3GPP TSG RAN WG1 #108-e R1-220xxxx

e-Meeting, February 21 – March 3, 2022

**Agenda item: 8.8.1.2**

**Source: Moderator (Nokia, Nokia Shanghai Bell)**

**Title: FL summary of TB processing over multi-slot PUSCH (AI 8.8.1.2)**

**Document for: Discussion and Decision**

# Introduction

TB processing over multi-slot PUSCH was included as one of the enhancements, for both FR1 and FR2 as well as TDD and FDD, to be specified in the NR coverage enhancement work item approved in RAN1#90-e [1]:

* *Specification of PUSCH enhancements [RAN1, RAN4]*
	+ *Specify mechanism(s) to support TB processing over multi-slot PUSCH [RAN1]*
		- *TBS determined based on multiple slots and transmitted over multiple slots.*

Section 2 summarizes the remaining aspects of TB processing over multi-slot PUSCH based on companies’ contributions submitted under AI 8.8.1.2 to RAN1 #108-e [3]-[23].

All related proposals from different contributions, organized per aspect, are listed in Appendix A, for reference.

Previous Rel-17 agreements are listed in Appendix B, for reference.

# Summary of contributions on TB processing over multi-slot PUSCH

Contributions submitted under AI 8.8.1.2 discussed several aspects of TB processing over multi-slot PUSCH (referred to as TBoMS in this document, for simplicity). A systematic categorization will be used to summarize the content of all contributions. This is done according to both the number of submitted proposals on the different aspects and on the relevance the latter have for designing the feature, from FL’s perspective. Concerning the second criterion, its rationale is given by the natural relationship of consequentiality which exists between different aspects. In the remainder of the document, aspects are thus categorized as follows:

* **High priority aspects**
	+ Rate matching - Starting bit in each slot for the single TBoMS according to Option C
* **Mid priority aspects**
	+ NA
* **Other aspects**
	+ Time domain resource determination
		- Time domain resource determination for TBoMS for CG-PUSCH Type 1
		- Early termination of TBoMS
		- Out of order handling for TBoMS
	+ FDRA
	+ TBoMS repetitions
	+ UCI multiplexing
		- HARQ-ACK multiplexing in case of missed DCI
		- SP/A-CSI multiplexing on PUSCH for TBoMS
	+ Frequency hopping
	+ Interlaced TBoMS transmissions

The categorization above will determine the initial priority order for the discussions to be held for AI 8.8.1.2. In this context, section 2.1 will focus on discussions which will be discussed during RAN1 #108-e. Section 2.3 will collect all other aspects.

Tags [OPEN], [CLOSED] and [PAUSED] will be used to identify the status of the discussion at any moment of the meeting. New sections for specific aspects will be open during the meeting, should discussions for the higher priority aspects progress fast.

## High priority aspects

One high priority aspect is identified at the beginning of the meeting:

1. Rate matching - Starting bit in each slot for the single TBoMS according to Option C

Several companies have discussed at large about such aspect in the submitted contributions. Summary, discussion, and proposals on these aspects are provided in the following. Sub-section numbers follow the list above, for simplicity.

### [OPEN] Rate Matching - Starting bit in each slot for the single TBoMS according to Option C

This aspect has been discussed in detail in all contributions, FL’s recommendations and guidelines as per Final FL’s summary of AI 8.8.1.2 in RAN1 #107-bis-e were followed. This helps the description of both companies’ preferences and possible FL’s proposal.

The target during this meeting is to finalize the missing agreement(s) to conclude the design of the rate-matching part of TBoMS, as per agreement on Option C made during RAN #90-e.

To achieve this target, FL’s recommendation is to work as a group on a **constructive self-contained proposal** which may account for the preferences expressed by companies concerning the three aspects described by FL at the end of RAN1 #107-bis-e and consider **it** as an alternative to a simple approach based on describing Option C with a couple of sentences. To achieve this, first a summary of companies’ preferences on the three aspects is provided, with some comments from the FL. Subsequently, a first FL’s proposal will be formulated. In this context, it should be noted that four companies (Huawei/HiSi [3], InterDigital [11], NEC [21], LGE [22]) proposed complete proposals based on the independent preferences they expressed for the three aspects.

##### **Aspect 1 - The definition of G and E for TBoMS**

Two alternatives were proposed for this aspect, as follows.

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| ***Aspect 1 – Alt 1.***$G$ *is redefined as the total number of coded bits available for transmission of the transport block in a slot****Aspect 1 – Alt 2.*** *A new variable* $H$ *is introduced, only for TBoMS, defined as the total number of coded bits available for transmission of the transport block in a slot* |

Companies’ preferences are as follows, where only companies who expressed a single preference are included:

* Aspect 1 – Alt. 1 **[5]**:
	+ vivo [6], NTT DOCOMO [21], Apple [13], Samsung [16], TCL [3]
* Aspect 1 – Alt. 2 **[7]**:
	+ Huawei/HiSi [3], ZTE [5], CATT [7], Panasonic [15], InterDigital [11], CMCC [9], Xiaomi [10]

Three companies (Nokia/NSB, NEC, Ericsson) explained that the role of *H* and *G* (and *E*) may not be the same, given that:

* *H* would be used only to determine the index of the starting bit in each allocated slot for TBoMS (assuming no UCI multiplexing), whereas
* *G* (and *E*) provide the total number of UL-SCH coded bits available for transmission in a slot (depending on whether UCI multiplexing occurs or not).

FL’s comments on February 21

From FL’s perspective, the observations provided by Nokia/NSB, NEC and Ericsson are reasonable and could be used as a basis to find a clear solution agreeable to everyone.

To better understand this relationship, one may want to consider the discussion related to Aspect 2 as well, for which Interpretation 1 is preferred by most companies (i.e., 14), to ensure legacy implementation of rate-matching for PUSCH can be reused for TBoMS. To be more precise, Interpretation 1 in Aspect 2 assumes that the number of bits being selected in bit selection and provided as input to the bit interleaver, i.e., value *E* (and *G*), is determined considering UCI multiplexing.

In this context, the new parameter *H* is needed would be needed to be able to decouple the determination of the index of the starting bit in each slot (which is done independently of whether UCI multiplexing occurs or not) and the bit interleaving part of rate-matching for PUSCH (which according to current specification and PUSCH implementations depends on whether UCI multiplexing occurs or not in the slot).

Therefore, if Interpretation 1 of Aspect 2 is retained for starting bit selection in each slot, i.e., the backward compatible approach, a parameter different from *G* (i.e., *H*) is needed to characterize the total number of coded bits available for transmission of the TB in a slot allocated for TBoMS assuming no UCI multiplexing.

In contrast, if Interpretation 2 in Aspect 2 is adopted, then the new parameter *H* may not be needed for starting bit selection.

Having said this, and regardless of which interpretation in Aspect 2 is adopted (i.e., whether *H* is introduced or not), the redefinition of *G* would always seem to provide a cleaner approach to reflect the processing per slot for TBoMS as per existing agreements, since the number of bits being selected in bit selection (*E*) (and, in general, the rate-matching) is applied per slot.

The logic above will be used to formulate FL’s proposal 1 (please see below).

##### **Aspect 2 - The value of G and E for TBoMS (or, alternatively, the value of H)**

Two alternatives were proposed for this aspect, as follows.

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| **Aspect 2 – Interpretation 1.** The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.**Aspect 2 – Interpretation 2.** The starting index of circular buffer is determined assuming no UCI multiplexing, and the number of bits being selected in bit selection (value E) is determined assuming no UCI multiplexing. |

Companies’ preferences are as follows:

* Aspect 2 – Interpretation 1 **[14]**:
	+ Huawei/HiSi [3], Nokia/NSB [17], vivo [6], ZTE [5], CATT [7], Panasonic [15], NTT DOCOMO [21], InterDigital [11], Intel [12], NEC [20], Ericsson [18], Samsung [16], Qualcomm [14], TCL [4]
* Aspect 2 – Interpretation 2 **[4]**:
	+ Apple [13], CMCC [9], Xiaomi [10], WILUS [23]

FL’s comments on February 21

From the above summary, it is evident that the majority view is Interpretation 1. The arguments brought in favour of Interpretation 1 are technically accurate and sensible from FL’s perspective. Indeed, maintaining legacy UCI multiplexing to minimize implementation and specification impact seems a solid course of action, which also respects the literal interpretation of existing agreements on UCI multiplexing:

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| **Agreement*** For TBoMS, UCI is multiplexed on the individual overlapping slot for UL transmission in one carrier
* FFS: timeline requirements
* FFS: details on the calculation of the number of coded modulation symbols per layer for UCI multiplexing on a single TBoMS.
* Note: no new UCI multiplexing mechanism other than existing puncturing or rate-matching is introduced for TBoMS in Rel-17.
 |

In this regard, Interpretation 1 is indeed more suitable to fulfil this target. In contrast, Interpretation 2 changes the legacy definition of *G* (and *E*), which defines the total number of coded bits available for transmission of the TB assuming UCI multiplexing, if any. In this case, instead of rate-matching the data bits around the UCI payload (other than one or two HARQ-ACK bits) as in the legacy behaviour, one would puncture the data bits regardless of which UCI type is multiplexed. This would result in a new UCI multiplexing mechanism other than existing puncturing or rate-matching, in turn requiring a new TBoMS-specific UCI multiplexing implementation to be supported. The technical advantages, if any, brought by such a deep change are very unclear.

The logic above will be used to formulate FL’s proposal 1 (please see below).

##### **Aspect 3 – Handling of the filler bits in TBoMS**

Two alternatives were proposed for this aspect, as follows.

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| **Aspect 3 – Direction 1.** Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.**Aspect 3 – Direction 2.** Filler bits are not considered to pre-determine the index of the starting bit for each allocated slot for TBoMS and overlap between bit sequences transmitted over consecutive slots is allowed. |

Companies’ preferences are as follows, where only companies who expressed a single preference are included:

* Aspect 3 – Direction 1 **[15]**:
	+ Huawei/HiSi [3], Nokia/NSB [17], OPPO [8], CATT [7], Panasonic [15], NTT DOCOMO [21], InterDigital [11], Intel [12], Apple [13], CMCC [9], Ericsson [18], Qualcomm [14], Sharp [19], TCL [4], WILUS [23]
* Aspect 3 – Direction 2 **[2]**:
	+ Xiaomi [10], Samsung [16]

Three companies (vivo [6], ZTE [5], NEC [20]) stated that both directions are acceptable, with NEC proposing it to make them depend on a condition on the number of filler bits.

FL’s comments on February 21

From the above summary, almost all companies expressed a preference in favour of Direction 1. From FL’s perspective, the fact that UE knows in advance the number and position of all filler bits for all the slots of the TBoMS demonstrates that Direction 1 is feasible, technically solid and fully compliant with existing agreements on the continuous bit selection from the buffer (with no gaps or overlaps). Direction 2 is favoured only by 2 companies, and according to some interpretation would also require amending or reverting existing agreements on the continuous bit selection as per Option C:

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| --- |
| **Agreement**For the bit selection for each transmitted slot for TBoMS, one of the following is to be down selected in RAN1 #107-e for determining the index of the starting coded bit in the circular buffer:* Option B: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot.
* Option C: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.

FFS: whether the index of the starting coded bit for each transmitted slot is expressed as a multiple integer of the lifting size Zc |

In this context and given that this is the last meeting of the Rel-17 WI, RAN1 should avoid any discussion related to amending or reverting an existing agreement, especially in this case (please remember that RAN1 was not able to decide independently and needed RAN plenary intervention to resolve the discussion).

For these reasons, FL’s recommendation is to go for the super majority view.

The logic above will be used to formulate FL’s proposal 1 (please see below).

#### **First round of discussion**

Given the above FL’s comments, companies’ and FL’s understandings and companies’ preferences, it would seem reasonable to formulate the following proposal.

**FL’s proposal 1**

**For bit-section of TBoMS:**

* ***G* in Clause 5.4.2.1 of TS 38.212 is redefined as the total number of coded bits available for transmission of the transport block in a slot.**

**For determining the index of the starting coded bit in the circular buffer for the n-th slot of a single TBoMS, RAN1 to down-select one of the following two options during RAN1 #108-e.**

|  |
| --- |
| **Option 1***The index of the starting coded bit in the circular buffer for the* $n$*-th slot of a single TBoMS, i.e.,* $s\_{n}$*, is calculated as* $s\_{n}=\left\{\begin{matrix}k\_{0}&n=0\\(s\_{n-1}+H+τ\_{n-1})mod N\_{cb}&n=1, …,N-1\end{matrix}\right.$*Where:** $N$ *is the number of slots allocated for TBoMS*
* $N\_{cb}$ *is the length of circular buffer*
* $H$ *is the total number of coded bits available for transmission of the TB in a slot allocated for TBoMS,* assuming no UCI multiplexing
* $τ\_{n-1}$ *is the number of filler bits skipped in the bit selection in the* $\left(n-1\right)$*-th slot allocated for TBoMS, if any*

*Note: this equation describes the logic of the bit-selection for TBoMS; decision on where and how to capture this in TS 38.212 is up to the Editor.* |

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| **Option 2**Adopt the following TP for TS 38.2125.4.2.1 Bit selection**<Unchanged parts omitted>**Denote by  the redundancy version number for this transmission (= 0, 1, 2 or 3), the rate matching output bit sequence , , is generated as follows, where  is given by Table 5.4.2.1-2 according to the value of  and LDPC base graph if *numberOfSlotsTBoMS* is not present in the resource allocation table or the value of *numberOfSlotsTBoMS* in the row indicated by the Time domain resource assignment field in DCI is 1, otherwise for the first allocated slot is given by Table 5.4.2.1-2 according to the value of  and LDPC base graph and for *n*-th slot, $n=2,3,4,…$*numberOfSlotsTBoMS,* is the bit next to the last selected bit by the bit selection in the previous slot assuming the UCI is not multiplexed:  |

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 1**. If you can agree to the proposed approach but have suggestions for the wording, please add them in the second table below. Micro-optimizations should be avoided, of course. **Let us focus on the concepts and be constructive**. I am adding a third table to express a preliminary preference on the two Options, for me to be able to understand if it makes sense to keep the current structure of the proposal or if we should simply focus on one of the two options. Thank you.

**FL’s proposal 1**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 1** | QC (with a minor edit), Intel (with some update for G), Sharp (with QC’s clarification), CATT, vivo |
| **Do not support FL’s Proposal 1** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 1, if any. |
| Huawei, HiSilicon | Regarding to these two options, option 2 introduces a new action, i.e., a bit selection assuming the UCI is not multiplexed. It means that UE needs to execute the bit selection action twice; the first determines the starting bit, and the second determines the selected coded bit sequence. So it complicates and limits the implementation of starting coded bit determination. (As we know we have several easier methods to determine the starting coded bits). In addition, since option 2 may introduce an additional bit selection process and the bit selected in the additional bit selection will be discarded when there is UCI multiplexing in the slot, we have concern on option 2. Compared with option 2, option 1 is clear enough and more flexible. So option 1 is supported. |
| QC | Can we edit the bullet on the filler bits as follows, to make sure that this entire process is executable before the beginning of a TBOMS transmission?* $τ\_{n-1}$ *is the number of filler bits that would be skipped in the bit selection step in the* $\left(n-1\right)$*-th slot allocated for TBoMS, ~~if any~~ assuming no UCI multiplexing.*

We need to make it clear to the editor that this process is only for starting bit determination. What actually happens when it is time to transmit on a slot could be different depending on UCI multiplexing, cancellation, prioritization, etc. We are executing a “virtual” rate matching process here and I want to make sure the editor understands that. |
| Intel | We are fine with the proposal in principle. For the redefinition of G, our understanding is that the definition of G in Section 6.2.6 (as captured below) should also be updated:

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| The bits after code block concatenation are denoted by, where  is the total number of coded bits for transmission.  |

**For bit-section of TBoMS:*** ***G* in Clause 5.4.2.1 and 6.2.6 of TS 38.212 is redefined as the total number of coded bits available for transmission of the transport block in a slot.**
 |
| Sharp | Clarification proposed by Qualcomm sounds good to us. We should clarify that the proposal 1 defines behaviour for the starting bit determination, but does not define the actual rate-matching behaviour. With this clarification, we are OK with Option 1. |
| Samsung | To HW: I think the proposed direction, is anyway separating “determines the starting bit” and “determines the selected coded bit sequence”; I don't think option 2 will bring anything additional than option 1; in short. Same implementation is adopted for both options.We have few unclear part on the proposals, so we would like to vote after we clearly understand it,1. In proposal, G is redefined, but in proposed option, H is used. Although we find these two are same in logic. We tried to find the clue in the context, could FL remind that what I have missed?
2. For aspect 3, our intention was that, since the starting bit position is now separated, so caring filler bits or not fir starting bit is not that significant. Because, we also agree Since majority company wanted to care it, we can live with it. Just to clarify our understanding:
	1. If we are going to introduce a new H for TBoMS starting bit determination, then we could list the impact of UCI and filler directly in definition of H, e.g.,

**H is the total number of coded bits available for transmission of the TB in a slot allocated for TBoMS, assuming no UCI multiplexing but including τ\_(n-1) filler bits skipped in the (n-1)-th slot allocated for TBoMS, if any;**So that, H is now representing somehow like the “extracted bit” from the coded sequence, but not the “transmitted bit”. And we feel this could might caring QC’s change as well.1. Another thing is the operation of “$mod N\_{cb}$” is done at the actual bit selection psedo-code process, for starting bit determination, we might not need this.
 |
| CATT | Regarding to the update from Qualcomm, we are fine to make it clear, but seems we do not have to remove ‘if any’ at the end of the sentence.  |
| vivo | We’re generally fine with the FL proposal. Regarding the G in section 6.2.6, since only one CB is allowed, code block concatenation procedure will not be applied for TBoMS. So, it should be fine to only mention “G in Clause 5.4.2.1” in the proposal as it is. |

|  |  |
| --- | --- |
|  | Company name |
| **Option 1** | Huawei, HiSilicon, QC (TP can come later), Intel, Sharp, CATT(either is fine), vivo |
| **Option 2** | CATT(either is fine) |

## Mid priority aspects

No mid priority aspect is identified at the beginning of the meeting.

## Others

As discussed at the beginning of Section 2, discussions on different aspects of TBoMS have been prioritized to ensure that constructive discussions and effective progress can be achieved during RAN1 #108-e. Priority has been given to the aspects and topics discussed in section 2.1. All other aspects are listed in this section, i.e., 2.3, where proposals made by companies in their contributions are reported and described in detail.

These aspects may not be handled during RAN1 #108-e unless technical need arises during the discussion on other aspects. For this reason, no specific FL’s proposal or recommendation is formulated at this stage. Should discussions for 2.1 converge to agreements, sections for specific aspects, currently in 2.3, may be open for discussions and corresponding FL’s proposals and recommendations may be formulated.

### [CLOSED] Time domain resource determination

#### [CLOSED] Time domain resource determination for TBoMS for CG-PUSCH Type-1

Five companies (Huawei/HiSi [3], InterDigital [11], Intel [12], Apple [13], Sharp [19]) commented on this aspect, proposing to support Type-1 CG-PUSCH for TBoMS, where the number of allocated slots for TBoMS is indicated using a new RRC parameter in ConfiguredGrantConfig.

This issue has been debated in detail during #107-bis-e and no consensus could be reached. Most companies believe that there is no need to discuss the support of Type-1 CG-PUSCH at such a late stage, given that a more controllable and flexible framework for scheduling a CG-PUSCH exists for TBoMS, i.e., Type-2.

Now, if the situation was that a super majority exists in favour of the introduction of support of Type-1 CG for TBoMS, I would simply sketch up a couple of proposals and ask for a quick discussion online. However, this is not the case. Indeed, it is very much clear that some companies are strongly against the introduction of the support of Type-1 CG for TBoMS.

Given that more pressing matters exist for this AI, this discussion will not be opened (again) during #108-e, unless all other high priority issues have been closed first.

#### [CLOSED] Early termination of TBoMS

One company (Xiaomi [10]) proposed that early termination mechanism for TBoMS with configured grant is supported and the early termination mechanism for TBoMS with dynamic grant is FFS.

#### [CLOSED] Out of order handling for TBoMS

One company (Intel [12]) proposed clarifying the out of order scheduling scenarios in case of TBoMS.

### [CLOSED] FDRA

Two companies (Xiaomi [10], TCL [4]) proposed that the maximum number of PRBs allocated for TBoMS is limited by gNB scheduling.

### [CLOSED] TBoMS repetitions

One company (InterDigital [11]) proposed supporting non-interleaved mapping for TBoMS repetitions when DMRS bundling is enabled and interleaved mapping for TBoMS repetitions when DMRS bundling is disabled.

### [CLOSED] UCI multiplexing

One company (InterDigital [11]) proposed supporting non-interleaved mapping for TBoMS repetitions when DMRS bundling is enabled and interleaved mapping for TBoMS repetitions when DMRS bundling is disabled.

#### [CLOSED] HARQ-ACK multiplexing in case of missed DCI

One company commented on this aspect (ZTE [5]). The following proposals were made:

* + *For single TBoMS transmission and no overlapping PUCCH with HARQ-ACK within a span of one PUCCH slot, if T-DAI in UL grant is not equal to 4 for Type 2 codebook or is equal to 1 for Type 1 codebook, the UE should multiplex HARQ-ACK in the PUSCH following the T-DAI in UL grant.*
	+ *One of the slots for TBoMS transmission should be specified for HARQ-ACK multiplexing if the UE does not know the PUCCH slot due to missing detection of the DL DCI and the T-DAI in the UL grant is not equal to 4 for Type 2 codebook or is equal to 1 for Type 1 codebook.*

This issue has been discussed in detail during RAN1 #107-bis-e. The outcome of that discussion was that an overwhelming majority of companies think that this issue, if any, should be deprioritized and the problem at hand should be discussed and solved in other AIs.

#### [CLOSED] SP/A-CSI multiplexing on PUSCH for TBoMS

One company (Intel [12]) proposed that existing mechanism as defined for SP/A-CSI multiplexing on PUSCH repetition Type A is reused for TBoMS.

### [CLOSED] Frequency hopping

One company (Xiaomi [10]) proposed that intra-TB frequency hopping for TBoMS is supported.

### [CLOSED] Interlaced TBoMS transmissions

One company (Qualcomm [14]) proposed that interlaced TBoMS transmissions (carrying different TBs) are not permitted. A UE does not expect a TBoMS transmission in a component carrier to begin before the completion of an ongoing TBoMS transmission in the same component carrier.

### [CLOSED] Data rate calculation and UE behaviour related to TBS determination

One company (TCL [4]) proposed that the data rate constraint conditions should be modified for TBoMS.

# 3 Proposals for GTW

# 4 Agreements during RAN1 #108-e

# References

1. RP-202928 New WID on NR coverage enhancements, China Telecom, RAN#90e, Dec. 2020
2. TR 38.830 Study on NR coverage enhancements, 3GPP RAN1 Technical Report, Dec. 2020
3. R1-2200967 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2202240 Discussion on TB processing over multi-slot PUSCH, TCL Communication Ltd.
5. R1-2201165 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2201105 Remaining issues on PUSCH TB processing over multiple slots, vivo
7. R1-2201374 Discussion on TB processing over multi-slot PUSCH, CATT
8. R1-2201284 Further considerations for TB over multi-slot PUSCH, OPPO
9. R1-2201869 Discussion on TB processing over multi-slot PUSCH, CMCC
10. R1-2201925 Discussion on TB processing over multi-slot PUSCH, Xiaomi
11. R1-2201658 TB processing over multiple slots, InterDigital, Inc.
12. R1-2201709 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
13. R1-2201781 Discussion on TB processing over multi-slot PUSCH, Apple
14. R1-2202152 TB processing over multi-slot PUSCH, Qualcomm Incorporated
15. R1-2201380 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
16. R1-2202027 TB processing over multi-slot PUSCH, Samsung
17. R1-2201013 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
18. R1-2201962 Remaining issues for TB Processing over Multi-Slot PUSCH, Ericsson
19. R1-2202198 Transport block processing over multi-slot PUSCH, Sharp
20. R1-2201905 Discussion on TB processing over multi-slot PUSCH, NEC
21. R1-2201488 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.
22. R1-2202300 Discussions on TB processing over multi-slot PUSCH, LG Electronics
23. R1-2202487 Remaining issues for TB processing over multi-slot PUSCH, WILUS Inc.

# Appendix A: Proposals from contributions aggregated by topic

## A.1 Time domain resource determination

**Time domain resource determination for TBoMS for CG-PUSCH Type 1**

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| **R1-2200967 Huawei/HiSilicon*****Proposal 1:*** *For TBoMS transmission with type 1 configured grant, a new field should be introduced in IE ConfiguredGrantConfig to indicate the number* $N$ *of allocated slots for a single TBoMS transmission.** *The corresponding proposed text changes for TS 38.214 and TS 38.212 are given in Appendix A and Appendix B, respectively.*

**R1-2201658 InterDigital Inc.****Proposal 1:** The number N of allocated slots for TBoMS transmission for type 1 CG is indicated using the RRC configuration of the configured grant.**R1-2201709 Intel****Proposal 2*** Type-1 CG-PUSCH is supported for TBoMS.
* Number of slots for TBoMS transmission is configured in *ConfiguredGrantConfig*.

**R1-2201781 Apple****Proposal 1:** For type 1 configured grant, introduce IE *numberOfSlotsTBoMS-r17* in *ConfiguredGrantConfig* to indicate the number of allocated slots for TBoMS* + - Parameter *repK-r17* is to indicate the repetition number of TBoMS
		- The total number of slots allocated for TBoMS, i.e., *numberOfSlotsTBoMS-r17\** *repK-r17,* is not larger than 32

**Proposal 2** The initial transmission of a transport block for TBoMS with configured grant type 1 is the same as the agreed restriction on configured grant type 2.**R1-2202197 Sharp****Proposal 2:** A value N for indicating the number of slots for a single TBoMS is configured in *rrc-ConfiguredUplinkGrant* for type-1 configured grant. |

**Early termination of TBoMS**

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| **R1-2201925 Xiaomi****Proposal 2:** Support the early termination mechanism for TBoMS with configured grant.* FFS: Whether to support early termination of TBoMS with dynamic grant
 |

**Others**

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| **R1-2201709 Intel****Proposal 3*** For out of order handling for TBoMS:
	+ Consider Case A), B) and C) in Figure 2 of R1-2201709 as out of order scheduling.

**Proposal 4*** Agree on TP#1 for cancellation of TBoMS transmission*.*

**Proposal 5*** Agree on TP#2 for TBoMS transmission with counting based on available slots for CG-PUSCH*.*

**R1-2201925 Xiaomi****Proposal 1:** Don’t support fallback DCI format for the scheduling of TBoMS PUSCH.**R1-2202197 Sharp****Proposal 3:** Adopt Text proposal #1 (on available slot determination procedure for TBoMS with configured grant). |

## A.2 Rate-matching

**Definition of G for TBoMS and possible introduction of H**

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| **R1-2200967 Huawei/HiSilicon*****Proposal 2:*** *A new parameter H should be introduced to determine the starting coded bit.** *H is the total number of coded bits available for transmission of the transport block in a slot assuming no UCI multiplexing occurred.*

**R1-2201013 Nokia/NSB****Proposal 1.** For rate matching of TBoMS, a new variable H is introduced to calculate the starting bit index of each slot. A re-definition of G and E per slot would not be needed, but possible with no further specification change.**R1-2201105 vivo****Proposal 1:** For capturing Option-C for determination of starting bit for each slot of TBoMS, following Alt/interpretation/direction is preferred.* Alt 1: $G$ is redefined as the total number of coded bits available for transmission of the transport block in a slot;

**R1-2201165 ZTE*****Proposal 1:*** *Regarding Aspect 1, Aspect 1 – Alt 2 is slightly preferred.* **R1-2201374 CATT****Proposal 1:** For Aspect 1, prefer Alt 2, i.e. a new variable $H$ is introduced, only for TBoMS, defined as the total number of coded bits available for transmission of the transport block in a slot.**R1-2201318 Panasonic****Proposal:** Following alternative, interpretation, and direction are taken to implement Option C on the determination of the starting index of circular buffer to the specification.* Aspect 1: The definition of $G$ and $E$ for TBoMS
	+ Alt.2: A new variable $H$ is introduced, only for TBoMS, defined as the total number of coded bit available for transmission of the transport block in a slot

**R1-2201488 NTT DOCOMO****Proposal 1:** Redefine *G* as the total number of coded bits available for transmission of the transport block in a slot, because it is backward compatible in terms of the implementation.**R1-2201658 InterDigital Inc.****Proposal 2:** For TBoMS, a new variable $H$ defined as the total number of coded bits available for transmission of the transport block in a slot is introduced (Aspect 1 – Alt 2).**R1-2201709 Intel****Proposal 1*** Support Alternative 2 for Aspect 1.
	+ A new variable H is introduced only for TBoMS, which is defined as the total number of coded bits available for transmission of the transport block in a slot.

**R1-2201781 Apple****Proposal 3:** Parameter G is reinterpreted for TBoMS as the total number of coded bits available for transmission of the transport block in a slot.**R1-2201869 CMCC****Proposal 1:**Introducing a new definition for TBOMS as total number of coded bits available for transmission of the transport block in a slot. i.e. Alt 2 is preferred for the issue of Aspect 1.**R1-2201905 NEC****Proposal 1:** Support Aspect 2 - Interpretation 1, i.e. the starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.* to determine the number of bits being selected, using modified Aspect 1 – Alt 1, i.e. G is redefined, only for TBoMS, as the total number of coded bits available for transmission of the transport block in a slot;
* to determine the starting index of circular buffer, using modified Aspect 1 – Alt 2, i.e. A new variable H is introduced, only for TBoMS, defined as the total number of coded bits available for transmission of ~~the transport block~~ PUSCH in a slot;

**R1-2201925 Xiaomi****Proposal 5:** Introduce a new variable H for TBoMS to perform rate matching.**R1-2201962 Ericsson****Proposal 1.** Whether to use a redefined G or a new parameter for the determination of the total number of UL-SCH coded bits available for transmission in a slot and the determination of the index of starting coded bit is to be discussed.**Proposal 5.** A redefined G is preferred for the determination of the total number of UL-SCH coded bits available for transmission in a slot.**Proposal 6.** A new parameter H is used for the determination of the index of the starting coded bit assuming no UCI multiplexing and considering filler bits.**R1-2202027 Samsung*****Proposal 1:*** *it is concluded that: from RAN1 perspective, the G is the total number of coded bits available for transmission of the transport block for a slot.***R1-2202240 TCL*****Proposal 1:*** *G is redefined as the total number of coded bits available for transmission of the transport block in a slot (Alt 1).* |

**Value of G and E for TBoMS**

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| **R1-2200967 Huawei/HiSilicon*****Proposal 3:*** *The index of starting coded bit is determined assuming no UCI multiplexing, but the number of coded bits being selected in bit selection (value E) is determined considering UCI multiplexing.***R1-2201013 Nokia/NSB****Proposal 2.** For the value of G and E for TBoMS, adopt Interpretation 1 for Option C, i.e., the starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.**R1-2201105 vivo****Proposal 1:** For capturing Option-C for determination of starting bit for each slot of TBoMS, following Alt/interpretation/direction is preferred.* Interpretation 1: The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.

**R1-2201165 ZTE*****Proposal 2:*** *Regarding Aspect 2*, *Aspect 2 – Interpretation 1 is preferred.* **R1-2201374 CATT****Proposal 2:** For Aspect 2, Interpretation 1 should be adopted, i.e. the starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value *E*) is determined considering UCI multiplexing.**R1-2201318 Panasonic****Proposal:** Following alternative, interpretation, and direction are taken to implement Option C on the determination of the starting index of circular buffer to the specification.* Aspect 2: The value of $G$ and $E$ for TBoMS
	+ Interpretation 1: The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value $E$) is determined considering UCI multiplexing.

**R1-2201488 NTT DOCOMO****Proposal 2:** The number of bits being selected in bit selection (value *E*) should be determined considering the coded bits available for UCI multiplexing.**R1-2201658 InterDigital Inc.****Proposal 3:** The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing (Aspect 2 – Interpretation 1).**R1-2201709 Intel****Proposal 1*** Support Interpretation 1 for Aspect 2.
	+ The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value H) is determined considering UCI multiplexing.

**R1-2201781 Apple****Proposal 4:** Adopt Interpretation 2 for TBoMS rate mathiching, i.e., the starting index of circular buffer is determined assuming no UCI multiplexing, and the number of bits being selected in bit selection (value E) is determined assuming no UCI multiplexing.**R1-2201869 CMCC****Proposal 2:** The Aspect 2 – Interpretation 2 should be adopted to determine the started coded bit in circular buffer. **R1-2201905 NEC****Proposal 1:** Support Aspect 2 - Interpretation 1, i.e. the starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.* to determine the number of bits being selected, using modified Aspect 1 – Alt 1, i.e. G is redefined, only for TBoMS, as the total number of coded bits available for transmission of the transport block in a slot;
* to determine the starting index of circular buffer, using modified Aspect 1 – Alt 2, i.e. A new variable H is introduced, only for TBoMS, defined as the total number of coded bits available for transmission of ~~the transport block~~ PUSCH in a slot;

**R1-2201925 Xiaomi****Proposal 6:** Adopt Interpretation 2 for the value of H to perform bit selection and starting bit determination for TBoMS.**R1-2201962 Ericsson****Proposal 2.** For TBoMS, the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing.**Proposal 3.** For the determination of the index of the starting coded bit, a redefined G or a new parameter is equal to the total number of coded bits available for transmission of the TB in a slot assuming no UCI multiplexing in previous slots.**Proposal 5.** A redefined G is preferred for the determination of the total number of UL-SCH coded bits available for transmission in a slot.**R1-2202027 Samsung*****Proposal 2:*** *Interpretation 1 should be adopted.***R1-2202152 Qualcomm****Proposal 1:** For Option C for starting bit determination, clarify that the starting starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) for rate matching is determined considering UCI multiplexing.**R1-2202240 TCL*****Proposal 2:***  *The starting index of circular buffer is determined assuming no UCI multiplexing, but the number of bits being selected in bit selection (value E) is determined considering UCI multiplexing (Interpretation 1).***R1-2202487 WILUS*****Proposal 1:*** *The starting index of circular buffer is determined assuming no UCI multiplexing, and the number of bits being selected in bit selection (value E) is determined assuming no UCI multiplexing (Interpretation 2).* |

**Handling of the filler bits for TBoMS**

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| **R1-2200967 Huawei/HiSilicon*****Proposal 4:*** *Filler bits should be considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.***R1-2201013 Nokia/NSB****Proposal 3.** Direction 1 should be adopted for handling the filler bits, i.e., filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.**R1-2201105 vivo****Proposal 1:** For capturing Option-C for determination of starting bit for each slot of TBoMS, following Alt/interpretation/direction is preferred.* On handing filler bits in TBoMS, either Direction 1 or Direction 2 is fine.

**R1-2201165 ZTE*****Proposal 3:*** *Both directions on the handling of filler bits are acceptable and Aspect 3 – Direction 2 is slightly preferred.***R1-2201274 OPPO*****Proposal 1:*** *Filler bits are considered in the description of the solution in the specification for starting bits determination of each slot for TBoMS.***R1-2201374 CATT****Proposal 3:** For Aspect 3, prefer Direction 1, i.e. filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.**R1-2201318 Panasonic****Proposal:** Following alternative, interpretation, and direction are taken to implement Option C on the determination of the starting index of circular buffer to the specification.* Aspect 3: Handling of the filler bits in TBoMS
	+ Direction 1: Filler bits are considered to predetermine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.

**R1-2201488 NTT DOCOMO****Proposal 3:** Filler bits should be considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.**R1-2201658 InterDigital Inc.****Proposal 4:** Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots (Aspect 3 – Direction 1).**R1-2201709 Intel****Proposal 1*** Support Direction 1 for Aspect 3.
	+ Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.

**R1-2201781 Apple****Proposal 5:** Direction 1 is adopted for filler bits handling in TBoMS, i.e., Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots.**R1-2201869 CMCC****Proposal 3:** Aspect 3 – Direction 1 is preferred considering it will not induce the transmission of overlapped bits and efficiency of operations.**R1-2201905 NEC****Proposal 2:** The difference between Aspect 3 – Direction 1 and Aspect 3 – Direction 2 is only on the calculation of the starting index of circular buffer. No other impact is expected.**Proposal 5:** If there is no consensus in the group on either considering filler bits or not considering filler bits, a compromised proposal is to support both under different condition.* when the number of filler bits in circular buffer is less than a threshold, e.g. $K-K^{'}\leq Z\_{c}$ , not consider filler bit, i.e. option 1 in proposal 4;
* when the number of filler bits in circular buffer is larger than a threshold, e.g. $K-K^{'}>Z\_{c}$ , consider filler bit, i.e. option 2 in proposal 4;

**R1-2201925 Xiaomi****Proposal 7:** Don’t take filler bits into consideration for determining the index of starting bit for each allocated slot for TBoMS.**R1-2201962 Ericsson****Proposal 4.** Filler bits are considered for the determination of the index of the starting coded bit.**Proposal 6.** A new parameter H is used for the determination of the index of the starting coded bit assuming no UCI multiplexing and considering filler bits.**R1-2202027 Samsung*****Proposal 3:*** *Direction 2 (no consideration of filler bits) should be supported.***R1-2202152 Qualcomm****Proposal 2:** For starting bit determination for each slot of a TBOMS, filler bits shall be taken into account.**R1-2202197 Sharp****Proposal 1:** Filler bits are considered to implement Option C as agreed in RAN plenary.**R1-2202240 TCL*****Proposal 3:*** *Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots (Direction 1).***R1-2202487 WILUS*****Proposal 2:*** *Filler bits are considered to pre-determine the index of the starting bit for each allocated slot for TBoMS, to ensure no overlap exists between bit sequences transmitted over consecutive slots (Direction 1).* |

**Complete proposals for the determination of the index of starting coded bits in each allocated slot for TBoMS**

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| **R1-2200967 Huawei/HiSilicon*****Proposal 5:*** *For TBoMS transmission, the index of starting coded bits can be determined based on the following method, and the corresponding proposed text changes for TS 38.212 is given in Appendix C.*

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| *The index of starting coded bits* $k\_{0}$ *in each slot allocated for TBoMS transmission can be determined as follows:** *For the first slot within N slots in one TBoMS repetition,* $k\_{0}$ *is determined by RV;*
* *For the other slots within N slots in one TBoMS repetition,* $k\_{0}=\left(k\_{0}^{'}+H+τ\right)modN\_{cb}$*, where*
	+ $k\_{0}^{'}$ *denotes the index of starting coded bit in the previous slot,*
	+ *H is the total number of coded bits available for transmission of the transport block in the previous slot assuming no UCI multiplexing occurred,*
	+ $τ$ *denotes the number of filler bits skipped during the bit selection in the previous slot, and*
	+ $N\_{cb}$ *denotes the length of circular buffer.*
 |

**R1-2201658 InterDigital Inc.****Proposal 5:** The index of the starting coded bits in the circular buffer for the $n$-th slot of a single TBoMS, i.e., $s\_{n}$, is calculated as $$s\_{n}=\left\{\begin{matrix}k\_{0}&n=0\\(s\_{n-1}+τ\_{n-1})mod N\_{cb}&n=1, …,N-1\end{matrix}\right.$$Where:* $k\_{0}$ is the starting position of different redundancy version
* $τ\_{n-1}$ is the total number of coded bits available for transmission of the TB in a slot allocated for TBoMS (new introduced parameter *H*), assuming no UCI multiplexing, plus filler bits in the $\left(n-1\right)$-th slot allocated for TBoMS, if any.
* $N\_{cb}$ is the circular buffer length
* N is the number of slots allocated for TBoMS.

**R1-2201905 NEC****Proposal 3:** Direct calculation is used to determine the starting index of circular buffer.* Note 1: Direct calculation means to calculate the starting index directly based on k0 (RV indication), H (in proposal 1), in addition to the starting and ending index of filler.
* Note 2: Indirect calculation means to calculate the starting index indirectly by inspecting circular buffer in advance to skip filler bits to find the starting index.

**R1-2202300 LGE*****Proposal :*** *The index of the starting coded bit in the circular buffer for the* $n$*-th slot of a single TBoMS, i.e.,* $s\_{n}$*, is calculated as* $s\_{n}=\left\{\begin{matrix}k\_{0}&n=0\\(s\_{n-1}+τ\_{n-1})mod N\_{cb}&n=1, …,N-1\end{matrix}\right.$*,**Where:** $τ\_{n-1}$ *is given by the total number of coded bits available for transmission of the TB in a slot allocated for TBoMS (denoted as H), assuming no UCI multiplexing, plus filler bits in the* $\left(n-1\right)$*-th slot allocated for TBoMS, if any.*
* *N is the number of slots allocated for TBoMS.*

*Note: this equation describes the logic of the bit-selection for TBoMS; decision on where and how to capture this in TS 38.212 is up to the Editor.* |

## A.3 UCI multiplexing, dropping rules, uplink cancellation

**UCI multiplexing**

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| **R1-2201165 ZTE*****Proposal 4:*** *For single TBoMS transmission and no overlapping PUCCH with HARQ-ACK within a span of one PUCCH slot, if T-DAI in UL grant is not equal to 4 for Type 2 codebook or is equal to 1 for Type 1 codebook, the UE should multiplex HARQ-ACK in the PUSCH following the T-DAI in UL grant.****Proposal 5:*** *One of the slots for TBoMS transmission should be specified for HARQ-ACK multiplexing if the UE does not know the PUCCH slot due to missing detection of the DL DCI and the T-DAI in the UL grant is not equal to 4 for Type 2 codebook or is equal to 1 for Type 1 codebook.***R1-2201709 Intel****Proposal 6*** Existing mechanism as defined for SP/A-CSI multiplexing on PUSCH repetition type A is reused for that for TBoMS.
* Agree on TP#3 for SP/A-CSI multiplexing on TBoMS*.*
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## A.4 FDRA

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| **R1-2201925 Xiaomi****Proposal 4:** Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling.**R1-2202240 TCL*****Proposal 5:*** *The maximum number of PRBs can be limited when TBoMS is enabled.* |

## A.5 TBoMS repetitions

**Slot mapping for TBoMS repetitions**

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| **R1-2201658 InterDigital Inc.****Proposal 6:** Support type 1(non-interleaved) mapping when DMRS bundling is enabled and type 2 (interleaved) mapping for TBoMS repetitions when DMRS bundling is disabled shown in Figure 1Figure 1 Examples of TBoMS repetition mapping: Type 1 (non-interleaved mapping) vs. Type 2 (interleaved mapping) for N=4 (slots), M=2 (repetitions) |

**Others**

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| **R1-2201274 OPPO*****Proposed TP1 for 6.1.2.1 38.214.***……For a PUSCH transmission scheduled by DCI format 0\_1, or 0\_2, or 0\_0 with CRC scrambled by TC-RNTI, the redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, …$N∙K$-1, is determined according to table 6.1.2.1-2. For a PUSCH transmission of a PUSCH repetition Type A scheduled by RAR UL grant, the redundancy version to be applied on the *n*th transmission occasion of the TB, where n = 0, 1, …$N∙K$-1, is determined according to the first row of Table 6.1.2.1-2. Table 6.1.2.1-2: Redundancy version for PUSCH transmission

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| *rvid* indicated by the DCI scheduling the PUSCH | *rvid* to be applied to *n*th transmission occasion (repetition Type A~~)~~  or repetition of TB processing over multiple slots) or *n*th actual repetition (repetition Type B) |
| *((n-(n mod N))/N)* mod 4 = 0 | *((n-(n mod N))/N)* mod 4 = 0 | *((n-(n mod N))/N)* mod 4 = 0 | *((n-(n mod N))/N)* mod 4 = 0 |
| 0 | 0 | 2 | 3 | 1 |
| 2 | 2 | 3 | 1 | 0 |
| 3 | 3 | 1 | 0 | 2 |
| 1 | 1 | 0 | 2 | 3 |

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## A.6 Frequency hopping

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| **R1-2201925 Xiaomi****Proposal 3:** Support intra-TB frequency hopping for TB processing over multi-slot PUSCH. |

## A.7 Interlaced TBoMS transmissions

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| **R1-2202152 Qualcomm****Proposal 3:** Interlaced TBoMS transmissions (carrying different TBs) are not permitted. A UE does not expect a TBoMS transmission in a component carrier to begin before the completion of an ongoing TBoMS transmission in the same component carrier. |

## A.8 Data Rate calculation and UE behavior related to TBS determination

**Data rate calculation**

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| **R1-2202240 TCL*****Proposal 4:*** *The data rate constraint conditions should be modified for TBoMS.*  |

# Appendix B: Previous agreements on TB processing over multi-slot PUSCH

Working assumption: 🡪 Agreement:

For TBS determination of TBoMS:

* *NohPRB* is configured by xOverhead and represents the overhead per slot.
* *NohPRB* is assumed to be the same for all the slots over which the TBoMS transmission is allocated.

Note: xOverhead configuration is as per Rel-15/16.

Agreement:

The following 2 options for time domain resource determination for TBoMS are considered for down-selection during RAN1 #105-e:

* Option 1: Time domain resource determination for TBoMS can be performed only via PUSCH repetition Type A like TDRA.
* Option 2: Time domain resource determination for TBoMS can be performed via PUSCH repetition Type A like TDRA or via PUSCH repetition Type B like TDRA.
	1. The use of PUSCH repetition Type B like TDRA for time domain resource determination is according to an additional UE capability for a TBoMS capable UE.
	2. FFS DMRS pattern for PUSCH repetition Type B like TDRA

**Working assumption**

A transmission occasion for TBoMS (TOT) is constituted of at least one slot or multiple consecutive physical slots for UL transmission

* FFS: whether the concept of TOT will be used for designing aspects related to signal generation, e.g., rate-matching, power control, etc.
* FFS: whether such concept will be specified or not.

Agreement:

* The structure of TBoMS will be according to only one of these two options (to be down-selected in RAN1#106-e)
	+ Option 3, if a design based on single RV is adopted.
	+ Option 4, if a design based on different RVs is adopted.
* FFS: other details, e.g., rate-matching, TBS determination, collision handling, etc.
* The single RV is not constrained to have only the same coded bits in each slot or in each TOT
* The concept of TOT as per the corresponding Working assumption is used to define Option 3 and Option 4 and may or may not be used to design other details, e.g., rate-matching, TBS determination, collision handling and so on.

Agreement:

Time domain resource determination for TBoMS can be performed only via PUSCH repetition Type A like TDRA.

* FFS: details
* FFS: whether or not optimizations for time domain resource determination are necessary for allocating resource in the S slots (for the unpaired spectrum case)

**Working assumption**

Allocating resources for TBoMS in the special slot in TDD is possible according to the agreed time domain resource determination for TBoMS.

Agreement:

The following three options for rate-matching for TBoMS are considered for down-selection during RAN1 #106-e, where only one option will be selected:

* Option a: Rate-matching is performed per slot;
* Option b: Rate matching is performed continuously across all the allocated slot(s) per TOT;
* Option c: Rate matching is performed continuously across all the allocated slots/TOTs for TBoMS

Note: “rate-matching is performed per X” means that the time unit for the bit selection and bit interleaving is X.

Note2: the above 3 options imply that the UL resource in the time unit may or may not be consecutive (depending on the given option)

Agreement:

Number of slots allocated for TBoMS is determined by using a row index of a TDRA list, configured via RRC.

* FFS: details.

Agreement:

The following approach is used to calculate NInfo for TBoMS:

* Approach 2: Based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by K≥1.
	+ FFS: the definition of K.

L is the number of symbols determined using the SLIV of PUSCH indicated via TDRA

FFS: impacts and further details if repetitions of TBoMS is supported.

FFS: whether the symbols over which the TBoMS transmission is allocated are the same or can be different from the symbols over which the TBoMS transmission is performed, and details on how to handle such scenarios.

Agreement:

Non-consecutive physical slots for UL transmission can be used to transmit TBoMS at least for unpaired spectrum.

* How TBoMS is transmitted over non-consecutive physical slots for UL transmission for unpaired spectrum is to be discussed further.
* Whether and how non-consecutive physical slots for UL transmission can be used to transmit TBoMS for paired spectrum and SUL band as well, is to be discussed further.

Working Assumption

The concept of transmission occasion for TBoMS (TOT) is utilized for the purpose of discussion, where a TOT is constituted of time domain resources which may or may not span multiple slots

* FFS: details, whether multiple slots which constitute a TOT are consecutive or non-consecutive physical slots for UL transmissions
* FFS: other details.
* FFS: whether such concept will be specified or not.

Agreements**:**

For the definition of a single TBoMS, down select among the following options:

* **Option 1**: Only one TOT is determined for a TBoMS. The TB is transmitted on the TOT using a single RV.
	+ FFS: whether and how the single RV is rate matched across the TOT, e.g., continuous rate-matching across the TOT, rate matched for each slot and so on.
* **Option 2**: Only one TOT is determined for a TBoMS. The TB is transmitted on the TOT using different RVs.
	+ FFS: how RV index is refreshed within the TOT, e.g. after each slot boundary, at every jump between two non-contiguous resources, if any, and so on.
* **Option 3**: Multiple TOTs are determined for a TBoMS. The TB is transmitted on the multiple TOTs using a single RV.
	+ FFS: how the single RV is rate matched across single or multiple TOTs, e.g., rate matched for each TOT, rate matched for all the TOTs, rate matched for each slot and so on.
* **Option 4**: Multiple TOTs are determined for a TBoMS. The TB is transmitted on the multiple TOTs using different RVs.
	+ FFS: whether and how RV index is refreshed within one TOT, e.g. after each slot boundary, at every jump between two non-contiguous resources, if any, and so on.
* FFS: the exact TBS determination procedure.
* FFS: whether a single TBoMS can be repeated or not.
* FFS: other implications, e.g., power control, collision handling and so on.

Agreement:

* Consider one or two of the following options as starting points to design time domain resource determination of TBoMS
	+ PUSCH repetition Type A like TDRA, i.e., the number of allocated symbols is the same in each slot.
	+ PUSCH repetition type B like TDRA, i.e., the number of allocated symbols in each slot are different.

Agreement:

* Consecutive physical slots for UL transmission can be used for TBoMS for unpaired spectrum.
	+ To resolve in RAN1#104b-e whether to support non-consecutive physical slots for UL transmission for TBoMS for unpaired spectrum.
* Consecutive physical slots for UL transmission can be used for TBoMS for paired spectrum and the SUL band.
	+ FFS if non-consecutive physical slots for UL transmission are also supported for paired spectrum and the SUL band.

Agreement:

* The same number of PRBs per symbol is allocated across slots for TBoMS transmission.

Agreement:

For TBoMS, the maximum supported TBS should not exceed legacy maximum supported TBS in Rel-15/16, for the same number of layers.

* FFS: Details and further constraints on the applicability of TBoMS.

Agreement:

One or two of the following approaches will be considered as a starting point to decide how NInfo for TBoMS is calculated (aiming for down selection in RAN1 #104-bis-e):

* Approach 1: Based on all REs determined across the symbols or slots (FFS whether symbols or slots are used) over which the TBoMS transmission is allocated.
* Approach 2: Based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by K≥1.
	+ FFS: the definition of K.

Note: L is the number of symbols determined using the SLIV of PUSCH indicated via TDRA

FFS: impacts and further details if repetitions of TBoMS is supported.

FFS: whether the symbols over which the TBoMS transmission is allocated are the same or can be different from the symbols over which the TBoMS transmission is performed, and details on how to handle such scenarios.

Agreement:

One or two of the following options will be considered (aiming for down-selection in RAN1#104b-e) to calculate NohPRB for TBoMS:

* Option 1: NohPRB is assumed to be the same for all the slots over which the TBoMS transmission is allocated and can be configured by xOverhead as in Rel-15/16.
* Option 2: NohPRB is calculated depending on both xOverhead and the number of symbols or slots (FFS whether symbol or slot are used) over which the TBoMS transmission is allocated.
	+ FFS: if either the number of symbols or the number of slots is used.
	+ FFS: if xOverhead is separately configured from the one in Rel-15/16.

FFS: impacts and further details if repetitions of TBoMS is supported.

FFS: whether the symbols over which the TBoMS transmission is allocated are the same or can be different from the symbols over which the TBoMS transmission is performed.

Agreement

The number of slots allocated for TBoMS is counted based on the available slots for UL transmission.

* The determination of available slots for PUSCH repetition Type A, as defined in AI 8.8.1.1, is reused.
* Note: Available slots for FDD or SUL could be revisited according to discussion in AI 8.8.1.1

Agreement

Allocating resources for TBoMS in the special slot in TDD is possible according to the agreed time domain resource determination for TBoMS.

* No further optimization to allocate resources for TBoMS in the special slot is supported.

Agreement

TBoMS is supported for both configured grant and dynamic grant.

Working Assumption

Single TBoMS structure of Option 3 is selected

* **Option 3**: Multiple TOTs are determined for a TBoMS. The TB is transmitted on the multiple TOTs using a single RV.
	+ FFS: how the single RV is rate matched across single or multiple TOTs, e.g., rate matched for each TOT, rate matched for all the TOTs, rate matched for each slot and so on.

**Agreement**

To calculate $N\_{info}$ for TBS determination, at least the scaling factor value K=N is supported, where N is the number of allocated slots for a single TBoMS.

FFS: whether further values 1<K<N are supported.

FFS: details related to the indication of K.

Note: No supporting the case K=1 for a single TBoMS.

**Agreement**

Repetitions of a single TBoMS are supported, where:

* The number of repetitions is denoted by M, i.e., the total number of allocated slots for TBoMS repetition is M\*N.
	+ Note: M\*N is no more than the max number of repetitions agreed for repetition Type A enhancement in agenda 8.8.1.1
* Available slot determination is according to existing agreements.
* The number and location of allocated symbols within an allocated slot for TBoMS transmission are the same among all repeated single TBoMS.
* FFS other aspects of TBoMS repetitions, e.g.:
	+ Details of time domain resource indication.
	+ Supported values for the number of TBoMS repetitions.
	+ How to indicate the number of TBoMS repetitions.
	+ Interactions with frequency hopping and precoder cycling across the M groups of N allocated slots for each single TBoMS repetition.
	+ Whether RV indices should be cycled across the M groups of N allocated slots for each single TBoMS repetition.
	+ Details of TBoMS retransmissions.
	+ Potential MAC layer impact, but should be decided by RAN2

Note: No additional dropping rule optimization will be introduced other than dropping rules for single TBoMS transmission.

**Agreement**

The UE determines whether or not to drop a slot determined as available for TBoMS transmission according to Rel-15/16 PUSCH dropping rules, where the dropped slot is still counted in the N allocated slots for the single TBoMS transmission.

FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s)

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| **Conclusion**Bit interleaving performed per ToT is precluded, and ToT will not be used in further discussion. |

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| **Conclusion**The N allocated slots for the single TBoMS are defined as the number of slots after available slot determination for a single TBoMS transmission, before dropping rules are applied.Note: the number of final transmitted slots for the single TBoMS may be lower than N, depending on dropping rules for TBoMS transmission. |

**Agreement**

* For transmission power determination of TBoMS transmission in Rel-17, RAN1 to down-select one of the following two options:
* Option 1: The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals
* Option 2: The transmission power determination of TBoMS should be based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.
* FFS: details on BPRE

**Agreement**

The number of MIMO layers (rank) for TBoMS transmission in Rel-17 is limited to 1.

**Agreement**

For a single TBoMS transmission and TBoMS repetitions in Rel-17, at least the legacy Rel-15/16 inter-slot frequency hopping framework used in PUSCH repetition Type A is supported.

* FFS: other frequency hopping schemes.

**Agreement**

* The number *N* of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via *PUSCH-TimeDomainAllocationList*. The ~~existing~~column for configuring the number of repetitions in the TDRA for Rel-17 PUSCH repetition Type A, i.e., *numberOfRepetitions,*is used for indicating the number of repetitions *M* of a single TBoMS, when TBoMS transmission is enabled.
* FFS: supported values of *N* and *M.*
* FFS: how to enable the TBoMS transmission
* FFS: details of retransmission of TBoMS

**Agreement**

For the repetition of a single TBoMS transmission, redundancy versions (RVs) are cycled across the TBoMS repetitions. The legacy Rel-15/16 RV sequences and RV index indication are reused.

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| **Conclusion**Values 1<K<N for the scaling factor to calculate N\_info for TBS determination for TBoMS transmission in Rel-17 are not supported. |

**Agreement**

At least the following values are supported in Rel-17 for the number*N* of allocated slots for the single TBoMS:

* 

FFS: whether *N*=1 is also supported depends on how TBoMS transmission feature is enabled (or disabled)

FFS: other values, if any.

FFS: further constraints on N\*M

**FL’s proposal 13**

The following values are supported in Rel-17 for the number*M*of repetitions of the single TBoMS:

* 

FFS: further constraints on N\*M, e.g., N\*M is a valid value according to agreements in AI 8.8.1.1

**Agreement**

BPRE for TBOMS is calculated as  where N is the number of slots allocated for a single TBOMS and  is the number of allocated REs in one allocated slot of a single TBOMS.

Note: How this equation or its equivalent is captured in the specification is left to the editor

**Agreement**

For a single TBoMS transmission and TBoMS repetitions in Rel-17, the legacy Rel-15/16 intra-slot frequency hopping framework used in PUSCH repetition Type A is supported.

* FFS: other frequency hopping schemes.

**Working Assumption**

For TBoMS in Rel-17, the following is supported:

* Bit interleaving is performed per slot.

       The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.

* Transmission is limited to one CB only.
* FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not
* FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS

Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further.

**Agreement**

For the bit selection for each transmitted slot for TBoMS, one of the following is to be down selected in RAN1 #107-e for determining the index of the starting coded bit in the circular buffer:

* Option B: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot.
* Option C: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.

FFS: whether the index of the starting coded bit for each transmitted slot is expressed as a multiple integer of the lifting size Zc

Note: Dropping/cancellation rules are not considered for the starting bit position determination in both Option B and Option C.

**Agreement**

For TBoMS transmission in Rel-17:

* TBoMS ~~transmission~~feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.
* ~~Dynamic switching between at least TboMS transmission and the legacy single-slot PUSCH transmission, by using a row in the TDRA table, is supported.~~
	+ TBoMS transmission is enabled when N>1, where N is the number of allocated slots for a single TBoMS.
	+ Single-slot PUSCH transmission is enabled when N=1.
	+ Supported combinations of N and M that can be configured in the TDRA table, these combinations are constrained by retransmission are to be further discussed

**Agreement**

A single RV is used to transmit a single TBoMS.

Note: It is common assumption for option B and option C for “Starting bit in each slot for the single TBoMS”

Note: below working assumption does not need confirm.

Working Assumption

Single TBoMS structure of Option 3 is selected

* **Option 3**: Multiple TOTs are determined for a TBoMS. The TB is transmitted on the multiple TOTs using a single RV.

FFS: how the single RV is rate matched across single or multiple TOTs, e.g., rate matched for each TOT, rate matched for all the TOTs, rate matched for each slot and so on.

Agreement

The working assumption is confirmed.

**Working Assumption**

For TBoMS in Rel-17, the following is supported:

* Bit interleaving is performed per slot.

       The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.

* Transmission is limited to one CB only.
* FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not
* FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS

Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further.

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| **Conclusion**There is no consensus in RAN1 to introduce any restriction on the combinations of N and M that can be configured in the TDRA table, other than the already agreed N\*M <= 32 restriction. |

**Agreement**

* For TBoMS, UCI is multiplexed on the individual overlapping slot for UL transmission in one carrier
* FFS: timeline requirements
* FFS: details on the calculation of the number of coded modulation symbols per layer for UCI multiplexing on a single TBoMS.
* Note: no new UCI multiplexing mechanism other than existing puncturing or rate-matching is introduced for TBoMS in Rel-17.

**Agreement**

For TBoMS repetitions, if the parameter numberOfRepetitions is not configured in the TDRA table, then the number of repetitions M of a single TBoMS is equal to 1.

**Agreement**

For a configured grant type 2, if M=1, or if M>1 and the configured grant is configured with startingFromRV0 set to 'off', the initial transmission of the transport block may only start at the first slot of the N\*M slots determined as available for PUSCH transmission of TBoMS. Otherwise, the initial transmission of the transport block may start at

-             The first slot of the N\*M slots determined as available for PUSCH transmission of TBoMS if the configured RV sequence is {0,2,3,1},

-             The first slot of any of the M groups of N slots determined as available for PUSCH transmission of TBoMS associated with RV=0, if the configured RV sequence is {0,3,0,3} or {0,0,0,0}.

Note: It is up to Editor to decide how to capture these rules.

**Agreement**

For UCI multiplexing on an available slot for TBoMS, the following are supported in Rel-17 for calculating , , ,  and :

*   is the number of symbols in an available slot for TBoMS in which UCI is multiplexed.
* The CB size is scaled by , where N is the number of slots allocated for TBoMS, i.e.,  becomes .

Note: It is up to the Editor to decide how to capture the scaling in the specification.

**Agreement**

The UE does not expect NW to indicate a TBoMS configuration which results in a TBS which exceeds the maximum TBS for single CB transmission.

**Agreement**

For the retransmission of a single TBoMS with or without repetition in Rel-17:

* The gNB schedules only complete retransmissions of TBs.
* How the retransmission of the entire TB is done is up to gNB, e.g., could be single slot PUSCH retransmission or TBoMS retransmission, etc.

Note: this has no specification impact.

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| **Conclusion**There is no consensus in RAN1 on whether the index of the starting coded bit in the circular buffer should be expressed as function of the lifting size $Z\_{c}$. |

**Agreement**

The Rel-16 per-slot transmission occasion definition is re-used for transmission power determination for TBoMS.

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| **Conclusion** * Configuration and/or indication of priority of TBoMS transmission is up to gNB.
* No new TBoMS-specific collision handling and dropping rules are introduced.
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Agreement

The following text proposal for TS 38.213, Clause 9.2.6~~, should be~~ is adopted.

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| 9.2.6       PUCCH repetition procedure<omitted text>If a UE would transmit a PUCCH over a first number  of slots and the UE would transmit a PUSCH with repetition Type A or a TB processing over multiple slots over a second number of slots, and the PUCCH transmission would overlap with the PUSCH transmission in one or more slots, and the conditions in clause 9.2.5 for multiplexing the UCI in the PUSCH are satisfied in the overlapping slots, the UE transmits the PUCCH and does not transmit the PUSCH in the overlapping slots.<omitted text> |

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| **Conclusion**Existing rules can be reused for UCI multiplexing on PUSCH in case of TBoMS and UL CA scenario. |

Agreement

A UE that supports TBoMS supports all values of N defined for TBoMS, and a UE that supports TBoMS repetition supports all values of M defined for TBoMS repetition.

Agreement

The use of TBoMS for HD-FDD UE with counting on available slot is supported.

Note: existing mechanism as in AI8.8.1.1 should be applied for this case

Agreement

* For CG-PUSCH transmissions of TBoMS, the UE is not expected to be configured with the time duration for the N\*M transmissions larger than the time duration derived by the periodicity P.