications.

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| --- | --- |
| Company | Views |
| Samsung | Thanks Moderator for clarifying our interpration is correct one. Our view is that Alt 2 should be supported.* Alt 1: if active BWP has a TDRA table, each of row has multiple SLIVs, Alt 1 cannot be applied. That is, the DCI format monitored in BWP has 0-bit CBGTI always. That is, in this case, gNB cannot change active BWP.
* Alt 2: we think this is a basic UE behavior, i.e., since there is no CBGTI bits, the UE assume that all CBGs are scheduled.
 |
| Intel | The DCI size is determined by the current active BWP. The location TDRA field in the DCI and its filed size is also determined by the current BWP The TDRA field is interpreted based on the indicated BWP for switching, including truncation or padding if necessary* The number of scheduled PUSCHs is then determined

If multiple PUSCHs are scheduled, * remaining DCI fields in the DCI will be interpreted based on the current active BWP and assuming multiple scheduled PUSCHs. there is no CBGTI in this case

otherwise,* remaining DCI fields in the DCI will be interpreted based on the current active BWP and assuming single scheduled PUSCH. There exists CBGTI field with size determined by the current active BWP
 |
| Moderator | **@ Samsung,**It’s up to gNB’s configuration. If DCI format 0\_1 would be used for CG (de)activation, gNB has to configure at least one row containing a single SLIV. In any case, I’d like to hear other companys’ views.**@ Intel,**That was my first thought. ☺However, how can UE determine CBGTI field size in the very first step in your reponse? That is, when the DCI size is determined by the current active BWP, the size of CBGTI field also needs to be determined. |
| Samsung | @Moderator. Thanks for the comments. CG PUSCH activation/deactivation is much simpler. First, DCI format 0\_0 is also used for Type-2 CG activation/deactivation. Second, there is Type-1 CG PUSCH. Third, only one single row in a BWP is enough to Type-2 CG activation/deactivation. For BWP switching, it is much complicated. Suppose that a row of index *i* (TDRA row index) in BWP#1 has single SLIV, a row of index *i* in BWP#2 has more than one SLIV. gNB can use the row of index *i* for BWP switching only if active BWP is BWP#1 and indicated BWP is BWP#2. It is because there is CBG field in the DCI format. But, this row cannot be used for BWP switching if active BWP is BWP#2 and indicated BWP is BWP#1. gNB should consider X TDRA table configurations for X BWPs if X BWP is configured in a cell. Here, X can be 4. The combinations is up to 12. @ Intel. Thanks for sharing your understanding. Suppose that two BWPs. * Active BWP: all rows has one SLIV
* Indicated BWP: all rows has N SLIVs (N>1)

The DCI size and field size is determined by the active BWP. Since there is no row with more than one SLIV, the DCI includes 1-bit NDI, 2-bit RV, and C-bit CBGTI (C is # of CBGs in a TB). Let’s assume your understanding, i.e., if the number of scheduled PUSCH is determined from the indicated BWP, remaining DCI fields in the DCI will be interpreted based on the current active BWP and assuming multiple scheduled PUSCHs. Then, how can a gNB ensure N-bit NDI, N-bit RV, and 0-bit CBGTI is included in the detected DCI format? Potentially, the DCI size (determined by the active BWP) cannot contain N-bit NDI, N-bit RV, and 0-bit CBGTI if 2\*N is larger than 1+2+C. |
| Huawei, HiSilicon | Thanks to Samsung for the analysis.Although our preference is Alt-1, we are also open to Alt 2 if it the majority view. |
| Moderator | **@ Samsung,**Thanks for the follow-up.I don’t think that is much complicated. For instance, TDRA row index 0 for all BWPs can be configured with a single SLIV and gNB can use this index 0 for BWP switching.Again, we need more views to conclude. |
| Intel  | In general, DCI size is determined by the current active BWP per existing spec. DCI field size determination based on single scheduled PUSCH or multiple scheduled PUSCHs only needs to be done when multi-PUSCH is configured on the current active BWP. In case of BWP switching, DCI field size determination needs assistance of indicated BWP (single or multiple scheduled PUSCHs by indicated BWP).@Samsung, in your example (the current active BWP is NOT configured with multi-PUSCH), our understanding is that we just follow existing spec since the DCI size and DCI field size are all known based on the configuration of the current active BWP. That is, the ‘1-bit NDI, 2-bit RV’ in the DCI is interpreted for the indicated BWP, which most likely results in zero paddings. The performance may not be that good, but it works. @Moderator, we understood CBG configuration is per cell, not per BWP. Therefore, the size of CBGTI is known to all BWPs. For the case current active BWP is configured with multi-PUSCH, we needs an interpretation of the DCI based on single or multiple SLIVs. If single PUSCH is scheduled by the TDRA field which is interpreted by indicated BWP, CBGTI has the configured size (other DCI fields are also interpreted assuming single PUSCH). otherwise, CBGTI is 0 bit in DCI (other DCI fields are also interpreted assuming multiple PUSCH). We also echo Moderator’s assessment, if both BWP is configured with at least a row with single SLIV, the existing spec can work without any CR. In summary, the existing spec works for both cases. We are open to hear more views.  |
| Samsung | @Moderator. Then only one row is used for BWP switching, even though other rows are available. There was no such a restriction in previous RAN1 specification.@Intel. Thanks for the comment. We are still unclear on “In case of BWP switching, DCI field size determination needs assistance of indicated BWP (single or multiple scheduled PUSCHs by indicated BWP)”.Does it mean that size of a DCI field (which is potentially able to be changed by # of scheduled PUSCH) is determined by **all BWPs configured with multi-PUSCH scheduling** before dectecting the DCI format?The simplest way I think is to determine a DCI field size by active BWP only. After that apply zero-padding and truncation. Non-active BWP’s configuration does not impact to the DCI detection (DCI size and DCI field contents) in the DCI monitored in active BWP.  |
| Intel2 | @Samsung, Thanks for discussions. There are two frequently appeared terms, DCI size and DCI field size in the discussions. DCI size should be determined by the current active BWP only. In fact, before decoding the DCI, UE doesn’t know if it is for BWP switching at all. Then, DCI field size determination should refer to the number of scheduled PUSCH by the TDRA field interpreted by the indicated BWP, if multi-PUSCH is configured on the current active BWP. Here is our view again. 1. DCI size is determined by the current active BWP (legacy behaivor)
2. Position and size of TDRA field in the DCI is also determined by the current active BWP (legacy behavior)
3. UE interprets the TDRA field by the TDRA table of the indicated BWP, then UE knows single or multiple PUSCHs are scheduled (legacy behavior, as section 12, 38.213)
4. If multiple PUSCHs are scheduled
	* remaining DCI field sizes in the DCI are interpreted based on the current active BWP and assuming multiple scheduled PUSCHs. there is no CBGTI in this case

otherwise,* + remaining DCI field sizes in the DCI are interpreted based on the current active BWP and assuming single scheduled PUSCH. There exists CBGTI field with size configured for the cell by high layer

Step 4) is also existing behavior. For a DCI format for multi-PUSCH scheduling, the UE needs to interpret TDRA field first (single or multiple scheduled PUSCH), then the UE knows about the size of other DCI fields in the DCI. The only difference in case of BWP switching is the number of scheduled PUSCHs is determined by the indicated BWP. On the other hand, if our understanding is correct, Samsung’s proposal will interpret the TDRA field twice, right?1. in a first time, the TDRA field is interpreted by the TDRA table of the current active BWP, then UE knows single or mulitple scheduled PUSCHs (virtual, not for transmission) which is used to determine sizes of other DCI fields
2. In a second time, UE interprets the TDRA field by the TDRA table of the indicated BWP, then UE knows the actual number of scheduled PUSCHs for transmission.
 |
| Samsung | @Intel. Thanks for the discussion. First, our understanding is to interprete the TDRA field twice as you mentioned. Second, let me take a toy example to explain what is a concern in your understanding. Toy example. * The active BWP has a TDRA table where each row has up to 2 PUSCHs
* The indicated BWP has a TDRA table where each row has up to 8 PUSCHs
* DCI payload size monitored in an active BWP is 47bits, including (all bit size of each field are arbitrary)
	+ 1-bit Indentifier,
	+ 2-bit BWP indicator
	+ 15-bit FDRA
	+ 4-bit TDRA
	+ 5-bit MCS
	+ 2-bit NDI (due to multi-PUSCH scheduling in the active BWP)
	+ 2-bit RV (due to multi-PUSCH scheduling in the active BWP)
	+ 4-bit HPN
	+ 2-bit 1st DAI
	+ 2-bit TPC command for scheduled PUSCH
	+ 4-bit Precoding information and number of layers
	+ 2-bit Antenna ports
	+ 2-bit SRS request
* Intel’s interpretation: use 8 PUSCHs in the indicated BWP to determine field sizes in the detected DCI format.
	+ 1-bit Indentifier,
	+ 2-bit BWP indicator (indicating BWP swticing)
	+ 15-bit FDRA
	+ 4-bit TDRA
	+ 5-bit MCS
	+ 8-bit NDI (by intel’s interpretation)
	+ 8-bit RV (by intel’s interpretation)
	+ 4-bit HPN
	+ 0-bit 1st DAI (no this field since the detected DCI format has 47bits)
	+ 0-bit TPC command for scheduled PUSCH (no this field since the detected DCI format has 47bits)
	+ 0-bit Precoding information and number of layers (no this field since the detected DCI format has 47bits)
	+ 0-bit Antenna ports (no this field since the detected DCI format has 47bits)
	+ 0-bit SRS request (no this field since the detected DCI format has 47bits)
	+ 🡪 1st DAI, TPC command for scheduld PUSCH, Precoding information and number of layers, Antenna ports, and SRS request have 0 bits so that zero-padding is applied. (no flexibility to indicate a value other than ‘0’)
* Samsung’s interpretation: use 2 PUSCHs in the active BWP to determined field sizes in the detected DCI format.
	+ 1-bit Indentifier,
	+ 2-bit BWP indicator
	+ 15-bit FDRA
	+ 4-bit TDRA
	+ 5-bit MCS
	+ 2-bit NDI (based on Samsung’s interpretation)
	+ 2-bit RV (based on Samsung’s interpretation)
	+ 4-bit HPN
	+ 2-bit 1st DAI
	+ 2-bit TPC command for scheduled PUSCH
	+ 4-bit Precoding information and number of layers
	+ 2-bit Antenna ports
	+ 2-bit SRS request
	+ 🡪 2-bit NDI and 2-bit RV field are zero-padded till obtain 8-bit NDI and 8-bit RV

From the toy example, our understanding is that if Intel’s understading is correct, there is a large scheduling restriction since the DCI monitored in the active BWP cannot contain some of fields. If I missed something, please correct me. And I would like to hear other companies’s understanding.  |
| Intel3 | We are not willing to make a two-company discussion, but the question is dedicated to Intel 😊It seems the key confusion comes from following part* + 8-bit NDI (by intel’s interpretation)
	+ 8-bit RV (by intel’s interpretation)

In our understanding, the ONLY information which impacts DCI field size dtermination by the indicated BWP is single or multiple scheduled PUSCH. Therefore, with Samsung’s example, when UE obtains ‘multiple PUSCHs’ assuming 2 to 8 PUSCHs are scheduled on the indicated BWP, UE will determine the DCI size based on ‘multiple PUSCHs’ in the current active BWP, so the field sizes are* + 2-bit NDI (based on Samsung’s interpretation)
	+ 2-bit RV (based on Samsung’s interpretation)

Having said above, it is really important to hear more inputs from other companies.  |

# [Closed] Issue#6: TBoMS support of multi-PUSCH scheduling

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| Company | Views |
| [7] ASUSTeK | **Observation 1**: There is no clear agreement and conclusion specifying whether *numberOfSlotsTBoMS-r17* and *pusch-TimeDomainAllocationListForMultiPUSCH* could be configured simultaneously.**Proposal**: For TBoMS and multi-PUSCHs, down-select one alternative:* **Alt1**: a UE does not expect to be configured with both *numberOfSlotsTBoMS* and *pusch-TimeDomainAllocationListForMultiPUSCH*.
* **Alt2**: a UE could be configured with both *numberOfSlotsTBoMS* and *pusch-TimeDomainAllocationListForMultiPUSCH* when gNB can make sure that for all n, n-th allocation with *numberOfSlotsTBoMS* and (n+1)-th allocation does not overlap in time domain.
 |

## [Moderator’s note] From my understanding, the following agreement is aligned with above Alt1 in ASUSTeK [7].

Agreement: (RAN1#104-e)

* 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.

Companies are encouraged to provide views on the above Proposal from ASUSTeK [7] and Moderator’s note. If **Alt1** is taken, we may need to send an LS to RAN2 to inform RAN1’s understanding.

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| Company | Views |
| Samsung | It is unclear the agreement moderator pointed out is relevant to TBoMS or not since TB is not repeated in TBoMS. One TB is just mapped to multiple slot. We have no strong views on TBoMS with multi-PUSCH scheduling. But, since TBoMS is basically used for coverage limited scenarios, DCI scheduling multi-PUSCH is not a good option. DCI payload size is too large to support coverage limited scenarios.  |
| Moderator | Sorry for the confusion.What I intended to highlight was not the yellow one but the cyan one above. |
| Huawei, HiSilicon  | We support Alt1 which is also inline with the agreement cited by the Moderator.  |
| vivo | Agree with moderator and we support Alt1. |
| Samsung2 | Thanks for the Moderator. Now I see the point. We agree with the Moderator’s view.  |
| ASUSTeK | Thanks Moderator’s comments. We agree with Moderator’s view, and agree to send LS to RAN2. |
| ZTE, Sanechips | Support Alt1. |
| Ericsson | Support Alt-1 which is in-line with the RAN1#104-e agreement |
| Nokia, NSB | Support Alt1. |
| DOCOMO | Support Alt 1. |
| Fujitsu | Support Alt 1. |
| Moderator | All companies support Alt 1. We can send an LS to RAN2 accordingly. |

### Proposal #6 (RAN2 LS for multi-PUSCH scheduling):

* Send an LS to RAN2 with the following contents.

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| RAN1 made the following agreement in RAN1#104-e. As highlighted below, a UE does not expect to be configured with both *numberOfSlotsTBoMS-r17* and *pusch-TimeDomainAllocationListForMultiPUSCH-r16*.

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| Agreement: (RAN1#104-e)* 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.
 |

Therefore, RAN1 respectfully request RAN2 to update 331 specification in line with the above RAN1 agreement. |

Companies are encouraged to provide views on Proposal #6.

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| Company | Views |
| Huawei, HiSilicon | We are fine with Proposal#6 |
| Samsung | We support the proposal. |
| Ericsson | Support Proposal #6 |
| CATT | Support |
| vivo | Support |
| ZTE, Sanechips | Support. |
| Moderator | Proposal#6 was agreed and Issue#6 can be closed. |

# [Active] Issue#7: Applicable SCS for e-type3 HARQ-ACK codebook

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| Company | Views |
| [8] CATT | **Reason for change**: In Rel-16, Type-3 HARQ-ACK codebook was introduced for NR-U, which was supported in FR1 only. Accordingly, only subcarrier spacings of 15, 30 and 60kHz ($μ=0,1,2$) are considered for processing time of Type-3 HARQ-ACK codebook.However, Type-3 HARQ-ACK codebook is supported for HARQ-ACK retransmission in Rel-17, which should be supported in FR1, FR2-1 and FR2-2. Hence, $μ=3,5,6$ should also be considered for processing time of Type-3 HARQ-ACK codebook.**Summary of change**: Remove the limitation that only $μ=0,1,2$ is considered for processing time of Type-3 HARQ-ACK codebook.**Consequences if not approved:** There is no processing time defined for Type-3 HARQ-ACK codebook in FR2-1 and FR2-2.See TP#C. |

## [Moderator’s note] This issue was originally assigned to email thread [112bis-e-R17-URLLC-01]. However, considering the fact that this is highly related to Issue#3 in this email thread, it was transferred to this email thread.

### Proposal #7 (eType-3 HARQ-ACK CB):

* Adopt TP#C for TS 38.213 Section 9.1.4 in R1-2304037.

Companies are encouraged to provide views on TP#C. If TP#B and TP#C are agreeable, those can be merged into a single CR.

|  |  |
| --- | --- |
| Company | Views |
| Ericsson | Support TP#CFine to merge TP#B and TP#C into a single CR.Note: I believe the correct Tdoc reference in Proposal #7 should be R1-2302655 |
| vivo | Support TP#C |
| Huawei, HiSilicon | Support adopting TP#C |
| ZTE, Sanechips | Support. |
| Fujitsu | Support. |
| Samsung | Support. |
| CATT | Support proposal #7 |
| Intel | Support |
| Nokia, Nokia Shanghai Bell | Support |

# Reference

1. R1-2302670 Draft CR on editorial correction of pdsch-TimeDomainAllocationListForMultiPDSCH CATT
2. R1-2302671 Draft CR on alignment of the condition on R\_Tgeneration and candidate PDSCH reception determination CATT
3. R1-2302672 Discussion on R\_Tgeneration and candidate PDSCH reception determination for the features extending NR operation to 71 GHz CATT
4. R1-2302673 Discussion on 32 HARQ process in PDSCH-HARQ-ACK-EnhType3 configuration for the features extending NR operation to 71 GHz CATT
5. R1-2303104 Discussion on BWP operations in FR2-2 Samsung
6. R1-2303105 Draft CR on BWP switching with CBG-based transmission in FR2-2 Samsung
7. R1-2303816 Discussion on TBoMS regarding multi-PUSCH ASUSTeK
8. R1-2302655 Correction on the applicable subcarrier spacings of Type-3 HARQ-ACK codebook CATT

# TPs

## TP#A

5.1.2.1 Resource allocation in time domain

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

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* in which one or more rows contain multiple SLIVs for PDSCH, the UE does not expect to be configured with higher layer parameter *repetitionNumber* in *pdsch-TimeDomainAllocationListForMultiPDSCH*.

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* in which one or more rows contain multiple SLIVs for PDSCH on a DL BWP of a serving cell, the UE does not apply *pdsch-AggregationFactor* in *PDSCH-config*, if configured, to DCI format 1\_1 on the DL BWP of the serving cell.

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* 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.

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

For *pdsch-TimeDomainAllocationListForMultiPDSCH* in *pdsch-Config* each PDSCH has a separate SLIV, mapping type and *K0*. The number of scheduled PDSCHs is signalled by the number of indicated SLIVs in the row of the *pdsch-TimeDomainAllocationListForMultiPDSCH* signalled in DCI format 1\_1.

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* in which one or more rows contain multiple *SLIV*s for PDSCH on a DL BWP of a serving cell, and the UE is indicated re-transmission of PDSCH corresponding to a DL SPS by DCI format 1\_1, the UE does not expect that the number of indicated *SLIV*s in the row of the *pdsch-TimeDomainAllocationListForMultiPDSCH* by the DCI is more than one.

5.1.2.1.1 Determination of the resource allocation table to be used for PDSCH

Table 5.1.2.1.1-1 and Table 5.1.2.1.1-1A define which PDSCH time domain resource allocation configuration to apply. Either a default PDSCH time domain allocation A, B or C according to tables 5.1.2.1.1-2, 5.1.2.1.1-3, 5.1.2.1.1-4 and 5.1.2.1.1-5 is applied, or the higher layer configured *pdsch-TimeDomainAllocationList* or *pdsch-TimeDomainAllocationListForMultiPDSCH* or *pdsch-TimeDomainAllocationListDCI-1-2* is applied. For operation with shared spectrum channel access in frequency range 1, as described in [16, TS 37.213], UE reinterprets *S* and *L* in row 9 of Table 5.1.2.1.1-2 as *S=6* and *L=7*.

**Table 5.1.2.1.1-1: Applicable PDSCH time domain resource allocation for DCI formats 1\_0, 1\_1, 4\_0, 4\_1 and 4\_2**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **RNTI** | **PDCCH search space** | **SS/PBCH block and CORESET multiplexing pattern** | ***PDSCH-ConfigCommon* includes *pdsch-TimeDomainAllocationList*** | ***PDSCH-Config* includes *pdsch-TimeDomainAllocationList*** | ***pdsch-ConfigMCCH / pdsch-ConfigMTCH*  includes *pdsch-TimeDomainAllocationList******Or*** ***pdsch-ConfigMulticast* includes *pdsch-TimeDomainAllocationList*** | ***PDSCH-Config* includes *pdsch-TimeDomainAllocationListForMultiPDSCH*** | **PDSCH time domain resource allocation to apply** |
| SI-RNTI | Type0 common | 1 | - | - | - | - | Default A for normal CP |
| 2 | - | - | - | - | Default B |
| 3 | - | - | - | - | Default C |
| SI-RNTI | Type0A common | 1 | No | - | - | - | Default A |
| 2 | No | - | - | - | Default B |
| 3 | No | - | - | - | Default C |
| 1,2,3 | Yes | - | - | - | *Pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| RA-RNTI, MSGB-RNTI, TC-RNTI | Type1 common | 1,2,3 | No | - | - | - | Default A |
| 1,2,3 | Yes | - | - | - | *Pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| P-RNTI | Type2 common | 1 | No | - | - | - | Default A |
| 2 | No | - | - | - | Default B |
| 3 | No | - | - | - | Default C |
| 1,2,3 | Yes | - | - | - | *Pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| MCCH-RNTI  | Type 0/0B common for broadcast | 1 | No | - | No | *-* | Default A |
| 2 | No | - | No | *-* | Default B |
| 3 | No | - | No | *-* | Default C |
| 1,2,3 | Yes | - | No | *-* | *pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| 1,2,3 | No/Yes | - | Yes | *-* | *pdsch-TimeDomainAllocationList provided in pdsch-ConfigMCCH* |
| G-RNTI for broadcast | Type 0/0B common for broadcast | 1 | No | - | No | *-* | Default A |
| 2 | No | - | No | *-* | Default B |
| 3 | No | - | No | *-* | Default C |
| 1,2,3 | Yes | - | No | *-* | *pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| 1,2,3 | No/Yes | - | Yes | *-* | *pdsch-TimeDomainAllocationList* provided in *pdsch-ConfigMTCH,* if configured, otherwise *TimeDomainAllocationList* provided in *pdsch-ConfigMCCH* |
| C-RNTI, MCS-C-RNTI, CS-RNTI | Any common search space associated with CORESET 0 | 1, 2, 3 | No | - | - | - | Default A |
| 1, 2, 3 | Yes | - | - | *-* | *pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon* |
| C-RNTI, MCS-C-RNTI, CS-RNTI | Any common search space not associated with CORESET 0UE specific search space | 1,2,3 | No | No | - | - | Default A |
| 1,2,3 | Yes | No | - | *-* | *pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon*  |
| 1,2,3 | No/Yes | Yes | - | *-* | *pdsch-TimeDomainAllocationList* provided in *PDSCH-Config* |
| 1,2,3 | No/Yes | - | - | Yes | *pdsch-TimeDomainAllocationListForMultiPDSCH* provided in *PDSCH-Config (Note 2)* |
| G-RNTI for multicast, G-CS-RNTI  | Type 3 common search space for multicast | 1,2,3 | No | - | No | - | *Default A* |
| 1,2,3 | Yes | - | No | - | *pdsch-TimeDomainAllocationList* provided in *PDSCH-ConfigCommon (Note 1)* |
| 1,2,3 | No/Yes | - | Yes | - | *pdsch-TimeDomainAllocationList* provided in *pdsch-ConfigMulticast**(Note 1)* |
| Note 1: For a UE that supports multicast, the same TDRA table applies to all G-RNTIs and G-CS-RNTIs (configured for multicast) if configured on a given serving cell.Note 2: If *pdsch-TimeDomainAllocationListForMultiPDSCH* is provided, it is applicable to DCI format 1\_1 only. |

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

5.1.3.2 Transport block size determination

In case the higher layer parameter *maxNrofCodeWordsScheduledByDCI* in *PDSCH-config* 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. In case the higher layer parameter *maxNrofCodeWordsScheduledByDCI* in *pdsch-ConfigMulticast* indicates that two codeword transmission is enabled, then one of the two transport blocks is disabled by DCI format 4\_2 if *IMCS* = 26 and if *rvid* = 1 for the corresponding transport block. When the UE is configured with higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, 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.

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

5.1.4.2 PDSCH resource mapping with RE level granularity

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

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

5.1.5 Antenna ports quasi co-location

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

If a UE is configured with *pdsch-TimeDomainAllocationListForMultiPDSCH* in which one or more rows contain multiple *SLIV*s for PDSCH on a DL BWP of a serving cell, and the UE is receiving a DCI carrying the *TCI-State* indication and without DL assignment, the UE does not expect that the number of indicated *SLIV*s in the row of the *pdsch-TimeDomainAllocationListForMultiPDSCH* by the DCI is more than one.

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

If a PDSCH is scheduled by a DCI format having the TCI field present, the TCI field in DCI in the scheduling component carrier points to the activated TCI states in the scheduled component carrier or DL BWP, the UE shall use the *TCI-State* according to the value of the '*Transmission Configuration Indication*' field in the detected PDCCH with DCI for determining PDSCH antenna port quasi co-location. The UE may assume that the DM-RS ports of PDSCH of a serving cell are quasi co-located with the RS(s) in the TCI state with respect to the QCL type parameter(s) given by the indicated TCI state if the time offset between the reception of the DL DCI and the corresponding PDSCH is equal to or greater than a threshold *timeDurationForQCL*, where the threshold is based on reported UE capability [13, TS 38.306]. For a single slot PDSCH, the indicated TCI state(s) should be based on the activated TCI states in the slot with the scheduled PDSCH. For a multi-slot PDSCH or the UE is configured with higher layer parameter *pdsch-TimeDomainAllocationListForMultiPDSCH*, the indicated TCI state(s) should be based on the activated TCI states in the first slot with the scheduled PDSCH(s), and UE shall expect the activated TCI states are the same across the slots with the scheduled PDSCH(s). When the UE is configured with CORESET associated with a search space set for cross-carrier scheduling and the UE is not configured with *enableDefaultBeamForCCS*, the UE expects *tci-PresentInDCI* is set as 'enabled' or *tci-PresentDCI-1-2* is configured for the CORESET, and if one or more of the TCI states configured for the serving cell scheduled by the search space set contains *qcl-Type* set to 'typeD', the UE expects the time offset between the reception of the detected PDCCH in the search space set and a corresponding PDSCH is larger than or equal to the threshold *timeDurationForQCL.*

## TP#B

* Reason for change
	+ Enhanced Type-3 HARQ-ACK codebook can not be supported for a serving cell configured with up to 32 HARQ processes.
* Summary of change
	+ In order to support up to 32 HARQ processes for enhanced type-3 HARQ-ACK codebook, $N\_{HARQ,c}^{DL}$ can be set to the value of *nrofHARQ-ProcessesForPDSCH-v1700* for serving cell $c$, if provided.
* Consequences if not approved
	+ Unclear UE behaviour to generate enhanced type-3 HARQ-ACK codebook for a serving cell if *nrofHARQ-ProcessesForPDSCH-v1700* is provided for the serving cell.

9.1.4 Type-3 HARQ-ACK codebook determination

If a UE is provided *pdsch-HARQ-ACK-OneShotFeedback*, the UE determines $\tilde{o}\_{0}^{ACK},\tilde{o}\_{1}^{ACK},…,\tilde{o}\_{O\_{ACK}-1}^{ACK}$ HARQ-ACK information bits, for a total number of $O\_{ACK}$ HARQ-ACK information bits, of a Type-3 HARQ-ACK codebook according to the following procedure. If the UE is provided *pdsch-HARQ-ACK-EnhType3ToAddModList* and a DCI format scheduling PDSCH reception and triggering the Type-3 HARQ-ACK codebook includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-EnhType3Index*, the UE determines a size of a set of indicated serving cells $N\_{cells}^{DL,ind}$ and a size of a set of indicated numbers of HARQ processes $N\_{HARQ,c}^{DL,ind}$ for each indicated serving cell and each indicated HARQ process number from the entry in *pdsch-HARQ-ACK-EnhType3ToAddModList* corresponding to the *pdsch-HARQ-ACK-EnhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-EnhType3Index* value is zero.

Set $N\_{cells}^{DL}$ to the number of configured serving cells or, when applicable, to $N\_{cells}^{DL,ind}$

Set $N\_{HARQ,c}^{DL}$ to the value of *nrofHARQ-ProcessesForPDSCH* or *nrofHARQ-ProcessesForPDSCH-v1700* for serving cell $c$, if provided; else, set $N\_{HARQ,c}^{DL}=8$ . When applicable, set $N\_{HARQ,c}^{DL}$ to $N\_{HARQ,c}^{DL,ind}$

## TP#C (from [8] CATT)

9.1.4 Type-3 HARQ-ACK codebook determination

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

If

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

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

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

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

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

the DCI format provides a request for a Type-3 HARQ-ACK codebook report and does not schedule a PDSCH reception. If the UE is provided *pdsch-HARQ-ACK-EnhType3ToAddModList* and the DCI format includes an enhanced Type 3 codebook indicator field that provides a value for *pdsch-HARQ-ACK-EnhType3Index*, the UE determines a number of indicated serving cells $N\_{cells}^{DL,ind}$ and a number of indicated HARQ processes $N\_{HARQ,c}^{DL,ind}$ for each indicated serving cell $c$ from the entry in *pdsch-HARQ-ACK-EnhType3ToAddModList* corresponding to the *pdsch-HARQ-ACK-EnhType3Index* value. If the DCI format does not include the enhanced Type 3 codebook indicator field, the *pdsch-HARQ-ACK-EnhType3Index* value is provided by the value of the MCS field for transport block 1 in the DCI format 1\_1 or the MCS field in the DCI format 1\_2. The UE is expected to provide HARQ-ACK information in response to the request for the Type-3 HARQ-ACK codebook after $N$ symbols from the last symbol of a PDCCH providing the DCI format, where the value of $N$ ~~for~~ $μ=0,1,2$ is provided in clause 10.2 by replacing "SPS PDSCH release" with "DCI format".

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

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