3GPP TSG RAN WG1 #107-bis-e R1-2200680

e-Meeting, January 17 – 25, 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 #107-e [3]-[21].

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**
  + Time domain resource determination
    - Time domain resource determination for TBoMS for CG-PUSCH
    - Time domain resource determination for TBoMS for CG-PUSCH Type 1
  + Rate matching
    - Starting bit in each slot for the single TBoMS according to Option C
  + UCI multiplexing
    - Timeline requirements
    - Dropping rules
    - HARQ-ACK multiplexing in case of missed DCI
    - The case of UL CA
* **Mid priority aspects**
  + Time domain resource determination
    - Candidate values for N
    - Candidate values for M
  + Data rate calculation and UE behavior related to TBS determination
    - How to handle configuration of TBS larger than the size of one CB
  + Transmission power determination
  + Support of TBoMS by HD-FDD UE
* **Other aspects**
  + Time domain resource determination
    - Support of TBoMS in case of counting based on physical slots
    - Early termination of TBoMS
    - Out of order handling for TBoMS
  + TBS determination
    - TBS capping
  + FDRA
  + TBoMS repetitions
    - Slot mapping for TBoMS repetitions
  + Frequency hopping
  + TBoMS retransmission
  + Interlaced TBoMS transmissions
  + DCI format for scheduling of TBoMS

The categorization above will determine the initial priority order for the discussions to be held for AI 8.8.1.2. In this context, sections 2.1 and 2.2 will focus on discussions which will (2.1 and some parts of 2.2) and may (remaining parts of 2.2) be discussed during RAN1 #107-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

Seven high priority aspects are identified at the beginning of the meeting:

1. Time domain resource determination
   1. Time domain resource determination for TBoMS for CG-PUSCH
   2. Time domain resource determination for TBoMS for CG-PUSCH Type 1
2. Rate matching
   * + 1. Starting bit in each slot for the single TBoMS according to Option C
3. UCI Multiplexing
   1. Timeline requirements
   2. Dropping rules
   3. HARQ-ACK multiplexing in case of missed DCI
   4. The case of UL CA

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

### [OPEN] Time domain resource determination

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail. Three high-level sub-aspects can be isolated as illustrated above. The summary of companies’ preferences and opinions based on the contributions is organized accordingly.

#### [OPEN] **Time domain resource determination for TBoMS for CG-PUSCH**

Companies’ preferences concerning the time domain resource determination for TBoMS for CG-PUSCH are as follows:

* The UE is not expected to be configured with the time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the time duration derived by the periodicity P **[2]**:
  + - Interdigital [11], Ericsson [18]

Furthermore, one company (Nokia/NSB [17]) brought forward a TP which proposes to capture the fact that the UE is not expected to be configured with the time duration for N\*K transmissions larger than the time duration derived by the periodicity P, where N is the number of allocated slots for TBoMS and K is the number of TBoMS repetitions.

This coincides with the preference expressed by the two companies mentioned above.

Finally, it is worth considering that a discussion on this aspect was already carried out during RAN1 #107-e, with no company objecting what is proposed by the 3 companies above. Eventually the proposal was never discussed online, nor via email, and a corresponding agreement was not made.

FL’s opinion is that if no strong objection exists, a quick agreement should be made on this aspect to switch the focus on other issues for the rest of the meeting.

The following proposal is formulated.

**FL’s proposal 1**

* **For 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.**
* **The above “time duration for the N\*M transmission” means the time duration between the start of the 1st slot of the N\*M available slots for TBoMS and the end of the last slot of the N\*M available slots for TBoMS, for any instance of a CG Type 2 period.**

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

Companies are invited to express their views on **FL’s proposal 1** below. Please comment **only if you have strong concerns**. If you do so, please also ensure you provide an alternative formulation of the proposal which captures the current spirit. Once again, it is very important for everyone to be **pragmatic and constructive**. Thank you.

**FL’s proposal 1**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 1** |  |
| **Do not support FL’s Proposal 1** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 1, if any. |
|  |  |
|  |  |
|  |  |

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

Several companies commented on this aspect. The following proposals have been made:

* Type-1 CG-PUSCH is supported for TBoMS and the number of allocated slots for TBoMS is indicated using a new RRC parameter in ConfiguredGrantConfig **[4]**:
  + - Huawei/HiSi [3], Intel [12], Apple [13], Sharp [19]
* Type-1 CG for TBoMS is not supported **[2]**:
  + - Vivo [6], Nokia/NSB [17]

Additionally, one company (CMCC [9]) proposes that if Type-1 CG-PUSCH is supported for TBOMS, no impact to legacy UEs should be ensured.

From FL’s perspective, a decision on whether support for Type-1 CG-PUSCH for TBoMS should be added cannot be made unless the group decide to revert a couple of existing agreements on how the number of slots allocated to TBoMS is indicated to UE.

Indeed, the following two agreements exist:

|  |
| --- |
| **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 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 TBoMS transmission in Rel-17:   * TBoMS 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.   + 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 |

From the above we can see that RAN1 already agreed that:

* The number *N* of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via *PUSCH-TimeDomainAllocationList*.
* TBoMS 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.
* No FFS was agreed related to possible other ways to indicate the number *N* of allocated slots for TBoMS or enabling/disabling the TBoMS feature.

Therefore, if Type-1 CG-PUSCH was to be supported for TBoMS we would have that:

* The number *N* of allocated slots for TBoMS **would not be** indicated via a new column added to the TDRA table configured via *PUSCH-TimeDomainAllocationList*.
* TBoMS feature **would not be** enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.

As a result, **the two existing agreements would not be respected in this case**.

For completeness, it should also be noted that one argument used by the proponents of the support of Type-1 CG-PUSCH for TBoMS is that the following agreement also exists:

|  |
| --- |
| Agreement  TBoMS is supported for both configured grant and dynamic grant. |

From FL’s perspective, this last agreement is fully respected by current specification, where means to configure and schedule TBoMS exist for both DG and CG-PUSCH (Type 2). Indeed, the agreement does not state that all types of CG-PUSCH should allow the configuration and scheduling of TBoMS transmission.

Given the above observations, I would start the discussion with a question.

***2.1.1.2-Q1*** *Should existing agreements on how the number N of allocated slots for TBoMS is indicated and how the TBoMS feature is enabled/disabled be reverted?*

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

FL’s recommendation is to have a first round of discussion among companies about **2.1.1.2-Q1**. Corresponding tables are added below to this end. Companies are invited to be constructive, given the very limited available time and the relevance of this matter. Thank you.

**2.1.1.2-Q1**

|  |  |
| --- | --- |
|  | Company’s name for the answer to 2.1.1.2-Q1 |
| **Yes** |  |
| **No** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.2-Q1, if any. |
|  |  |
|  |  |
|  |  |

### [OPEN] Rate Matching

This aspect has been discussed in detail in several contributions, with specific focus on the index of the starting coded bits in each slot for TBoMS, following the agreement on Option C made during RAN #90-e.

Several contributions discussed how to capture this agreement in the specification. Proposals were made either in the form of explicit proposals (on the concepts) or in the form of text proposals. Concerning, the former type, from FL’s perspective the details of Option C are already very much clear on aspects such as the impact of dropping a slot on the bit selection, and the impact of the UCI multiplexing. Indeed, this has been the subject of numerous discussions, and yielded a very clear agreement during RAN1 #106-b-e (the part related to Option B is grayed out for simplicity):

|  |
| --- |
| **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. |

In summary, these aspects of the bit selection are already agreed:

* For each transmitted slot, 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
* Dropping/cancellation rules are not considered for the starting bit position determination in the bit-selection procedure.

Therefore, no rate-matching operation can occur in TBoMS and only bit puncturing is supported, dropped/cancelled slots do not impact the index of the starting coded bit for each transmitted slot.

In this context, one company (Huawei/Hisi [3]) proposed to express the index of the starting coded bit in the circular buffer as function of the lifting size . This issue has been debated repeatedly during the past meetings. No consensus could be achieved in the group on the benefits and the need of such constraint, and no agreement could be made. From FL’s perspective, there is no reason to reopen this discussion a simple conclusion can be sufficient to close the matter (please see below).

Now, moving to the text proposal discussion, from FL’s perspective there are two core decisions to be taken before deciding how to capture the agreed bit selection mechanism in the specification:

1. The same number of bits is selected for each allocated slot for TBoMS. Therefore, the offset between the starting coded bits of any two allocated slots for TBoMS is always an integer multiple of the number of bits selected in one slot. In this context, does the index of starting coded bit for each allocated slot need to be expressed as a function of the index of the starting coded bit for the previous allocated slot or rather as a function of the index of the starting coded bit for the first allocated slot for TBoMS?
2. If we focus on TS 38.212, we observe that rate matching procedures for PUSCH are described in two Clauses, i.e., 5.4.2 and 6.2.5. More precisely, 5.4.2 describes general procedures for Rate matching for LDPC code, valid for both PDSCH and PUSCH, whereas 6.2.5 describes Rate matching procedures for PUSCH only. In this context, two possible options exist to capture the description of the bit selection for TBoMS:
   1. Bit selection for TBoMS is described in Clause 5.4.2.1 only, where conditions on RRC parameters valid only for PUSCH are described, i.e., making it the description less general and arguably less aligned with the spirit of the Clause.
   2. Bit selection of TBoMS is described in Clause 6.2.5, to preserve the generality of Clause 5.4.2.1, where a simple exception for TBoMS is added in Clause 5.4.2.1, i.e., the latter will simply state that the procedure described therein is valid for all cases but TBoMS.

Given the above I would start the discussion with a proposal for a Conclusion and two questions.

**FL’s proposal 2**

**The following Conclusion is made:**

|  |
| --- |
| **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 .** |

***2.1.2-Q1*** *Given that the same number of bits is selected for each allocated slot for TBoMS, irrespective of slot dropping, collisions or UCI multiplexing, should the index of the starting coded bit for each allocated slot need to be expressed as a function of the index of the starting coded bit for the previous allocated slot or rather as a function of the index of the starting coded bit for the first allocated slot for TBoMS?*

***2.1.2-Q2*** *Should the bit selection for TBoMS be described in Clause 5.4.2.1 of TS 38.212 (where general procedures for PDSCH and PUSCH are described), or rather in 6.2.5 of TS 38.212 (where PUSCH-specific procedures are described)?*

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

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 2**.

**FL’s proposal 2**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 2** |  |
| **Do not support FL’s Proposal 2** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 2, if any. |
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|  |  |

Additionally, companies are invited to provide an answer to ***2.1.2-Q1*** and ***2.1.2-Q2*** in the tables below. If you add any additional comment, it is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

**2.1.2-Q1**

***The index of the starting coded bit for each allocated slot is expressed as a function of the index of***

|  |  |
| --- | --- |
|  | Company name |
| ***The starting coded bit for the previous allocated slot for TBoMS*** |  |
| ***The starting coded bit for the first***  ***allocated slot for TBoMS*** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.2-Q1, if any. |
|  |  |
|  |  |
|  |  |

**2.1.2-Q2**

|  |  |
| --- | --- |
|  | Company name |
| **5.4.2.1** |  |
| **6.2.5** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.2-Q2, if any. |
|  |  |
|  |  |
|  |  |

### [OPEN] UCI multiplexing

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail. The summary of companies’ preferences and opinions based on the contributions is organized accordingly.

#### [OPEN] **Timeline requirements**

Several contributions discussed about this aspect. All companies who commented also proposed to reuse the legacy timeline requirement used for multiplexing UCI on PUSCH in case of Type A PUSCH repetition, and apply it for the actual overlapped slot in the TBoMS (Nokia/NSB [17], Xiaomi [10], OPPO [8], Samsung [16], CATT [16], InterDigital [11])

One company (NEC [20]), proposed that CG-UCI multiplexes on the first slot of TBoMS transmission if CG-UCI multiplexing with TBoMS is supported, otherwise support of CG-UCI multiplexing with TBoMS should be removed from TS 38.212.

One company (TCL [4]) proposed that if UCI multiplexing in TBoMS is supported, then UCI repetition should be considered. However, this proposal violates an existing agreement on UCI multiplexed only on the overlapped slot and thus will not be discussed further in this document.

From FL’s perspective, it seems straightforward to reuse existing timeline requirements as proposed by all companies who commented on such aspect. At the same time, before formulating a proposal in this sense, I would like to ask companies to express their views on what has been proposed about CG-UCI.

**2.1.3.1-Q1** *Should the case of CG-UCI multiplexed on PUSCH be handled differently in case of TBoMS transmission? If yes, how?*

##### **First round of discussions**

Companies are invited to provide an answer to ***2.1.3.1-Q1*** in the tables below. If you add any additional comment, it is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

**2.1.3.1-Q1**

|  |  |
| --- | --- |
|  | Company name |
| ***Yes*** |  |
| ***No*** |  |

|  |  |
| --- | --- |
| Company | Additional comments/proposals related to 2.1.3.1-Q1, if any. |
|  |  |
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|  |  |

#### [OPEN] **Dropping/collisions**

Three companies commented on this aspect. Corresponding proposals we made.

One company proposed to consider TBoMS a low priority uplink transmission (Intel [12]).

One company proposed that PUCCH repetition can override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s) (Ericsson [19]).

One company proposed that only dropping the overlapped slot(s) should be considered for TBoMS transmission when collisions happen (TCL [4]).According to FL’s understanding, this is already covered by existing agreements and thus will not be handled in this meeting.

The following two questions are asked to start the discussion.

**2.1.3.2-Q1** *Should TBoMS be considered a low priority transmission?*

**2.1.3.2-Q2** Building on the previous question, *should PUCCH repetition be allowed to override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s)?*

##### **First round of discussions**

Companies are invited to provide an answer to ***2.1.3.2-Q1*** and ***2.1.3.2-Q2*** in the tables below. If you add any additional comment, it is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

**2.1.3.2-Q1**

|  |  |
| --- | --- |
|  | Company name |
| ***Yes*** |  |
| ***No*** |  |

|  |  |
| --- | --- |
| Company | Additional comments/proposals related to 2.1.3.2-Q1, if any. |
|  |  |
|  |  |
|  |  |

**2.1.3.2-Q2**

|  |  |
| --- | --- |
|  | Company name |
| ***Yes*** |  |
| ***No*** |  |

|  |  |
| --- | --- |
| Company | Additional comments/proposals related to 2.1.3.2-Q2, if any. |
|  |  |
|  |  |
|  |  |

#### [OPEN] **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.*

From FL’s perspective, the problem highlighted in [3] deserves some attention and is worth discussing. In this context, it is important to understand other companies’ views before taking any further step in this direction.

Companies are thus invited to express their views on Missed DCI – Proposal 1 and Proposal 2.

##### **First round of discussions**

Companies are invited to input their views in the corresponding tables below. Constructive attitude in this regard is greatly appreciated.

**Missed DCI – Proposal 1**

|  |  |
| --- | --- |
| Company | Views on Missed DCI – Proposal 1, if any. |
|  |  |
|  |  |
|  |  |

**Missed DCI – Proposal 2**

|  |  |
| --- | --- |
| Company | Views on Missed DCI – Proposal 2, if any. |
|  |  |
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|  |  |

#### [OPEN] **The case of UL CA**

Two companies commented on this aspect (CATT [7], OPPO [8]). Proposals were made to support UCI multiplexing on PUSCH, in case of TBoMS and UL CA scenario. More precisely, in [7] it was proposed to reuse existing mechanisms for PUSCH repetition Type A, whereas in [8] it was proposed to have minimal specification impact associated to the support of UCI multiplexing in case of TBoMS and UL CA scenario.

From FL’s perspective, what is discussed in [7] and [8] deserves some attention and is worth discussing. In this context, it is important to understand other companies’ views before taking any further step in this direction.

Companies are thus invited to express their views on the support UCI multiplexing on PUSCH in case of TBoMS and UL CA scenario.

The following question is formulated.

**2.1.3.4-Q1** *Should UCI multiplexing on PUSCH in case of TBoMS and UL CA scenario be supported? If yes, is any specification modification needed, or can existing rules and mechanisms for Type A PUSCH repetitions be reused for TBoMS?*

##### **First round of discussions**

FL’s recommendation is to have a first round of discussion about **2.1.3.4-Q1**. Companies are invited to input their views in the corresponding tables below. Constructive attitude in this regard is greatly appreciated.

**2.1.3.4-Q1**

|  |  |
| --- | --- |
|  | Company name |
| **Yes** |  |
| **No** |  |

|  |  |
| --- | --- |
| Company | Additional comments/view related to 2.1.3.4-Q1, if any. |
|  |  |
|  |  |
|  |  |

## Mid priority aspects

Five mid priority aspects are identified at the beginning of the meeting:

1. Time domain resource determination
   * 1. Candidate values for N
     2. Candidate values for M
2. Data rate calculation and UE behavior related to TBS determination
   * 1. How to handle configuration of TBS larger than the size of one CB
3. Transmission power determination
4. Support of TBoMS by HD-FDD UEs

Although arguably less paramount at this stage of the discussion, these aspects have been included here since they seem to impact the TBoMS design at a more fundamental level than aspects in Section 2.3. Summary, discussion, and FL’s comments/proposals on these aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### [OPEN] Time domain resource determination

#### [OPEN] **Candidate values for N**

One company (Ericsson [18]) proposed that {3, 5, 6, 12, 16, 32} can be considered for the candidate numbers of slots for a single TBoMS.

From FL’s perspective, candidate values for N have been discussed extensively in the previous meeting. Other candidate values for N aside from the agreed ones may not be needed. Therefore, I would like to collect companies’ views on this aspect before making any proposal.

***2.2.1.1-Q1.*** *Do you agree adding the following values to the list of candidate values for N?*

* *3, 5, 6, 12, 16, 32.*

##### **First round of discussions**

Companies are invited to provide an answer to **2.2.1.1-Q1** in the tables below. If you add any additional comment, it is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

|  |  |  |
| --- | --- | --- |
| Candidate value | Support | Not support |
| **3** |  |  |
| **5** |  |  |
| **6** |  |  |
| **12** |  |  |
| **16** |  |  |
| **32** |  |  |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.2.1.1-Q1, if any. |
|  |  |
|  |  |
|  |  |

#### [OPEN] **Candidate values for M**

One company (Ericsson [18]) proposed that if a UE supports TBoMS, it should support configuration with M\*N up to 32.

In RAN1#107-e meeting, the following was concluded:

|  |
| --- |
| 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. |

From FL’s perspective, and following the above conclusion, the gNB can configure any combination of N and M such that N\*M <= 32.

Therefore, it is straightforward assuming that a UE that supports TBoMS should also support the combinations with N\*M = 32. Otherwise, another restriction is needed, and it contradicts with the above conclusion.

At the same time, if we consider the TP provided in [18], it is clear that the proposal concerning the support of configuration with M\*N up to 32 in [18] targets the removal of the condition on UE capabilities present in TS 38.214.

The following question is thus formulated to collect companies’ views on this aspect.

***2.2.1.2-Q1****. Do you agree that if a UE supports TBoMS, it should support configuration with M\*N up to 32 and no condition on UE capabilities related to this aspect should exist?*

##### **First round of discussions**

Companies are invited to provide an answer to **2.2.1.2-Q1** in the tables below. If you add any additional comment, it is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

**2.2.1.2-Q1**

|  |  |
| --- | --- |
|  | Company name |
| **Yes** |  |
| **No** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.2.1.2-Q1, if any. |
|  |  |
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|  |  |

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

#### [OPEN] **How to handle configuration of TBS larger than the size of one CB**

One company (Huawei/HiSi [3]) proposed applying the following data rate constraint (changes in red) in Clause 6.1.4 of TS 38.214 for the transmission of TBoMS PUSCH,

* Within a cell group, a UE is not required to handle PUSCH(s) transmissions if the following condition is not satisfied at the point in time:

where still represents the scheduled bits for the m-th TB over multi-slot and is the slot number allocated for the PUSCH transmission of a single TBoMS in serving cell-j.

* For a j-th serving cell, the UE is not required to handle PUSCH transmissions if the following condition is not satisfied:

where represents the time duration of one symbol, and is the number of symbols assigned to the PUSCH within a slot.

One company (TCL [4]) proposed that the maximum TBS for TBoMS should be limited based on DataRateCC.

Furthermore, one company (ZTE [5]) brought forward a TP which proposes to capture that the data rate limitation for cell group should be updated to reflect TBoMS by scaling the TBS based on the number of slots for TB size determination.

In this context, the following FL proposal was formulated during RAN1#107-e. However, due to limited time for commenting before the end of the meeting, only one company expressed concern on the proposal. Therefore, from FL’s perspective, the discussion could resume during this meeting.

**FL’s proposal 3**

**Within a cell group, a UE is not required to handle a PUSCH transmission of a single TBoMS in slot sj in serving cell-j, and for j = 0,1,2.. J-1, slot sj overlapping with any given point in time, if the following condition is not satisfied at that point in time:**

**,**

**Where is the slot number allocated for the PUSCH transmission of a single TBoMS in serving cell-j.**

##### **First round of discussions**

FL’s recommendation is to have a first round of discussion about **FL’s proposal 3**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which considers the current spirit of the proposal. If you do so, I’d like to invite you to be pragmatic and acknowledge that focus on the scope of the WID and on the prioritization of the completion of the feature over the micro-optimizations which cannot be immediately agreed by everyone.

**FL’s proposal 3**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 3** |  |
| **Do not support FL’s Proposal 3** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 3, if any. |
|  |  |
|  |  |
|  |  |

### [OPEN] Transmission power determination

One company (Ericsson [18]) proposed reusing Rel-16 per-slot transmission occasion of power determination for TBoMS.

The following two agreements were made during RAN1#106-bis-e:

|  |
| --- |
| 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:  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 |

From FL’s perspective, the calculation of BPRE for TBoMS is clear from the above agreement. However, although the intention of reusing Rel-16 per-slot transmission occasion of power determination for TBoMS was also clear, it has never been officially agreed in RAN1. Therefore, the following proposal is formulated.

**FL’s proposal 4**

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

##### **First round of discussions**

FL’s recommendation is to have a first round of discussion about **FL’s proposal 4**. Companies are invited to input their views in the corresponding tables below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which considers the current spirit of the proposal. If you do so, I’d like to invite you to be pragmatic and acknowledge that focus on the scope of the WID and on the prioritization of the completion of the feature over the micro-optimizations which cannot be immediately agreed by everyone.

**FL’s proposal 4**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 4** |  |
| **Do not support FL’s Proposal 4** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 4, if any. |
|  |  |
|  |  |
|  |  |

### [OPEN] Support of TBoMS by HD-FDD UE

One company (Apple [13]) proposed that TBoMS is supported by the HD-FDD UE with the agreed available slot determination for HD-FDD UE.

From FL’s perspective, it is worth clarifying this aspect during RAN1#107-bis-e. According to the following specification excerpt from TS 38.214, the use of TBoMS for HD-FDD UE with counting on available slot has not been captured, which makes this topic still open for discussion.

|  |
| --- |
| 6.1.2.1 Resource allocation in time domain <<omitted text>>  For TB processing over multiple slots:  - For unpaired spectrum, the same symbol allocation is applied across the slots determined for the PUSCH transmission and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the slots determined for the PUSCH transmission, applying the same symbol allocation in each slot.  - For paired spectrum or supplementary uplink band, the same symbol allocation is applied across the consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the consecutive slots applying the same symbol allocation in each slot.  <<omitted text>> |

Therefore, the following proposal is formulated.

**FL’s proposal 5**

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

##### **First round of discussions**

FL’s recommendation is to have a first round of discussion about **FL’s proposal 5**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which considers the current spirit of the proposal. If you do so, I’d like to invite you to be pragmatic and acknowledge that focus on the scope of the WID and on the prioritization of the completion of the feature over the micro-optimizations which cannot be immediately agreed by everyone.

**FL’s proposal 5**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 5** |  |
| **Do not support FL’s Proposal 5** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 5, if any. |
|  |  |
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## 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 #107-bis-e. Priority has been given to the aspects and topics discussed in sections 2.1 and 2.2. 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 #107-bis-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 and 2.2 progress fast and 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] Support of TBoMS in case of counting based on physical slots

One company (Qualcomm [14]) proposed enabling the use of TBOMS even when PUSCH repetitions are counted based on physical slots.

#### [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] TBS determination

#### [CLOSED] TBS capping

One company (Huawei/HiSi [3]) brought forward a TP which proposes to capture that the actual determined TBS is determined as following:

* If and the determined TBS larger than 3824, the UE takes 3824 as the actual TBS,
* else if determined TBS larger than 8424, the UE takes 8424 as the actual TBS,
* else the determined TBS is taken as the actual TBS.

One company (NEC [20]) brought forward two alternatives for TP which propose to capture that the same constraints on TBS of TBoMS should be applied for the re-transmission of an initial transmission with TBoMS of the same TB.

### [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

#### [CLOSED] Slot mapping for 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] Frequency hopping

Two companies (CATT [7], Intel [12]) proposed that inter-slot frequency hopping with inter-slot bundling is supported for TBoMS for the case when DMRS bundling is applied.

Two companies (Xiaomi [10], TCL [4]) proposed that inter-slot frequency hopping with inter-slot bundling is supported for TBoMS.

One company (Intel [12]) proposed that frequency hopping pattern for TBoMS in case of inter-slot frequency hopping with inter-slot bundling is determined based on physical slot index.

One company (Intel [12]) proposed that, for repetition of a single TBoMS transmission, inter-repetition frequency hopping is supported.

FL’s comments on January 17

Relevant discussions on this topic may be carried out under AI 8.8.2 and/or AI 8.8.1.3.

### [CLOSED] TBoMS retransmission

One company (Panasonic [15]) proposed the following conclusion for clarification.

* For TBoMS, a TB can be sent either *numebrOfSlots* = 1 or *numberOfSlots* > 1 for (re)transmissions.
  + No specification change is expected.

One company (TCL [4]) proposed that a slot or a set of slots retransmission for TBoMS should be supported.

FL’s comments on January 17

From FL’s perspective, concerns brought by the above proposals should already be addressed by the following agreement made in RAN1#107-e meeting.

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

### [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] DCI format for scheduling of TBoMS

One company (Xiaomi [10]) proposed that fallback DCI format is not supported for the scheduling of TBoMS PUSCH.

# 3 Proposals for GTW

**FL’s proposal 1**

* For 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.
* The above “time duration for the N\*M transmission” means the time duration between the start of the 1st slot of the N\*M available slots for TBoMS and the end of the last slot of the N\*M available slots for TBoMS, for any instance of a CG Type 2 period.

**FL’s proposal 2**

The following Conclusion is made:

|  |
| --- |
| 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 . |

**FL’s proposal 3**

Within a cell group, a UE is not required to handle a PUSCH transmission of a single TBoMS in slot sj in serving cell-j, and for j = 0,1,2.. J-1, slot sj overlapping with any given point in time, if the following condition is not satisfied at that point in time:

,

Where is the slot number allocated for the PUSCH

**FL’s proposal 4**

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

**FL’s proposal 5**

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

# 4 Agreements during RAN1 #107-bis-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. R1-2200052 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2200604 Discussion on TB processing over multi-slot PUSCH, TCL Communication Ltd.
5. R1-2200112 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2200087 Remaining issues on PUSCH TB processing over multiple slots, vivo
7. R1-2200152 Discussion on TB processing over multi-slot PUSCH, CATT
8. R1-2200335 Further considerations for TB over multi-slot PUSCH, OPPO
9. R1-2200589 Discussion on TB processing over multi-slot PUSCH, CMCC
10. R1-2200466 Discussion on TB processing over multi-slot PUSCH, Xiaomi
11. R1-2200519 TB processing over multiple slots, InterDigital, Inc.
12. R1-2200380 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
13. R1-2200421 Discussion on TB processing over multi-slot PUSCH, Apple
14. R1-2200302 TB processing over multi-slot PUSCH, Qualcomm Incorporated
15. R1-2200321 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
16. R1-2200206 TB processing over multi-slot PUSCH, Samsung
17. R1-2200161 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
18. R1-2200656 Remaining issues for TB Processing over Multi-Slot PUSCH, Ericsson
19. R1-2200501 Transport block processing over multi-slot PUSCH, Sharp
20. R1-2200509 Discussion on TB processing over multi-slot PUSCH, NEC
21. R1-2200237 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.

# Appendix A: Proposals from contributions aggregated by topic

## A.1 Time domain resource determination

**TDRA Table**

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| --- |
| **R1-2200656 Ericsson**  **Proposal 6.** The UE is not expected to be configured with the time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the time duration derived by the periodicity P. |

**Candidate values for N**

|  |
| --- |
| **R1-2200656 Ericsson**  **Proposal 2.** {3, 5, 6, 12, 16, 32} can be considered for the candidate numbers of slots for a single TBoMS.  **Proposal 3.** If a UE supports TBoMS, it should support configuration with M\*N up to 32. |

**Candidate values for M**

|  |
| --- |
| **R1-2200656 Ericsson**  **Proposal 3.** If a UE supports TBoMS, it should support configuration with M\*N up to 32. |

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

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| --- |
| **R1-2200656 Ericsson**  **Proposal 6.** The UE is not expected to be configured with the time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the time duration derived by the periodicity P.  **R1-2200519 InterDigital Inc.**  **Proposal 4:** For TBoMS, the UE is not expected to be configured with for N∙K transmissions larger than the time duration derived by the periodicity P. |

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

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| --- |
| **R1-2200052 Huawei/HiSi**  ***Proposal 1:*** *For TBoMS transmission with type 1 configured grant, a new field should be introduced in IE ConfiguredGrantConfig to indicate the number of allocated slots for a single TBoMS transmission.*  **R1-2200519 Intel Corporation**  **Proposal 1**   * Type-1 CG-PUSCH is supported for TBoMS. * Number of slots for TBoMS transmission is configured in *ConfiguredGrantConfig*.   **R1-2200161 Nokia/NSB**  [*Proposal 6. TBoMS with Type 1 configured grant PUSCH is not supported in Rel-17.*](#_Toc92811192)  **R1-2200087 vivo**  Proposal 1: Type-1 CG for TBoMS is not supported.  **R1-2200421 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.  **R1-2200501 Sharp**  **Proposal 4:** A value N for indicating the number of slots for a single TBoMS is configured in *rrc-ConfiguredUplinkGrant* for type-1 configured grant.  **R1-2200589 CMCC**  **Proposal 1:** If the type 1 CG-PUSCH would be supported by TBOMS, it should ensure that legacy UEs should not be impact. |

**Early termination of TBoMS**

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| **R1-2200466 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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| **R1-2200656 Ericsson**  Proposal 1. Reuse resource determination and signaling of Rel-15/16 PUSCH repetition as much as possible to avoid specifying duplicate functionality.  **R1-2200380 Intel**  **Proposal 2**   * For out of order handling for TBoMS:   + Consider Case A), B) and C) in Figure 2 as out of order scheduling.     Figure 2. Out of order handling between TBoMS and single-slot PUSCH  **R1-2200302 Qualcomm**  **Proposal 1:** Enable the use of TBOMS even when PUSCH repetitions are counted based on physical slots. |

## A.2 Rate-matching

**How the index of the starting bit in each slot for the single TBoMS is chosen**

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| --- |
| **R1-2200112 ZTE**  **Proposal 3:** The coded bits that originally map to a dropped slot for the TBoMS transmission should be skipped for the rate matching for TBoMS.  **R1-2200152 CATT**  **Proposal 1:** Confirm that Option C is supported for bit selection of TBoMS. Relevant RAN1 CRs shall be prepared based on Option C.  **R1-2200302 Qualcomm**  **Proposal 2:** The index of the starting coded bit for the kth slot of a TBOMS transmission is given by , where  where   * , * is the modulation order, * is the number of REs available in the th slot for transmission and is given by ,   + is the scheduled bandwidth of the TBOMS transmission, expressed as a number of subcarriers,   + is the number of symbols allocated per slot of TBOMS as per the indicated/configured row of TDRA table, excluding the symbols with DMRS tones. * is set to be the starting bit index of the RV associated with the single TBOMS.   **R1-2200335 OPPO**  **Proposal 1:** Slot dropping should puncture those slots after interleaving and bit selection.  **R1-2200501 Sharp**  **Proposal 1:** TS38.212 should refer to transmission occasion index n in TS38.214 for starting coded bit determination.  **Proposal 2:** New starting coded bit determination procedure by referring to the previous allocated slot is not applied to transmission occasion n with (n mod N) = 0. |

## A.3 Data Rate calculation and UE behavior related to TBS determination

**Data rate calculation**

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| **R1-2200052 Huawei/HiSi**  ***Proposal 2****: Apply the following data rate constraint (changes in red) in Clause 6.1.4 of TS 38.214 for the transmission of TBoMS PUSCH,*   * *Within a cell group, a UE is not required to handle PUSCH(s) transmissions if the following condition is not satisfied at the point in time:*   *where still represents the scheduled bits for the m-th TB over multi-slot and is the slot number allocated for the PUSCH transmission of a single TBoMS in serving cell-j.*   * *For a j-th serving cell, the UE is not required to handle PUSCH transmissions if the following condition is not satisfied:*   *where represents the time duration of one symbol, and is the number of symbols assigned to the PUSCH within a slot.*  **R1-2200112 ZTE**  ***Proposal 4:*** *The data rate limitation for cell group should be updated to reflect TBoMS by* *scaling the TBS based on the number of slots for TB size determination.*  **R1-2200604 TCL**  ***Proposal 3:*** *The maximum TBS for TBoMS should be limited based on DataRateCC.* |

## A.4 TBS determination

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| **R1-2200052 Huawei/HiSi**  ***Proposal 4****: The actual determined TBS is determined as following:*   * *If and the determined TBS larger than 3824, the UE takes 3824 as the actual TBS,* * *else if determined TBS larger than 8424, the UE takes 8424 as the actual TBS,* * *else the determined TBS is taken as the actual TBS.*   *The corresponding proposed text changes for TS 38.214 is given in Appendix B.* |

## A.5 FDRA

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| --- |
| **R1-2200466 Xiaomi**  **Proposal 4:** Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling.  **R1-2200604 TCL**  **Proposal 4:** The maximum number of PRBs can be limited when TBoMS is enabled. |

## A.6 TBoMS repetitions

**Slot mapping for TBoMS repetitions**

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| **R1-2200519 InterDigital Inc.**  **Proposal 3:** Support type 1(non-interleaved) when DMRS bundling is enabled and type 2 (interleaved) mapping for TBoMS repetitions when DMRS bundling is disabled shown in Figure 1    Figure 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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| --- |
| **R1-2200335 OPPO**  **Proposal 4:** The TBoMS repetition should apply fixed RV sequence cycling among different actual repetitions of TBoMS.  The cycling unit is based on TBoMS instead of slot. |

## A.7 Transmission power determination

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| **R1-2200656 Ericsson**  **Proposal 5.** Reuse Rel-16 per-slot transmission occasion of power determination for TBoMS. |

## A.8 Frequency hopping

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| **R1-2200519 Intel Corporation**  **Proposal 3**   * In case of DMRS bundling, inter-slot frequency hopping with inter-slot bundling is supported for TBoMS.   + Frequency hopping pattern for TBoMS is determined based on physical slot index. * For repetition of a single TBoMS transmission, inter-repetition frequency hopping is supported.   **R1-2200152 CATT**  **Proposal 4:** Inter-slot frequency hopping with inter-slot bundling is supported for TBoMS at least for the case when DMRS bundling is applied.  **R1-2200466 Xiaomi**  **Proposal 3:** Support intra-TB frequency hopping for TB processing over multi-slot PUSCH.  **R1-2200604 TCL**  **Proposal 8:** The bundling of inter-slot frequency hopping should be supported for TBoMS. |

## A.9 Retransmissions

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| **R1-2200321 Panasonic**  **Proposal 2:** To make following conclusion for clarification.   * For TBoMS, a TB can be sent either *numebrOfSlots* = 1 or *numberOfSlots* > 1 for (re)transmissions.   + No specification change is expected.   **R1-2200604 TCL**  **Proposal 2.** A slot or a set of slots retransmission for TBoMS should be supported. |

## A.10 UCI multiplexing, dropping rules, uplink cancellation

**UCI multiplexing**

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| --- |
| **R1-2200161 Nokia/NSB**  *Proposal 2. Specification change is not needed for UCI multiplexing for TBoMS.*  **R1-2200112 ZTE**  **Proposal 1:** 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 2:** One of the slot 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.  **R1-2200152 CATT**  **Proposal 3:** For UL CA case, Rel-16 UCI multiplexing rules and mechanisms for PUSCH repetition Type A are applied to TBoMS.  **R1-2200335 OPPO**  **Proposal 3:** Supporting the UCI multiplexing TBoMS for UL CA with minimal specification impact.  **R1-2200509 NEC**  **Proposal 2:** CG-UCI multiplexes on the first slot of TBoMS transmission if CG-UCI multiplexing with TBoMS is supported, otherwise (if CG-UCI multiplexing with TBoMS is not supported) remove CG-UCI multiplexing with TBoMS in TS38.212.  **R1-2200604 TCL**  **Proposal 5:** UCI multiplexing is performed by puncturing or rate-matching depending on the determination time is before or latter the starting time of PUSCH preparation.  **Proposal 6:** If UCI multiplexing is performed by puncturing， may differ from rate-matching for UCI multiplexing.  **Proposal 7:** If UCI multiplexing in TBoMS is supported, UCI repetition should be considered. |

**Dropping rules, e.g., collision handling**

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| --- |
| **R1-2200519 Intel Corporation**  **Proposal 4**   * TBoMS is considered as low priority uplink transmission.   **R1-2200656 Ericsson**  **Proposal 4.** PUCCH repetition can override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s).  **R1-2200604 TCL**  **Proposal 1:** Only dropping the overlapped slot(s) should be considered for TBoMS transmission when collision happen. |

**Timeline requirements**

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| **R1-2200519 InterDigital Inc.**  **Proposal 1:** Rel-16 timeline constraint to multiplex UCI on PUSCH is used to determine whether to multiplex UCI on TBoMS or not.  ***R1-2200161 Nokia/NSB***  [*Proposal 3. For multiplexing UCI on the individual overlapping slot for TBoMS, the legacy Rel-15/16 timeline requirements are reused for each UCI type.*](#_Toc92811189)  **R1-2200152 CATT**  **Proposal 2:** Reuse Rel-16 timeline for UCI multiplexing on TBoMS.  **R1-2200206 Samsung**  ***Proposal 2:*** The legacy timeline requirement is reused and applied for the actual overlapped slot in the TBoMS***.***  **R1-2200335 OPPO**  **Proposal 2:** For timeline of UCI multiplexing TBoMS, we suggest to reuse all the timeline requirement of UCI multiplexing Type A PUSCH repetition in Rel-15.  **R1-2200466 Xiaomi**  **Proposal 5:** For TBoMS, reuse the timeline requirements for the UCI multiplexing on PUSCH repetition type A in Rel-16. |

**Uplink cancellation**

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| **R1-2200519 InterDigital Inc.**  **Proposal 2:** In case of uplink cancellation, the UE resumes the TBoMS transmission in the next allocated slot. |

## A.11 Interlaced TBoMS transmissions

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| --- |
| **R1-2200302 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.12 Support of TBoMS by HD-FDD UE

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| **R1-2200421 Apple**  **Proposal 3:** TBoMS is supported by the HD-FDD UE with the agreed available slot determination for HD-FDD UE. |

## A.13 DCI format for scheduling TBoMS

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| **R1-2200466 Xiaomi**  **Proposal 1:** Don’t support fallback DCI format for the scheduling of TBoMS PUSCH. |

# 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 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.