3GPP TSG RAN WG1 #104-bis-e R1-2103876

e-Meeting, April 12th – April 20th, 2021

**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**

# 1 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 key aspects of TB processing over multi-slot PUSCH based on companies’ contributions submitted under AI 8.8.1.2 to RAN1#104-bis-e [3]-[28].

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

# 2 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). From FL’s perspective, laying down the bases for a constructive discussion is of utmost priority to ensure good progress is achieved. The same systematic categorization used for #104-e will be used in this document to summarize the content of all contributions. This is done according to both FL’s understanding and number of submitted proposals on the different aspects. The rationale of the categorization 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:

* **Resource allocation aspects of TBoMS**
  + TDRA
  + FDRA
  + TBS determination
* **Basic design aspects of TBoMS**
  + Relationship between TBoMS and PUSCH repetitions
  + DM-RS
  + CB segmentation
  + Redundancy version and rate-matching
  + Interleaving
  + Link adaptation
* **Advanced design aspects of TBoMS**
  + Frequency hopping
  + Transmission power determination
  + Rank of TBoMS transmission
  + Channel estimation
  + Retransmissions
* **Signaling and interaction with other signals/channels**
  + Multi-slot/single-slot activation/switch
  + UCI multiplexing, SRS/DL collisions/cancellations
  + Service-like prioritization of TBoMS

The categorization above will be used to identify a priority order for the discussions to be held for AI 8.8.1.2. In this context, sections 2.1 to 2.3 will focus on aspects related to resource allocation for TBoMS, whereas Section 2.4 will collect all other aspects. In this context, during RAN1 #104-bis-e priority will be given to several aspects described in Sections 2.1 to 2.3, and two aspects described in Section 2.4 (namely the aspects discussed in Section 2.4.1, 2.4.2 and 2.4.5). Should discussions for the higher priority aspects progress fast, new sections for specific aspects, will be open.

## 2.1 TDRA

Five major sub-aspects of TDRA have been discussed by companies in the submitted contributions:

1. General framework for time domain resource determination
2. Indication of number of slots allocated for TBoMS
3. Constraints on how slots can be used for TBoMS
4. How to handle S slots
5. Definition of transmission occasion

Summary, discussion and proposals on these sub-aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### 2.1.1 [OPEN] General framework for time domain resource determination

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail, with reference to the agreements made during RAN1 #104-e, where two major options were listed for future discussion. high-level summary companies’ preferences based on the contributions, is as follows:

* **Option 1**. PUSCH repetition type A like TDRA, i.e., the number of allocated symbols is the same in each slot. [11 companies]:
  + Type B like is not supported: Fujitsu [9], vivo [6], IITH [12], OPPO [4], ZTE [5], Apple [16], Qualcomm [17], Lenovo/Motorola [26], LGE [27].
  + Support of Type B like is FFS: Panasonic [18], Ericsson [21].
* **Option 2**. PUSCH repetition type B like TDRA, i.e., the number of allocated symbols in each slot can be different [4 companies]:
  + Huawei/HiSilicon [3], Xiaomi [13], Interdigital [14], Nokia/NSB [20].
* **Option 3**. Both PUSCH repetition type A like TDRA and PUSCH repetition type B like TDRA should be supported [7 companies]:
  + CMCC (slight preference for Type A like) [11], NTT DOCOMO [25], Intel [15], Sharp [23], NEC [24], Wilus [28], Samsung [19].
* **Option 4**. No preference expressed yet; down-selection is suggested [3 companies]:
  + China Telecom [10] (FFS for special slots in case of Type A) [10], CATT [7], Sierra Wireless (the ability to specify gaps should be taken into consideration when choosing a TDRA design) [22].

FL’s comments

A large majority of companies expressed preference for Option1, i.e., type A like TDRA. The rationale of this option is its potential to reuse most if not all the existing signalling and indication framework. It is argued that this could also simplify the design of other more advanced aspects. In this context, time domain resource indication would be supported by reinterpreting or adding possibly small modifications to Rel-16 PUSCH repetitions signalling structures (as discussed later).

Type B like TDRA has been proposed by a smaller number of companies, albeit non-negligible. The rationale in this case is that limitations of Type A like TDRA do not allow to exploit the time resource in the most effective way. It is argued that the most valuable resource for coverage enhancement is the time resource, and coverage can be maximized using repetition type B like TDRA resource allocation for TBoMS.

A significant amount of companies proposes to support both alternatives to have the maximum flexibility, without trading arguable simplicity for lower efficiency and coverage. This is the second most popular option according to proposals in contributions.

Three companies have not expressed a preference yet. Future down-selection between options should occur and some directions to perform the down-selection are sketched.

From FL’s perspective, supporting time domain determination in Type A like TDRA fashion, i.e., the same number of symbols is used in each slot, is an acceptable solution for most companies. On the other hand, the possibility of supporting time domain determination in Type B like TDRA fashion should not be excluded from the discussion at this stage, given the evident technical merits in terms of maximum flexibility and efficiency. The following proposal is then made:

***FL proposal 1. For time domain resource determination for TBoMS, at least PUSCH repetition type A like TDRA, according to which the number of allocated symbols for TBoMS is the same in each slot, is supported.***

***FFS: Whether PUSCH repetition type B like TDRA, according to which the number of allocated symbols for TBoMS in each slot can be different, is also supported for time domain resource determination for TBoMS.***

#### 2.1.1.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about FL proposal 1. The goal is to identify the preferred direction RAN1 should pursue for defining and specifying time domain resource determination for TBoMS.

Companies are also invited to express additional views for defining and specifying TDRA determination for TBoMS, should they not agree with the proposal. In this case, it would be desirable if companies could also provide alternatives, if any, to give FL the possibility to find middle ground.

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| --- | --- |
| Company | Comments |
| vivo | Fine with the proposal.  Although type-B repetition may occupy more symbol for transmission, especially the symbols in special slots, the resources for other UL transmissions, e.g. PUCCH, SRS, should also be reserved. That is one of the motivations that invalid symbol pattern is introduced for Type-B repetition. If PUCCH resources and SRS resources are considered, the benefit of type-B like TDRA for TBoMS that taking advantage of UL symbols in special slots is minimized, compared with type-A like TDRA. |
| OPPO | We agree the TDRA from PUSCH repetition type A should be supported. The complexity is one of the major issues. Please note this is not limited to the Type A and Type B. The definition of “PUSCH repetition type A like” would also be good to be clarified. This is general and may bring more complexity.  We see it could be supported by directly apply PUSCH repetition type A configuration, including the TDRA, to the TBoMS. Minimum changes may need.  Or, we will define an independent TDRA configuration, using principle of type A.  To RAN1, we need also clarify that as the basic frame work we are discussing here. From our point of view, reusing the PUSCH repetition type A configuration as possible should be preferred. We can introduce few additional parameters for how many slots the TB is going to be determined on.  One suggestion is adding the sub-bullet: Reusing the PUSCH repetition type A configuration with necessary enhancement for TB determination on multiple slots.  For the FFS type B, we see it is much more complex if that reusing scheme is not considered. |
| CATT | OK with the proposal. We slightly prefer repetition type A like TDRA for simplicity.  But if consensus on non-consecutives UL slots in TDD is not reached, we should consider repetition type B like TDRA, which can at least provide the opportunity to utilize the UL symbols in the ‘S’ slots. |
| Lenovo, Motorola Mobility | We are fine with the proposal. |
| Ericsson | Support the proposal.  In our view, while we are not convinced of its benefit at this stage, the most straightforward use case for Type-B like TDRA is for the special slot. We share vivo’s concerns about where the SRS or PUCCH might be transmitted if it is not in the special slot, and also wonder about the net gain. However, we are open to further studying it. Type-B like TDRA where a PUSCH occupies part of a normal uplink slot fall into URLLC use cases, rather than coverage enhancement, since as much of a slot should be used for coverage as possible. |
| NTT DOCOMO | Fine with the proposal. We would like to support both type A and type B repetition like TDRA. However, type A repetition like TDRA can be assumed first to facilitate the discussion. |
| Samsung | One clarification point we want to make is that, in here, we are discussing the time domain resource determination of TBoMS PUSCH, which in a simple word is, to determine what the available slots/symbols for TBoMS transmission are. While the actual TBoMS transmission schemes (including TBS, RM, interleaving, etc) are separately discussed. If this is clear, we are then difficult to see why repetition type B like TDRA is somehow being deprioritized, which seems better to fit TBoMS purpose, trying to utilize the possible time-domain symbols as much as possible. From our understanding, the repetition type B TDRA should be supported, while type A somehow holds relatively more limitation.  Thus, we suggest both typeA/B-like TDRA methods to be supported. |
| Xiaomi | Repetition type B like TDRA provides more consecutive time domain resources without adding additional latency, which is essential for operation in unpaired spectrum. Besides, back-to-back transmission is helpful to maintain the phase continuity of PUSCH over multiple slots to facilitate the joint channel estimation to further improve the uplink coverage.  However, repetition type A like TDRA is more straightforward and simpler for TBoMS.  From our perspective, both PUSCH repetition type A and type B like TDRA should be supported for different use case of TB processing over multi-slot PUSCH. In short, we don’t support the proposal. |
| Apple | We are ok with this proposal in general. One concern is if we really intend to support both type of TDRA scheme. From our side, only supporting one scheme is preferred. |

### 2.1.2 [CLOSED] Indication of number of slots allocated for TBoMS

Observations on how the numbers of slots for transmitting TBoMS should be indicated by gNB are provided in different forms in several contributions. Explicit proposals are made in 5 contributions. Several options are considered. A high-level summary of such options, including companies’ preferences based on the contributions, follows:

* **Option 1**. Number of slots indicated/configured by using a row index of a TDRA list, configured via RRC [4 companies]:
  + - Fujitsu [9], ZTE [5], Samsung [19], Ericsson [21].
* **Option 2**. Indication of number of slots via DCI [1 company]
  + Details are FFS:
    - Apple [16].
* **Option 3**. By means of L [3 companies]
  + Reinterpretation of the meaning of L:
    - Xiaomi [13].
  + Indicating a number of symbols that can be larger than 14 (symbol groups can be considered)
    - Samsung [19].
  + L value in the TDRA table is used to indicate the duration of PUSCH transmission occasion in the last slot:
    - * Repetition factor indicates the number of slots for multiple PUSCH transmission occasions where one slot contains only PUSCH transmission occasion.
      * Duration of PUSCH transmission occasions for all other slots is 14 symbols.
    - Lenovo/Motorola [26].

FL’s comments

Option 1 is slightly more popular. On the other hand, number of contributors is not large hence further observations on the situation may not be so relevant at this stage. The general understanding is that semi-static or dynamic indication solutions used in Rel-16 for other parameters can be used for this indicator as well. Further discussion is needed.

#### 2.1.2.1 First round of discussions

If and when this section is open, companies will be invited to express views on the Options provided above for defining and specifying constraints, if any, on how to define and indicate the number of slots for TBoMS.

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| Company | Comments |
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### 2.1.3 [OPEN] Constraints on whether non-consecutive UL slots can be used for TBoMS

Observations on whether non-consecutive UL slots can be used for transmitting TBoMS are provided in different forms in several contributions, with reference to the agreements made during RAN1 #104-e. A high-level summary of companies’ preferences based on the contributions is as follows:

* **Option 1**: Non-consecutive U slots can be used to transmit TBoMS with no specific condition (i.e., can be applied for paired spectrum, unpaired spectrum and the SUL band) [6 companies]:
  + - Fujitsu [9], Huawei/HiSi [3], Nokia/NSB [20], Sierra Wireless [22], LGE [27], MediaTek [8]
* **Option 2**: Non-consecutive U slots can be used to transmit TBoMS at least for unpaired spectrum [10 companies]:
  + - China Telecom [10], CMCC [11] (whether to support for paired spectrum and SUL band should depend on the discussion on collision handling), NTT Docomo [25], IITH [12], OPPO [4], CATT [7], InterDigital [14], Intel [15], Samsung [19], Ericsson [21] (in TDD or FDD)
* **Option 3**: Define a transmission occasion as consecutive symbols/slots and support non-consecutive U slots for TBoMS under the form of repeating the TB across transmission occasions [3 companies]:
  + - Vivo [6], IITH [12] (enhance PUSCH repetition type-A framework to support transmission over non-contiguous slots), Qualcomm [17]

Other than the above three main options, the following was also proposed:

* One company (Panasonic [18]) proposed that whether both consecutive and non-consecutive physical slot for UL transmission can be used or not for TBoMS should be the requirement to determine TBS determination approach.

FL’s comments

A large majority of companies prefer supporting non-consecutive U slots at least for unpaired spectrum, i.e., Option 2. 6 companies would prefer to have support of non-consecutive UL slots, with no specific condition. 3 companies would tie the support of non-consecutive slots to the construction of TBoMS as an enhanced Type A PUSCH repetition.

In this context, there is no consensus on the need of discussing possible definitions of transmission occasion for TBoMS prior to any decision on the support of non-consecutive U slots for TBoMS. From FL’s perspective, this is not unreasonable. The concept of transmission occasion is indeed tied to concept of PUSCH repetitions. It may or may not become a relevant concept if and when the support of TBoMS repetitions, if any, will be discussed. The need of discussing such aspect in the context of support to non-consecutive U slots qualifies more as a preference than an evident technical need. Consequently, such need is not clear, and FL suggests to proceed according to the most straightforward logic flow, compartmentalizing discussions as conventionally done in RAN1 for the sake of efficiency.

From FL’s perspective, deciding that non-consecutive U slots can be used to transmit TBoMS at least for unpaired spectrum, which is an extremely relevant use-case for TDD deployments, is an acceptable solution for most companies. The possibility of using non-consecutive U slots for transmitting TBoMS should not be discarded at this stage, and discussion on this aspect should continue. The following proposal is then made:

***FL proposal 2. Non-consecutive U slots can be used to transmit TBoMS at least for unpaired spectrum.***

***FFS: conditions, if any, on how TBoMS is transmitted over non-consecutive U slots for unpaired spectrum.***

***FFS: whether and how non-consecutive U slots can be used to transmit TBoMS for paired spectrum and SUL band as well.***

#### 2.1.3.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about FL proposal 2. The goal is to resume the discussion RAN1 had, and could not conclude, during RAN1 #104-e, to take steps forward and clarify support of non-consecutive U slots for transmitting TBoMS.

Companies can of course express their views. In case of negative feedback to FL proposal 2, it would be desirable if companies could also provide alternatives, if any, to give FL the possibility to find middle ground.

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| Company | Comments |
| vivo | Fine with the proposal. |
| OPPO | We can look at the supporting of the TBoMS in non-consecutive UL slots. We suggest also clarify the condition. E.g. Restricting the TB sizes for TBoMS … |
| CATT | Agree to reach a high-level consensus first. We can discuss if there are any the potential restrictions/conditions later. |
| Lenovo, Motorola Mobility | Fine with the proposal |
| Ericsson | We are OK with the proposal. |
| Samsung | We are generally fine with proposals. Does the “U” stand for UL or a representative letter of a number? We assumes it’s for UL. |
| Xiaomi | Fine with the proposal. |
| Apple | As commented during the online. This discussion can be after the detailed TBoMS scheme is determined, such as whether support transmission occasion, supporting TB segmentation or slot bundling. Different schemes have different level complexity increase to the implementation. |

### 2.1.4 [CLOSED] How to handle S slots

Only one specific proposal was made about this aspect. Observations on how S slots should be handled in the context of TBoMS are provided in different forms in several contributions, mostly in the context of the discussion on time domain resource determination.

* One company (China Telecom [10]) proposed that the special slots for unpaired spectrum should be utilized for UL transmission.

FL’s comments

FL suggests not to discuss this topic during #104-bis-e, unless need arises.

#### 2.1.4.1 First round of discussions

If and when this section is open, companies will be invited to express views on the Options provided above for defining and specifying constraints, if any, on how to handle S slots in the context of TBoMS.

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### 2.1.5 [OPEN] Definition of transmission occasion

The concept of “transmission occasion” in the context of TBoMS appears implicitly or explicitly in different forms in a small number of contributions. The content of the proposals therein can be summarized as follows.

* **Option 1**. TBoMS transmission occasion is specified in terms of the number of slots for one TB processed [1 company]:
  + - Apple [16];
* **Option 2**. A transmission occasion of a TBoMS transmission constitutes a set of contiguous resources (symbols) spanning one or more slots [3 companies]:
  + - Qualcomm [17] (a TBoMS transmission can constitute transmissions across one or more transmission occasions), Panasonic [18], vivo [6].

FL’s comments

As briefly discussed in Section 2.1.3, very few companies believe there is a technical need of discussing possible definitions of transmission occasion for TBoMS. Indeed, the concept of transmission occasion is tied to the concept of PUSCH repetitions. Consequently, such need is not clear until support of repetitions of TBoMS, if any, is discussed (please refer to Section 2.4.1). As stated above, FL suggests to proceed according to the most straightforward logic flow, compartmentalizing discussions as conventionally done in RAN1 for the sake of efficiency.

Having said this, a first round discussion will be open on this aspect to let companies express their views (once again) in favor or against the definition of transmission occasion for TBoMS.

#### 2.1.5.1 First round of discussions

From FL’s perspective, an opportunity for this discussion to take place has already been given during RAN1 #104-e. Most companies did not see any need for this discussion to take place. I think RAN1 cannot afford going back on forth on this “issue” during several meetings, so I would like to invite all interested companies to discuss it once again and provide views in constructive ways. If no agreement/convergence can be achieved, or novel elements to increase its relevance in the meantime arise, this discussion will be closed on 04/15.

Companies are invited to input their views below.

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| Company | Comments |
| vivo | In vivo’s understanding, one of the motivations of define Tx occasion is to support PUSCH repetition for TBoMS, and also may have impacts on TB size determination, if the resources for N\_info calculation is not the same as that the symbols allocated.  Furthermore, it also impacts the discussion on how to handle the collision between TBoMS and other transmission. For example, if symbol for TBoMS is indicated as not available by CI, SFI or a high priority transmission, should UE cancel part of the TBoMS transmission or whole TBoMS transmission. If transmission on part of the TBoMS resources is cancelled, the time domain granularity for dropping need to be defined, which can be regarded as a transmission occasion.  Hence, we suggest to leave the door open for the concept of transmission occasion. |
| OPPO | We do not see the justification. We can come back to the issue in later stage. To us, it seems to be more signalling virtual concept. |
| CATT | We are open to discuss this feature, but we also think that TBoMS is not kind of repetition. We have doubt that, is the concept of transmission occasion of TBoMS (or similar things) essential to support this feature? If introduced, will it be applied to TDD only, or both TDD and FDD? |
| Lenovo, Motorola Mobility | In our view, there is no clear motivation to explicitly define the TBoMS transmission occasion and agree with FL’s comments that this is mainly tied to repetition of TBoMS which is itself not yet agreed |
| Ericsson | This is not an easy discussion, as vivo points out. We would add that power control also uses the notion of a transmission occasion. One possibility is that we have different definitions of transmission occasion in different contexts, e.g. power control could be for one slot, while if an RV spans multiple slots, the transmission occasion for the RV would be multiple slots. |
| Samsung | The discussion on this new definition could wait a bit later. |
| Apple | We are considering the transmission occasion can facilitate the discussion, and makes the discussion easier. The pure TBoMS gain is limited, to enhancement the coverage, repetition on top of TBoMS is promising and discussing now. |

### 2.1.6 [CLOSED] Constraint on the maximum number of slots for TBoMS

Observations on constraints on the maximum number of slots for TBoMS are provided in different forms in several contributions, which can be summarized as follows.

* One company (IITH [12]) proposed that if N\_prb used for TBoMS is not restricted, then a restriction on the number of slots aggregated for TBoMS is required.
* One company (Ericsson [21]) proposed that if TBoMS with more than 2 slots is to be supported, TBoMS configuration uses the number of available slots, otherwise physical slots are used. As a starting point, consider 2 or 4 slots as the candidate numbers of slots for a TBoMS.
* One company (Sierra Wireless [22]) proposed that multi-slot encoding should be specified with a maximum of 2 slots of encoding.

FL’s comments

From FL’s perspective, this is a less fundamental topic RAN1 can afford discussing when more paramount aspects of TBoMS have been agreed on. FL suggests not to discuss this topic during #104-bis-e, unless need arises.

#### 2.1.6.1 First round of discussions

If and when this section is open, companies will be invited to express views on the Options provided above for the definition of constraints on the maximum number of slots that can be used for TBoMS.

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### 2.1.7 [CLOSED] Other proposals for TDRA

Another proposal related to TDRA of TBoMS, and not reported elsewhere in this section, was made. Its content can be summarized as follows.

* One company (NEC [24]) proposed that some enhancement to reduce segment within a slot for PUSCH repetition type B like TDRA should be consider TDRA for TBoMS.

FL’s comments

From FL’s perspective, this is a less fundamental topic RAN1 can afford discussing when more paramount aspects of TBoMS have been agreed on. FL suggests not to discuss this topic during #104-bis-e, unless need arises.

## 2.2 FDRA

### 2.2.1 [CLOSED] Maximum number of PRBs allocated for TBoMS

Several contributions acknowledged the fundamental nature of this aspect and discussed it in detail. Discussions on the major reason behind the performance increase observed in case of multi-slot TB transmissions as compared to their single-slot counterpart are carried out therein.

It is argued that TBoMS is beneficial in terms of PSD boosting, since it concentrates transmission power in a narrow frequency resource and frequency domain resource multiplexing. Moreover, there seems to be no need to occupy more frequency domain resource to achieve a lower code rate, given that the TB can be transmitted over multiple slots. It is finally observed that restricting the number of PRBs for the FDRA of TBoMS transmission may also reduce DCI size, which could positively impact the coverage of PDCCH as a by-product.

Several proposals are made in this regard. A high-level summary of all options, including companies’ preferences based on the contributions, follows:

* **Option 1**. FDRA for TBoMS is limited to a small number of PRBs [5 companies]:
  + - ZTE [5], Xiaomi [13], Samsung [19], LGE [27], IITH [12] (if N\_prb used for TBoMS is not restricted, then a restriction on the number of slots aggregated for TBoMS is required);
* **Option 2**. No explicit limitation on number of PRBs for TBoMS FDRA [1 company]:
  + - Vivo [6] (limitation on number of PRBs for TBoMS can be achieved by proper NW scheduling).

Partially different technical understandings on why TBoMS is expected to bring gains as compared to single-slot counterpart have been provided in other contributions submitted to this AI, even if no proposal was added therein. From FL’s perspective, this important aspect of FDRA for TBoMS deserves more discussion before commenting further. On the one hand, the reason why this aspect should not be left to gNB’s implementation is unclear. On the other hand, its relevance for subsequent discussions on TBS determination, link adaptation and (possibly) frequency hopping justify its presence in this section.

#### 2.2.1.1 First round of discussions

Companies are invited to express their views on this topic, considering the two Options above. The goal is to decide whether the max number of PRBs allocated to TBoMS should be limited. FL’s proposal, if any, will be formulated after the first round of discussions.

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| Company | Comments |
| vivo | As we discussed in last meeting, limited PRB number can be achieved by proper NW scheduling.  For reduced DCI size brought by limited DCI size, the coverage of DCI is not bottleneck based on outcome of SI. Furthermore, it is not clear the whether the UL grant is provided by the same DCI format as that for regular PUSCHs or a new DCI format. If legacy DCI format is reused, the DCI size can not be reduced. For new DCI format, whether the benefit can be obtained also depends on the outcome of DCI size alignment, higher UE capability may be required if more DCI sizes need to be decoded. |
| OPPO | We think the TB size can be decided first. Then we can see if the PRB should be limited later. |
| CATT | Option 2 is preferred.  The gNB shall control and schedule the FDRA well according to its knowledge in link performance and network situation. It should be up to gNB implementation. |
| Lenovo, Motorola Mobility | We support Option 2 and agree with Vivo that NW scheduling can take care of the appropriate number of PRBs |
| Ericsson | In short, we are open to discuss if restrictions on the number of PRBs are needed, but it should be studied further especially with respect to performance as the feature lead points out.  From our results in R1-2103446, we observe that in the cases where TBoMS shows some gain vs. a Rel-15/16 baseline, there is less with larger TBS than with smaller TBS. But it is not clear that these cases where the gain is found are configurations that make sense. So our view overall given this potentially limited gain of TBoMS is that TBoMS specification and implementation impact should be minimized, and if fewer PRBs support that goal, we are Ok with limiting the number of PRBs. |
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## 2.3 TBS determination

TBS determination was discussed by many companies. Indeed, it is an aspect which will have to be discussed and properly defined, regardless of how other aspects of TBoMS are dealt with. Three major sub-aspects of TBS determination have been discussed by companies in the submitted contributions:

2.3.1 calculation

2.3.2 calculation

2.3.3 Constraint on maximum TBS for TBoMS

Summary, discussion and proposals on these sub-aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### 2.3.1 [OPEN] calculation

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail. The discussions focused on the two approaches identified in the agreement made in RAN1#104-e meeting for calculation. A high-level summary of companies’ preferences based on the contributions, is as follows:

* **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 [10 companies]:
  + Fujitsu [9], China Telecom [10], ZTE [5], InterDigital [14], Intel [15], Samsung [19], Nokia/NSB [20], Ericsson [21], Lenovo/Motorola [26],
  + CMCC [11] (Approach 1 should be further discussed based on the counting of slots. The symbols over which the TBoMS transmission is allocated can be different from the symbols over which the TBoMS transmission is performed due to collisions).
* **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 [10 companies]:
  + is equal to the total number of slots allocated for TBoMS transmission:
    - IITH [12]
  + may or may not be equal to the total number of slots allocated for TBoMS transmission:
    - Panasonic [18], CATT [7], NEC [24] (as starting point), LGE [27], WILUS [28] (as a baseline), OPPO [4];
    - vivo [6] (K is number of slots in the first transmission occasion/repetition);
    - Sharp [23] (K is indicated through a DCI format for scheduling the PUSCH or RRC signaling);
    - Qualcomm [17] ( is the number of resource elements available in a transmission occasion of TBoMS. A new scaling factor S is introduced to scale the when computing ).

The following was also additionally proposed for the two approaches above:

* One company (CMCC [11]) proposed that considering the process delay, the slot number in Approach 1 and the K value in Approach 2 should be limited.
* One company (NTT Docomo [25]) proposed that NInfo calculation for TBoMS should be compatible for both PUSCH repetition type A and B like TDRA or discussed after concluding TDRA determination for TBoMS.
* One company (Apple [16]) proposed that the same PUSCH mapping type and SLIV are applied to slots for TB transmission.
* One company (OPPO [4]) proposed that TBS determination of TBoMS is configured with PUSCH repetition operation. The enhanced Type A PUSCH repetition is included.

FL’s comments

The two approaches identified during RAN1 #104-e received equal support. From FL’s perspective, it is probably not so meaningful to provide a proposal at this stage, and further discussion should be carried out by companies.

#### 2.3.1.1 First round of discussions

Companies are invited to provide additional views on the two approaches above. Constructive attitude is highly appreciated, given the very balanced situation we have at present. The goal is to resume the discussion RAN1 had, and could not conclude, during RAN1 #104-e, to take steps forward and clarify how is calculated for TBoMS.

In this context, it would be desirable if companies could also indicate availability to support the two approaches, if applicable, highlighting first/second preference, to give FL the possibility to find middle ground.

|  |  |
| --- | --- |
| Company | Comments |
| vivo | Approach 2 should be adopted.  Since, most companies support repetition on top of TBoMS, as summarized in section 2.4.1, Approach 2 is preferred which can well support TBoMS + repetition.  TBoMS with repetition seems not supported by Approach 1, if TB size is determined based on all allocated REs and the coded bits are mapped to all of the allocated REs. |
| OPPO | Approach 2 can be preferred. We think it can be simply added in the current spec with a K parameter. |
| CATT | Slightly prefer Approach 2 for clear calculation reference. Also, if repetition type A/B like TDRA is agreed, these 2 approaches have no much inner difference. |
| Lenovo, Motorola Mobility | In our view, Approach 1 provides the calculation based on actual number of symbols (REs) on which the PUSCH is determined, where for Approach 2, the actual allocation might be different than that indicated by L and K. For this reasons, we support Approach 1. |
| Ericsson | The WID says the following, which we think gets us pretty far in the TBS determination design.   * + Specify mechanism(s) to support TB processing over multi-slot PUSCH [RAN1]     - TBS determined based on multiple slots and transmitted over multiple slots.   For us, the details of Ninfo calculation is something that should follow what we do with TDRA: if the number of symbols in a slot varies, then Approach 1 may work better. We note that the TBS is calculated ‘based on’ all of an allocation, so we don’t see why repetition has is precluded by Option 1. On the other hand, if we only have Type A, both approaches can work. So our suggestion would be to focus on TDRA and, if repetition impacts TBS determination, if repetition is supported. In the meantime, we have some guidance from the WID.  All that said, if we must choose now, we support approach 1 given its generality. |
| Samsung | Approach 1 is preferred.  No matter which TDRA method is decided, the consequence is that UE sees a group of REs to be used for TBoMS transmission, while option2 to do some optimization on calculation which seems unnecessary, by either TDRA methods we are discussing, it will not affect eventually UE should know the complete RE number to be used for TBS determination. Although TBS determination/calculation is with mathematically quantization so that super precise may not be easy, approach 1 can clearly be closer to get what the resource practically to accommodate. |
| Xiaomi | Approach 1 is preferred. It is more accurate if PUSCH repetition type B like TDRA is used. In addition, no matter what TDRA method is adopted, it can always work well, which helps to postpone the meeting progress without waiting until the exact TDRA method is determined. |
| Apple | Approach 2 is preferred. We share the views as vivo and OPPO. |

### 2.3.2 [OPEN] calculation

Most contributions discussed this aspect, which has a precise impact on TBS determination and, as such, needs to be discussed carefully. The discussions in the submitted contributions focused on the two options identified in the agreements made during RAN1 #104-e meeting. A high-level summary of companies’ preferences based on the contributions, is as follows.

* **Option 1**. 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 [9 companies].
  + - IITH [12], vivo [6], ZTE [5], Apple [16], Qualcomm [17], Ericsson [21], Lenovo/Motorola [26], LGE [27], WILUS [28] (baseline).
* **Option 2**. 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 [4 companies]:
  + - CMCC [11], CATT [7], Intel [15], Nokia/NSB [20].

The following was also additionally proposed for the two approaches above:

* One company (NTT Docomo [25]) proposed that NohPRB calculation for TBoMS should be compatible for both PUSCH repetition type A and B like TDRA or discussed after concluding TDRA determination for TBoMS.

FL’s comments

A majority of companies prefer Option 1, while only 4 companies support Option 2. It is worth observing that it was argued by one company [20], that Option 2 may also encompass Option 1, when is calculated depending on both *xOverhead* and the number of slots, adding that *xOverhead* would need to be scaled for the number of slots in Option 1 as well.

From FL’s perspective, the difference between the two options is that Option 2 can be compatible with both approaches discussed in Section 2.1.1 for time domain resource determination, whereas Option 1 seems compatible only with PUSCH repetition type A like TDRA. In this context, if only the latter is retained in Section 2.1.1, then agreeing on Option 1 should be a natural consequence. On the other hand, the observation in [20] highlights a possible middle ground between the two options and could be used as a starting point for the discussion if other companies agree with the assessment. The following proposal is thus formulated:

***FL proposal 3. is calculated depending on both xOverhead (configured as in Rel-15/16) and on at least the number of slots over which TBoMS is transmitted.***

***FFS: whether, and upon which conditions, can also be calculated depending on both xOverhead and the number of symbols over which TBoMS is transmitted.***

#### 2.3.2.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about FL proposal 3. The goal is to identify the preferred direction RAN1 should pursue for defining and specifying calculation for TBOMS.

Companies are also invited to express additional views, should they not agree with the proposal. In this case, it would be desirable if companies could also provide alternatives, if any, to give FL the possibility to find middle ground.

|  |  |
| --- | --- |
| Company | Comments |
| vivo | We understand FL’s motivation. But the main sentence seems to exclude the case that TB is mapped to a **subset** of the slots allocated, i.e. TB mapped to a transmission occasion? So maybe we can make the following revision:  ***FL proposal 3. is calculated depending on both xOverhead (configured as in Rel-15/16) and on at least the number of slots or subset of the slots over which TBoMS is transmitted.***  ***FFS: whether, and upon which conditions, can also be calculated depending on both xOverhead and the number of symbols over which TBoMS is transmitted.*** |
| OPPO | To be explicit, option 1. See the difficult to support 2 options for one purpose. |
| CATT | OK with the proposal. We also hope to reach convergence on TDRA to provide guidance to this proposal. |
| Lenovo, Motorola Mobility | We are fine with FL proposal as a compromise |
| Ericsson | Support the proposal. |
| NTT DOCOMO | Support the proposal |
| Samsung | In rel15/16, the ***xOverhead*** is configured per PRB (regardless the number of OFDM symbols for a slot), so we can see for each slot, it should be same value. Although the total overhead for TBS determination for TBoMS will count the number of slot,won’t. so suggest to change to:  ***The total overhead for TBS determination in TBoMS is calculated depending on both xOverhead (i.e., configured as in Rel-15/16) and on ~~at least~~ the number of slots over which TBoMS is transmitted.*** |
| Xiaomi | Support the proposal. |
| Apple | We are fine with this proposal. |

### 2.3.3 [CLOSED] Constraint on maximum TBS for TBoMS

The potential constraint on maximum TBS for TBoMS was discussed in several submitted contributions and can be summarized as follows.

* Two companies (Huawei/HiSi [3], CATT [7]) proposed that further constraint on maximum TBS for TBoMS is not needed.
* One company (ZTE [5]) proposed that the maximum TBS can be limited by the conditions of data rate limitations DataRate and DataRateCC.
* One company (Qualcomm [17]) proposed to restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock).

FL’s comments

From FL’s perspective, this is a less fundamental topic RAN1 can afford discussing when more paramount aspects of TBoMS have been agreed on. FL suggests not to discuss this topic during #104-bis-e, unless need arises.

#### 2.3.3.1 First round of discussions

If and when this section is open, companies will be invited to express views on the constraints, if any, on the maximum TBS that can be used for TBoMS.

|  |  |
| --- | --- |
| Company | Comments |
|  |  |
|  |  |
|  |  |

## 2.4 Others

As discussed at the beginning of Section 2, aspects and topics related to several aspects of TBoMS have been prioritized in order to ensure that constructive discussions and effective progress can be achieved during RAN1 #104-bis-e. In this context, priority has been given to the aspects and topics discussed in sections 2.1 to 2.3, which mostly focus on resource allocation for TBoMS and related matters. All other aspects are listed in this section, i.e, 2.4, where proposals made by companies in their contributions are reported and described in detail. Discussion on two of these aspects is open, i.e., the ones described in Sections 2.4.1, 2.4.2 and 2.4.5, and one FL proposal is also formulated.

No specific FL’s proposal or recommendation is formulated for other aspects at this stage, since such aspects may not be handled during RAN1 #104-bis-e. Should discussions for 2.1 to 2.3, 2.4.1, 2.4.2 and 2.4.5 progress fast, new sections for specific aspects, currently in 2.4, will be open for discussions and corresponding FL’s proposals and recommendations would be made.

### [OPEN] Relationship between TBoMS and PUSCH repetitions

After the preliminary discussions occurred during the GTW scheduled on April, 13th, it became evident that a fundamental step to be taken is the clarification of the relationship between TBoMS and PUSCH repetitions. From FL’s perspective, two major directions can be identified:

* **Approach 1**: TBoMS is designed as a Type A PUSCH repetitions enhancement, in which TBS is determined based on the available resources over one or multiple slots.
  + Note1: This approach may have at least the following implications:
    - A transmission occasion of a TBoMS transmission constitutes a set of contiguous resources (symbols) spanning one or more slots.
    - TBoMS transmission is performed over one or more transmission occasions
    - RV cycling is applied across transmission occasions.
    - is the total number of REs available in a single transmission occasion of a TBoMS.
    - The PUSCH repetition type A and RV cycling framework in R15/R16 is repurposed for TBoMS transmission across multiple transmission occasions.
* **Approach 2**: TBoMS is designed as a new feature which shares several indicators with Type A/B PUSCH repetitions, e.g., TDRA, but that provides an alternative way of using the resource given by multiple slots.
  + Note1: This approach may have at least the following implications:
    - The TBS is determined based on the resources available over multiple slots.
    - TBoMS transmission is performed over multiple slots.
    - Different bit to resource mapping mechanisms are possible (RV cycling based or not).
    - is the total number of REs available in several slots.
    - Signaling used in the feature can reuse part of the existing PUSCH repetition Type A/B framework.
  + Note2: the expression “Type A/B” is used to capture the fact that RAN1 has not decided whether Type A and/or Type like TDRA are used by TBoMS for time domain resource determination. It does not imply any specific preference for Approach 2.

It has been noted that many discussions RAN1 is having in other sections of this document may be impacted by the decision on which Approach to use for the design TBoMS. Therefore, this discussion is to be carried out with high priority and a final decision should be made during this meeting.

A question I would like to add from FL’s perspective is also the following:

* If TBoMS is designed according to Approach 1 and becomes a Type A PUSCH repetitions enhancement, can we still claim that RAN1 is fulfilling what is mandated in the WID, where Type A PUSCH enhancements are supposed to be discussed and specified in AI 8.8.1.1?

#### 2.4.1.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about Approach 1 and Approach 2 (and FL’s question). Companies are invited not to express preferences on specific aspects of the designs according to both approaches, but only preferences on the approaches. Specific design aspects can be discussed in other sections. Corrections to the notes can of course be suggested.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | We lean toward approach 2, since our understanding of TBoMS is to provide more time domain resources for a transport block: the WID calls for TBS determined based on multiple slots. How the RV determination works, and if the TBS calculation is in line with the WID is not so clear to us in Approach 1. We therefore have a similar doubt as in the FL question. |
| NTT DOCOMO | Approach 1 is not qualified to be TBoMS. It is hard to find the motivation to just increase TBS as an enhancement of PUSCH repetition type A.  TBoMS is a technique to enhance coverage performance. It is not the enhanced technique of normal repetitions. Just some mechanisms of repetitions can be reused for TBoMS since they are the same in a sense that resources over multi-slot are assigned for one TB. We think this topic is very tied to 2.4.5 redundancy version and rate-matching. Concluding 2.4.5 can make it clear the difference between repetitions and TBoMS. |
| Samsung | Approach 2 is more aligned with our understanding. |
| Xiaomi | Generally support Approach 2. TBoMS is quite a different coverage enhancement method from PUSCH repetition. The purpose of use of TBoMS is to obtain the power boosting gain by limiting RBs in an OFDM symbol, and to obtain more coding gain by extending the time domain resource. While, the purpose of use of PUSCH repetition is to achieve a lower coding rate. Thus, TBoMS should be discussed as a new feature.  Besides, considering TBoMS and repetition are two features, a question need to be discussed is whether these two features can be used together and how to design the related signalling procedure. |
| Apple | Try to understand the proposal better, comparing the proposed Approach 1 and Approach 2, we don’t see the big difference. If we remove the “RV cycling is applied across transmission occasions” in Approach 1 and remove “the type B framework” in Approach 2, both approaches are almost the same. I think the key difference of two approaches is the whole TB is mapping to one slot (then perform the repetition) or mapping to multiple slots directly.   * **Approach 1**: TBoMS is designed as a Type A PUSCH repetitions enhancement, in which TBS is determined based on the available resources over ~~one or~~ multiple slots.   + Note1: This approach may have at least the following implications:     - A transmission occasion of a TBoMS transmission constitutes a set of contiguous resources (symbols) spanning ~~one or~~ more slots.     - The coded bits of the TB are mapping separately to each slots of the transmission occasion with RV cycling       * Each slot could be self-decodable     - TBoMS transmission is performed over one or more transmission occasions     - RV cycling is applied across transmission occasions.   Apple: above two bullets are related to repetition on top of TBoMS repetition, which can apply to both approaches. Or just remove these two bullets to discuss the TBoMS only.   * + - is the total number of REs available in a single transmission occasion of a TBoMS.     - The PUSCH repetition type A and RV cycling framework in R15/R16 is repurposed for TBoMS transmission across multiple transmission occasions. * **Approach 2**: TBoMS is designed as a new feature which shares several indicators with Type A/B PUSCH repetitions, e.g., TDRA, but that provides an alternative way of using the resource given by multiple slots.   + Note1: This approach may have at least the following implications:     - The TBS is determined based on the resources available over multiple slots.     - TBoMS transmission is performed over multiple slots.     - Different bit to resource mapping mechanisms are possible (RV cycling based or not).       * single slot is not self-decodable   Apple: Does this bullet mean “The coded bits of the TB are mapping to all the slots, which are used to determine the TBS”?   * + - is the total number of REs available in several slots.     - Signaling used in the feature can reuse part of the existing PUSCH repetition Type A/B framework.   Note2: the expression “Type A/B” is used to capture the fact that RAN1 has not decided whether Type A and/or Type like TDRA are used by TBoMS for time domain resource determination. It does not imply any specific preference for Approach 2. |

### [CLOSED] Repetitions of TBoMS

Repetitions of TBoMS were discussed in several contributions, which can be summarized as follows:

* Eight companies (NTT Docomo [25], Xiaomi [13], Intel [15], Apple [16], Samsung [19], Sierra Wireless [22], Sharp [23], LGE [27]) proposed that repetition should be supported on top of TBoMS.
* Two companies proposed to support repetition of TBoMS with constraint:
  + One company (Panasonic [18]) proposed that repetition of TBoMS is considered only if overall coding rate lower than which has been specified in MCS table for URLLC is necessary.
  + One company (Huawei/HiSi [3]) proposed that repetition of TBoMS is supported, and the overall number of slots for TBoMS with repetition should be limited.
* One company (CMCC [11]) proposed that repetition of TBoMS should not be supported.
* Two companies (ZTE [5], Ericsson [21]) proposed further discussion on whether repetition of TBoMS should be supported or not.
* One company (China Telecom [10]) proposed down selection between setting the maximum number of aggregated slots for TBoMS to be the same as the maximum number of repetitions for PUSCH repetition type A or supporting repetition of TBoMS.

FL’s comments

Most companies prefer supporting repetitions of TBoMS. One company prefers not to support PUSCH repetitions for TBoMS. One company explicitly proposes to implement TBoMS as a special case of PUSCH repetitions type A (details are provided in [17]), whereas another company proposes not to consider TBoMS should as a PUSCH repetition type A and/or type B enhancement.

From FL’s perspective, the situation seems rather in favour of supporting repetitions of TBoMS. It is acknowledged that the technical need of repetitions of TBoMS may depend on how TBoMS feature is finally designed. In this regard, it may be worth observing that once such aspects are designed, adding support to repetitions of TBoMS would be an incremental effort, given that time-domain constraints, if any, would be clear by then. Thus, since more foundational aspects are still on the table, FL’s suggestion is to focus on these and “keep the door open” to repetitions of TBoMS. The following proposal is then formulated:

***FL proposal 4. Support of repetitions of TBoMS is considered FFS.***

#### 2.4.2.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about FL proposal 4. The goal is to ensure that more foundational aspect of TBoMS are worked out before discussing repetitions of TBoMS.

Companies are invited to express additional views, should they not agree with the proposal. In this case, it would be desirable if companies could also provide alternatives, if any, to give FL the possibility to find middle ground.

|  |  |
| --- | --- |
| Company | Comments |
| vivo | Since large majority prefer to support TBoMS with repetition, perhaps agree to support repetition of TBoMS may facilitate the discussion in TDRA determination and TBS determination? |
| OPPO | That depends on definition of TBoMS. Seems one definition have a TBoMS “span” in multiple slots and the repetitions are based on that “span”  It can also be looked as TBoMS have a TB slot determination parameter “K” slots. It is used when PUSCH repetition is configured. In this understanding, we see they are configured together. |
| CATT | OK with the proposal. |
| Lenovo, Motorola Mobility | We support the FL’s proposal |
| Ericsson | We are open to further study, but are not ready to agree to specify repetition at this stage. If the number of slots in a TBoMS transmission is somehow limited, then it is more likely that repetition could be beneficial. But since HARQ always outperforms repetition, repetition can be seen as a PDCCH overhead savings rather than a coverage enhancing feature. Then having TBoMS and repetition together, both of which reduce PDCCH overhead, may be overkill. |
| Xiaomi | We support the proposal. |

### [CLOSED] DM-RS

DM-RS allocation was discussed in several contributions, which can be classified into the following sub-topics:

**DM-RS allocation for TBoMS in general**

* One company (Ericsson [21]) proposed that the same DMRS configuration is used in all slots of TBoMS.
* Two companies (Sharp [23], MediaTek [8]) proposed that DMRS location can be slot specific as legacy operation.

**DM-RS allocation for TBoMS in case joint channel estimation is enabled**

* One company (Samsung [19]) proposed to further study time domain allocation of DM-RS considering joint channel estimation over multi-slot and transmissions (e.g. DM-RS allocation is determined per PUSCH transmission, or per slot).
* One company (Sharp [23]) proposed that DMRS configuration for length larger than 14 should be studied in joint channel estimation AI.

### [CLOSED] CB segmentation

Concerning TB processing for mapping the TB on a resource that spans across multiple slots, the following proposals about CB segmentation were discussed in several contributions:

* One company (Ericsson [21]) proposed that CB segmentation can be considered for TBoMS.
* One company (LGE [27]) proposed that the maximum TBS for TBoMS should be reduced so that CB segmentation does not occur.
* One company (Apple [16]) proposed that the TBoMS terminology should be clarified by down-selecting between TB segmentation and slot bundling.
* One company (Qualcomm [17]) proposed that RAN1 should prioritize design considerations for TBoMS that help prevent or reduce small payload segmentation.

### [OPEN] Redundancy version and rate-matching

Concerning TB processing for mapping the TB on the resource that spans across multiple slots, the following proposals on redundancy version and rate-matching were made:

* Four companies (China Telecom [10], OPPO [4], Nokia/NSB [20], Ericsson [21]) proposed that continuous rate-matching with a single RV should be considered for TBoMS.
* Three companies (Huawei/HiSi [3], Samsung [19], MediaTek [8]) proposed that continuous rate-matching and RV-based segmented rate-matching (RV cycling) should be further studied.
* Two companies (Qualcomm [17], Panasonic [18]) proposed that RV index for a transmission occasion that constitutes a set of contiguous resources (symbols) spanning one or more slots can be a single RV index or an updated RV index is used each time a slot boundary is crossed.
* One company (Sharp [23]) proposed that if a single PUSCH crossing slot boundaries without repetition is supported for TBoMS transmission, some reserved resources (e.g., DL region) which overlaps with the single PUSCH should be punctured or rate matched.
* One company (Qualcomm [17]) proposed repeating TBoMS across transmission occasion that constitutes a set of contiguous resources (symbols) spanning one or more slots using PUSCH repetition type A and RV cycling framework. FFS: limits on maximum duration of a transmission occasion.
* One company (Nokia/NSB [20]) proposed that RAN1 should specify TBoMS as an independent feature according to WID and TBoMS should not be considered as an enhancement of neither PUSCH repetition type A nor type B, regardless of how time domain resource determination is indicated.

FL’s comments

RV and rate matching could be considered as aspects which should be discussed only after decisions on aspects such as resource allocation (time and frequency domain) and TBS determination are taken. However, these aspects can be tied to other considerations affecting decisions and preferences companies have on resource allocation (time and frequency domain) and TBS determination. In this sense, discussing RV and rate matching could offer further opportunities to companies to better understand each other’s point of view and converge to acceptable outcomes and middle ground.

From FL’s perspective situation does not seem to offer clear directions for which consensus exists across companies, which could be used to draft a first FL proposal. Further discussion is necessary.

#### 2.4.5.1 First round of discussions

FL’s recommendation is to have first round of discussion among companies about RV and rate-matching.

Companies are invited to express views and preferences.

|  |  |
| --- | --- |
| Company | Comments |
| OPPO | To ensure the performance 1 RV mapping to continuous slots should be supported at least for FDD. |
| CATT | In our understanding, single RV is the baseline of TBoMS. If RV-based segmented rate-matching (RV cycling) is applied, there seems no much difference between TBoMS and normal repetition mechanism. But we are open to discuss if RV cycling is proven to be critical for TBoMS. |
| Ericsson | We are not firmly opposed to e.g. multiple RVs in a TBoMS transmission, but think that a single RV is the most logical starting point. If a strong benefit to multiple RVs within a TBoMS can be demonstrated, we can be open to that. |
| NTT DOCOMO | In TBoMS, segmentations of a single RV should be assigned over all assigned resources for TBoMS. Otherwise, it is pretty much the same as repetition and hard to find the motivation of supporting TBoMS  Also, we think this topic should be discussed earlier than TDRA. TDRA of TBoMS depends on how rate-matching outputs are assigned to resources in time domain. |
| Samsung | It seems premature to make decision, as we proposed in the tdoc, we just list the possible operation on the table, and see more companies’ comments. |
| Xiaomi | We share the same view as Ericsson. |

### [CLOSED] Interleaving

One company (Samsung [19]) proposed that slot-based interleaving is supported for TBoMS.

### [CLOSED] Link adaptation

One company (Ericsson [21]) proposed that the same MCS index is used in all slots of TBoMS.

### [CLOSED] Frequency hopping

Frequency hopping (FH) aspects were discussed, and corresponding proposals were made, depending on whether joint channel estimation and repetition are supported for TBoMS:

* One company (Intel [15]) proposed that inter-slot FH should be supported for TBoMS.
* Four companies (Panasonic [18], Xiaomi [13], Intel [15], Lenovo/Motorola [26]) proposed that inter-slot FH with inter-slot bundling should be supported for TBoMS.

### [CLOSED] Transmission power determination

The transmission power determination was discussed in several contributions and can be summarized as follows:

* One company (ZTE [5]) proposed that the transmission power determination should be based on the multiple slots for TBoMS with excluding the overhead of reference signals.
* One company (Ericsson [21]) proposed that the transmission occasion of TBoMS for RV cycling and UL transmission power determination can be different. A transmission occasion of one slot is preferred for TBoMS transmission power determination. FFS: whether the power is fixed or how it can vary across slots.

### [CLOSED] Rank of TBoMS transmission

The rank of a TBoMS transmission (number of layers) was discussed in several contributions and can be summarized as follows.

* One company (Ericsson [21]) proposed that the same number of layers is used in all slots of TBoMS.
* Two companies (vivo [6], Qualcomm [17]) proposed that TBoMS should be limited to single-layer transmission.

### [CLOSED] Retransmissions

Details of retransmission of a TBoMS were discussed in several contributions and can be summarized as follows.

* One company (CMCC [11]) proposed that per-slot retransmission should be considered for the retransmission of TBoMS.
* One company (InterDigital [14]) proposed to support enhanced retransmission mechanisms to avoid the retransmission of the entire TBoMS.
* One company (Ericsson [21]) proposed that TB-based retransmission is considered for TBoMS, rather than CBG-based retransmission.

### [CLOSED] Collision handling

Details of collision handling between TBoMS PUSCH and PUCCH/SRS/DL symbols were discussed in several contributions and can be summarized as follows.

* Three companies (Fujitsu [9], ZTE [5], Ericsson [21]) proposed that repetition-like behaviour should be reused for collision handling between TBoMS and PUCCH.
  + One company (Ericsson [21]) proposed to add a constraint for the case when the number of symbols in each slot is the same for TBoMS that the above is applied if the number of physical slots is configured.
* One company (vivo [6]) proposed that for UCI multiplexing on TBoMS, the number of modulated symbols in the PUSCH for UCI multiplexing is determined based on the number of symbols for PUSCH in a slot that is overlapped with the PUCCH.
* One company (Samsung [19]) proposed that UCI multiplexing in TBoMS should be supported and parallel transmission of PUCCH and TBoMS is not preferred due to power splitting during CE situation.
* Seven companies (Huawei/HiSi [3], ZTE [5], CATT [7], Intel [15], Ericsson [21], LGE [27], WILUS [28]) proposed to further discuss collision handling of PUCCH vs. TBoMS PUSCH including the UCI multiplexing mechanism, e.g. how to determine the number of REs for UCI multiplexing.

### [CLOSED] TBoMS vs. single slot PUSCH transmission indication

The indication of TBoMS feature, i.e. indication on whether a PUSCH transmission should follow TBoMS or legacy PUSCH transmission, was discussed in several contributions. Corresponding proposals can be summarized as follows.

* One company (InterDigital [14]) proposed to support dynamic switching between TBoMS and single-slot PUSCH.
* One company (China Telecom [10]) proposed that dynamic switching between TBoMS and single slot transmission can be differentiated by the indication of number of slots in DCI.
* One company (IITH [12]) proposed to support semi-static switching between TBoMS and single slot transmission.
* One company (Xiaomi [13]) proposed to consider configuration and/or indication procedures when both repetition and TBoMS are supported for a single UE.
* One company (Nokia/NSB [20]) proposed to further study details of indication method, including introducing a new field or reusing the available field in the scheduling DCI (or RRC parameter in case of configured grant configuration), e.g., some rows in the TDRA table are used to configure for multi-slot TB transmission.

# 3 [CLOSED] Proposals for GTW

# 4 [CLOSED] Agreements

# 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. R1-2102314 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2102408 Issues for TB over multi-slot PUSCH, OPPO
5. R1-2102498 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2102535 Discussion on PUSCH TB processing over multiple slots, vivo
7. R1-2102644 Discussion on TB processing over multi-slot PUSCH, CATT
8. R1-2102691 Discussion on TB processing over multi-slot PUSCH, MediaTek Inc.
9. R1-2102718 Views on TB processing over multi-slot PUSCH, Fujitsu
10. R1-2102861 Discussion on TB processing over multi-slot PUSCH, China Telecom
11. R1-2102894 Discussion on TB processing over multi-slot PUSCH, CMCC
12. R1-2102913 On TB processing over multiple slots for PUSCH, Indian Institute of Tech (H)
13. R1-2102993 TB processing over multi-slot PUSCH, Xiaomi
14. R1-2103008 TB processing over multi-slot PUSCH, InterDigital, Inc.
15. R1-2103043 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
16. R1-2103117 Discussion on TB processing over multi-slot PUSCH, Apple
17. R1-2103179 TB processing over multi-slot PUSCH, Qualcomm Incorporated
18. R1-2103208 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
19. R1-2103252 TB processing over multi-slot PUSCH, Samsung
20. R1-2103381 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
21. R1-2103445 TB Processing over Multi-Slot PUSCH, Ericsson
22. R1-2103461 Design Considerations for TB Processing over Multi-Slot PUSCH, Sierra Wireless
23. R1-2103480 TB processing over multi-slot PUSCH, Sharp
24. R1-2103514 Discussion on TB processing over multi-slot PUSCH, NEC
25. R1-2103588 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.
26. R1-2103616 Enhancements for TB processing over multi-slot PUSCH, Lenovo, Motorola Mobility
27. R1-2103625 Discussions on TB processing over multi-slot PUSCH, LG Electronics
28. R1-2103700 Discussion on TB processing over multi-slot PUSCH, WILUS Inc.

# Appendix A: Proposals from contributions aggregated by topic

## A.1 TDRA

**Constraint on number of allocated symbols per slot and across slots**

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| **R1-2102718 Fujitsu**  Proposal 1: Consider Rel-17 PUSCH repetition type A like TDRA with the following features as the baseline for time domain resource allocation for TBoMS,   * The number of allocated symbols is the same in each slot. * The number of slots is indicated/configured by using a row index of a TDRA list which is configured by RRC.   **R1-2102861 China Telecom**  Proposal 4: Down select on the following options for the time domain resource determination of TBoMS.   * Option 1: PUSCH repetition type A like TDRA, i.e., the number of allocated symbols is the same in each slot, for normal slots. FFS: TDRA for special slots. * Option 2: PUSCH repetition type B like TDRA, i.e., the number of allocated symbols in each slot can be different.   **R1-2102894 CMCC**  Proposal 1: Both mechanisms of type A and type B like TDRA could supported. But if the prioritization is necessary, the type A should be prioritized.  **R1-2103208 Panasonic Corporation**  Proposal 1: Support PUSCH repetition Type A like TDRA, i.e., the number of allocated symbols is the same in each slot.   * + FFS whether to additionally support PUSCH repetition Type B like TDRA, i.e., the number of allocated symbols in each slot can be different.     - Before the decision of the support of PUSCH repetition type B like TDRA, TBS determination Approach 1 or 2 should be concluded as the different approaches have different interaction with time domain resource allocation.   **R1-2103588 NTT DOCOMO, INC.**  Proposal 1: Both PUSCH repetition type A and type B like TDRA should be considered for TDRA for TBoMS.  **R1-2102535 vivo**  Proposal 1: PUSCH repetition Type-A like TDRA is adopted for TBoMS.  **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: Start with PUSCH repetition type A like TDRA, i.e., the number of allocated symbols in each slot is same.  **R1-2102314 Huawei, HiSilicon**  Proposal 1: Repetition type B like TDRA should be supported for TBoMS.  **R1-2102408 OPPO**  Proposal 2: At least PUSCH repetition type A like TDRA is used for TBoMS.  The existing PUSCH repetition type A TRRA can be the starting point.  **R1-2102498 ZTE**  Proposal 1: For time domain resource determination of TBoMS, PUSCH repetition type A like TDRA should be supported.  **R1-2102644 CATT**  Proposal 2: Down-select the TDRA method for TBoMS from the following options:   * 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 can be different   **R1-2102993 Xiaomi**  Proposal 1: PUSCH repetition type B like TDRA is preferred for TB processing over multi-slot PUSCH.  Proposal 2: Redesign or reinterpret “repetition number” and/ or “L” field in TDRA for multi-slot PUSCH.  **R1-2103008 INTERDIGITAL, INC.**  Proposal 3: The number of allocated symbols in each slot can be different in TBoMS.  **R1-2103043 Intel Corporation**  Proposal 1: Both repetition type A and type B based TDRA mechanisms are supported for TBoMS.  **R1-2103117 Apple**  Proposal 5: PUSCH repetition type A-like resource determination scheme is supported.  **R1-2103179 Qualcomm Incorporated**  Proposal 3: PUSCH repetition Type A serves as a starting point for time domain resource determination of TBoMS.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 2: For the time-domain resource allocation of TBoMS, the number of allocated symbols in each slot can be different. The design of time-domain resource allocation for TBoMS should allow the feature to leverage as much as possible the UL resource in time-domain.  **R1-2103445 Ericsson**  Proposal 4: TBoMS with the same number of symbols in each slot can be prioritized.   * + Support for different numbers of symbols in slots can be further studied for TBoMS with special slots.   R1-2103480 Sharp  Proposal 1: PUSCH repetition type A and type B are supported for signaling time domain resource for TBoMS transmission.  R1-2103514 NEC  Proposal 1: Support both PUSCH repetition type A and PUSCH repetition type B like TDRA for TBoMS.  R1-2103616 Lenovo, Motorola Mobility  Proposal 1: For one TB processing over multi-slot PUSCH in NR coverage enhancements in Rel-17, support PUSCH repetition type A like time-domain resource allocation with following interpretation:   * Repetition factor indicates the number of slots for multiple PUSCH transmission occasions where one slot contains only PUSCH transmission occasion * L value in the TDRA table is used to indicate the duration of PUSCH transmission occasion in the last slot * Duration of PUSCH transmission occasions for all other slots is 14 symbols.   **R1-2103625 LG ELECTRONICS**  Proposal 1: The symbol allocation is applied in each slot for TBoMS PUSCH transmission.  Proposal 2: Consider to allow collision between TBoMS PUSCH and SRS resource.  **R1-2103700 WILUS INC.**  Proposal 1: Both PUSCH repetition type A-like TDRA and PUSCH repetition type B-like TDRA can be supported for time domain resource determination of TB processing over multi-slot PUSCH.   * Further study how to determine TDRA-related aspects such as RV, DMRS pattern, and UL transmission power. |

**The use of non-consecutive slots for TBoMS**

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| **R1-2102718 Fujitsu**  Proposal 3: Both consecutive and non-consecutive UL slots can be used to transmit TBoMS  **R1-2102861 China Telecom**  Proposal 2: Non-consecutive physical slots for UL transmission for TBoMS should be supported for unpaired spectrum.  Proposal 3: For TBoMS, the special slots for unpaired spectrum should be utilized for UL transmission.  **R1-2102894 CMCC**  Proposal 2: The non-consecutive physical slots for UL TBoMS should be supported for the unpaired spectrum at least.  Proposal 3: Whether the non-consecutive physical slots are supported for the paired spectrum and SUL band should depend on the discussion of collision solutions.  **R1-2103208 Panasonic Corporation**  Proposal 2: Whether both consecutive and non-consecutive physical slot for UL transmission can be used or not for TBoMS should be the requirement to determine TBS determination approach.  **R1-2103588 NTT DOCOMO, INC.**  Proposal 2: TB processing over non-consecutive physical slots for UL transmission should be supported for unpaired spectrum.  **R1-2102535 vivo**  Proposal 2: The TDRA for TBoMS is composed of multiple transmission occasions, and each transmission occasion can be composed of multiple slots.   * A TB is mapped to a Tx occasion, and the multiple slots in Tx occasion are consecutive slots; * UE transmits different repetitions on different occasions.   **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: Support non-consecutive physical slots for UL transmission for TBoMS for unpaired spectrum.  Proposal: Enhance PUSCH repetition type-A framework to support transmission over non-contiguous slots.  **R1-2102314 Huawei, HiSilicon**  Proposal 2: Non-consecutive slots should be supported for TBoMS for unpaired spectrum, paired spectrum, and SUL band.  **R1-2102408 OPPO**  Proposal 3: TBoMS support non-consecutive physical slots for UL transmission in unpaired spectrum.  TBoMS support processing with simplified RV determination and TB size limit.  **R1-2102644 CATT**  Proposal 1: For unpaired spectrum, non-consecutive physical slots for UL transmission can be supported for TBoMS.  **R1-2103008 INTERDIGITAL, INC.**  Proposal 1: Support non-consecutive physical slots for UL transmission for TBoMS for unpaired spectrum  **R1-2103043 Intel Corporation**  Proposal 2   * Non-consecutive physical slots for UL transmission can be used for TBoMS for unpaired spectrum. * TBoMS can be transmitted on the basis of available UL slots.   **R1-2103252 Samsung**  Proposal 3: non-consecutive slots for UL transmission can be used for TBoMS for unpaired spectrum.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 3. For the time-domain resource allocation of TBoMS, non-consecutive physical slots for UL transmission are also supported for paired spectrum, unpaired spectrum and the SUL band.  Proposal 4. For the time-domain resource allocation of TBoMS, if non-consecutive physical slots for UL transmission are not supported for paired spectrum, unpaired spectrum and the SUL band, then PUSCH repetition type B like TDRA must be supported for time domain resource determination.  **R1-2103445 Ericsson**  Proposal 7: Non-consecutive physical slots can be supported for TBoMS in TDD or FDD.  **R1-2103461 Sierra Wireless**   1. Multi-slot encoding with gaps between repeats should be specified.   FFS: sizes of gaps  **R1-2103625 LG ELECTRONICS**  Proposal 3: Consecutive available slots can be used for TBoMS for unpaired spectrum, where adjacent available slots can be located in non-consecutive physical slots.  **R1-2102691 MediaTek Inc.**  Proposal 2: At least the consecutive slots for multi-slot PUSCH should be supported. |

**TDRA indication/determination**

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| **R1-2102498 ZTE**  Proposal 2: For TBoMS, the number of slots is jointly coded with the TDRA table.  **R1-2103252 Samsung**  Proposal 1: Consider following two options for time domain resource for a single TB in TBoMS:   * Option 1: Indicating number of slot for one TB based on Type A and/or Type B PUSCH   + Number of occupied repetition/slots can be configured. * Option 2: Directly indicating a number of symbol L that can be larger than 14.   + A symbols group can be considered * Other options are not precluded.   **R1-2103117 Apple**  Proposal 4: The number of slots for scheduled TB is dynamic indicated via DCI.  **R1-2103445 Ericsson**  Proposal 1: Reuse resource determination and signaling of Rel-15/16 PUSCH repetition as much as possible to avoid specifying duplicate functionality.  Proposal 2: Type-A like TBoMS can reuse the definition of S, L, K of PUSCH repetition Type A, with the only exception being that UL symbols across K slots constitute one TB.  Proposal 3: The time domain resource determination of Type-B like TBoMS, if supported, can reuse the definition of S and K of PUSCH repetition Type B, with K being the number of slots of a TB. |

**Others**

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| **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: If N\_prb used for TBoMS is not restricted, then a restriction on the number of slots aggregated for TBoMS is required.  **R1-2103117 Apple**  Proposal 1: Considering the maximum number of slots for TB transmission is 8.  Proposal 2: TBoMS transmission occasion is specified in terms of the number of slots for one TB processed.  **R1-2103179 Qualcomm Incorporated**  Proposal 2: Prioritize a modular approach to TBoMS transmission, i.e., when resources for TBoMS span across multiple contiguous/noncontiguous slots, view resources in each slot as one self-contained segment of a longer transmission.  Proposal 4: A transmission occasion of a TBoMS transmission constitutes a set of contiguous resources (symbols) spanning one or more slots. A TBoMS transmission can constitute transmissions across one or more transmission occasions. The PUSCH repetition type A and RV cycling framework in R15/R16 is repurposed for TBoMS transmission across multiple transmission occasions.   * FFS: limits on maximum duration of a transmission occasion of a TBoMS.   **R1-2103445 Ericsson**  Proposal 8: If TBoMS with more than 2 slots is to be supported, TBoMS configuration uses the number of available slots, otherwise physical slots are used.  Proposal 18: As a starting point, consider 2 or 4 slots as the candidate numbers of slots for a TBoMS.  **R1-2102691 MediaTek Inc**  Proposal 3: The number of slots for multi-slot PUSCH transmission can be configured by the network.  Proposal 4: The starting slot for multi-slot PUSCH transmission can be configured by the network or derived based on the timing of received uplink grant.  **R1-2103461 Sierra Wireless**   1. Multi-slot encoding should be specified with a maximum of 2 slots of encoding.   **R1-2103514 NEC**  Proposal 2: Some enhancement to reduce segment within a slot for PUSCH repetition type B like TDRA should be consider TDRA for TBoMS. |

## A.2 FDRA

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| R1-2102535 vivo  Proposal 7: Limitation on number of PRBs for TBoMS can be achieved by proper NW scheduling, and explicit limitation on number of PRBs for TBoMS is not needed.  R1-2102913 INDIAN INSTITUTE OF TECH (H)  Proposal: N\_prb used for TBoMS should be limited to satisfy the TB constraints.  Proposal: If N\_prb used for TBoMS is not restricted, then a restriction on the number of slots aggregated for TBoMS is required.  R1-2102498 ZTE  Proposal 5: The maximum number of PRBs can be limited when TBoMS is enabled.   * FFS how to determine the maximum number of PRBs.   R1-2102993 Xiaomi  Proposal 3: Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling.  R1-2103252 Samsung  Proposal 5: The maximal number of PRB allocated in time domain is reduced for TB over multi-slot.  R1-2103625 LG ELECTRONICS  Proposal 4: It is considerable to apply TB processing over multi-slot PUSCH when a PUSCH has a small number of PRBs. |

## A.3 TBS determination

***N*Info calculation**

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| **R1-2102718 Fujitsu**  Proposal 2: Unquantized intermediate variable (Ninfo) is obtained by the following:  **R1-2102861 China Telecom**  Proposal 5: For TBS calculation, NInfo for TBoMS is calculated Based on all REs determined across the symbols or slots over which the TBoMS transmission is allocated.  **R1-2102894 CMCC**  Proposal 4: The symbols over which the TBoMS transmission is allocated can be different from the symbols over which the TBoMS transmission is performed, considering collisions would happen between TBoMS and other transmissions.  Proposal 6: The Approach 1 should be further discussed based on the counting of slots.  Proposal 7: Considering the process delay, the slot number in Approach 1 and the K value in Approach 2 should be limited.  **R1-2103208 Panasonic Corporation**  Proposal 3: Support following approach for TBS determination and rate matching process for TBoMS.   * + TBS is calculated based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by .   + Multiple rate matching output bit sequence can be generated for TBoMS. Different RV is applied across slot or one PUSCH transmission occasion.   **R1-2103588 NTT DOCOMO, INC.**  Proposal 4: NInfo and NohPRB calculation for TBoMS should be compatible for both PUSCH repetition type A and B like TDRA or discussed after concluding TDRA determination for TBoMS.  **R1-2102535 vivo**  Proposal 3: Approach 2 is adopted for NInfo determination i.e. NInfo is scaled by K, where K is number of slots in the first Tx occasion/repetition.  **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: N\_info is calculated based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by K≥1, where K is the number of slots over which TBoMS performed.  **R1-2102498 ZTE**  Proposal 7: Approach 1 is supported for determination of NInfo for TBoMS.  **R1-2102644 CATT**  Proposal 3: For TBoMS, NInfo is calculated based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by K≥1, where L is the number of symbols determined.   * + FFS: the definition of K.   **R1-2103008 INTERDIGITAL, INC.**  Proposal 4: NInfo for TBoMS is calculated based on all REs determined across the symbols or slots over which the TBoMS transmission is allocated.  **R1-2103043 Intel Corporation**  Proposal 5   * For calculation of NInfo for TBoMS, approach 1 is adopted.   **R1-2103117 Apple**  Proposal 6: The same PUSCH mapping type and SLIV are applied to slots for TB transmission.  **R1-2103179 Qualcomm Incorporated**  Proposal 6: When determining for TBoMS, is the number of resource elements available in a transmission occasion of TBoMS.  Proposal 7: When determining for TBoMS, introduce a new scale factor to compute the intermediate number of information bits.  FFS: permitted values for the scale factor.  FFS: signaling aspects of the scale factor.  FFS: restrictions on when the scale factor can be used/signaled.  Note: No new TB sizes are introduced.  **R1-2103252 Samsung**  Proposal 6: NInfo for TBoMS is calculated based on all REs in all slots for the TB. 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.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 5: NInfo for TBoMS is calculated based on all REs determined across the symbols over which the TBoMS transmission is allocated.  **R1-2103445 Ericsson**  Proposal 5: Approach 1 is used to calculate .  **R1-2103514 NEC**  Proposal 3: Limit Ninfo upper bound to make sure that the maximum supported TBS not exceeds legacy maximum supported TBS in Rel-15/16 for TBoMS.  Proposal 4: Using approach 2 as a starting point to decide Ninfo as approach 2 can easily get the same TBS for initial transmission and retransmission.  R1-2103616 Lenovo, Motorola Mobility  Proposal 3: For one TB processing over multi-slot PUSCH in NR coverage enhancements in Rel-17, support calculation based on REs determined for all symbols across all the available slots.  **R1-2103625 LG ELECTRONICS**  Proposal 6: Ninfo for TBoMS PUSCH is obtained as where NRE is based on on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated and K is a scaling factor.  **R1-2103700 WILUS INC.**  Proposal 2: We propose to support Approach 2 for Ninfo calculation as a baseline.   * If the accurate calculation of Ninfo is deemed necessary, Approach 1 can be further considered.   **R1-2102408 OPPO**  Proposal 1: In TBoMS, TB size determination is configured with PUSCH repetition operation.  The TB can be transmitted in the multi-slot configured in the PUSCH repetition.  The enhanced Type A PUSCH repetition is included.  Proposal 4: For coverage enhancement, TB size of PUSCH can be derived by a larger than 1 factor in case when PUSCH repetition is configured.  Ninfo can be multiplied by factor of 2, 4, 8 for determining TBS.  Proposal 5: A multi-slot TB size factor is introduced for TB size determination in case when PUSCH repetition is configured.  The multi-slot TB size factor is not larger than configured number of slots for repetition.  **R1-2103480 Sharp**  Proposal 6: A TBS scaling factor K is indicated through a DCI format for scheduling the PUSCH or RRC signaling. |

**NohPRB calculation**

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| **R1-2102894 CMCC**  Proposal 8: The overhead per PRB N\_oh\_PRB should be counted based on the actual used symbols and slots.   * For the integral, N\_oh\_PRB could be reused * For the symbols less than 14, the N\_oh\_PRB should be counted based on the actual used symbols.   + A mapping between N\_oh\_PRB and symbols could be considered   **R1-2103588 NTT DOCOMO, INC.**  Proposal 4: NInfo and NohPRB calculation for TBoMS should be compatible for both PUSCH repetition type A and B like TDRA or discussed after concluding TDRA determination for TBoMS.  **R1-2102535 vivo**  Proposal 4: Option 1 is adopted for NohPRB determination, i.e. NohPRB is assumed to be the same for all the slots over which the TBoMS transmission is allocated.  **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: Same overhead is assumed for all the slots over which TBoMS transmission is performed.  **R1-2102498 ZTE**  Proposal 8: Option 1 is supported for determination of NohPRB for TBoMS.  **R1-2102644 CATT**  Proposal 4: For TBoMS, 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.   **R1-2103043 Intel Corporation**  Proposal 6   * For determination of NohPRB for TBoMS, Option 2 is adopted.   **R1-2103117 Apple**  Proposal 7: Option 1 is supported for TBS determination.  **R1-2103179 Qualcomm Incorporated**  Proposal 8: For TBoMS, is assumed to be the same across an entire TBoMS transmission occasion is configured via xOverhead as in Rel-15/16.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 6. For calculation for TBoMS, consider only Option 2, which also includes Option 1 (if the number of slots is used together with xOverhead to calculate ), and focus the discussion on whether the number of slots or symbols should be used to calculate .  Proposal 7. For calculation for TBoMS, is calculated depending on both xOverhead and the number of symbols over which the TBoMS transmission is allocated.  **R1-2103445 Ericsson**  Proposal 6: Option 1 is used to determine NohPRB, given the lower standardization effort needed.  R1-2103616 Lenovo, Motorola Mobility  Proposal 4: For one TB processing over multi-slot PUSCH in NR coverage enhancements in Rel-17, 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 calculation.  **R1-2103625 LG ELECTRONICS**  Proposal 7: 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.  **R1-2103700 WILUS INC.**  Proposal 3: We propose to support Option 1 for Noh calculation as a baseline.   * Option 2 can be further considered if the accurate calculation on Noh is deemed necessary. |

**Contraint on maximum TBS for TBoMS**

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| **R1-2102314 Huawei, HiSilicon**  Proposal 4: Further constraint on maximum TB size for TBoMS is not needed.  **R1-2102498 ZTE**  Proposal 9: The maximum TBS can be limited by the conditions of date rate limitations DataRate and DataRateCC.  **R1-2102644 CATT**  Proposal 5: For TBoMS, no restriction other than the maximum TBS is enforced by specification.  **R1-2103179 Qualcomm Incorporated**  Proposal 9: Restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock). Furthermore, restrict TBoMS transmission to single layer transmissions. |

## A.4 Relationship between TBoMS and PUSCH repetitions

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| **R1-2102861 China Telecom**  Proposal 6: Down selection on the following options for TBoMS:   * Option 1: The maximum number of aggregated slots for TBoMS is the same as the maximum number of repetitions for PUSCH repetition type A in Rel-17. * Option 2: PUSCH repetition on top of TBoMS is supported in Rel-17.   **R1-2102894 CMCC**  Proposal 5: There is no need to support the repetition of TBoMS.  **R1-2103208 Panasonic Corporation**  Proposal 4: Repetition of TBoMS is considered if overall coding rate lower than which has been specified in MCS table for URLLC is necessary.  **R1-2103588 NTT DOCOMO, INC.**  Proposal 3: Support a repetition for TB processing over multi-slot PUSCH.  **R1-2102314 Huawei, HiSilicon**  Proposal 5: Repetition is supported for TB over multiple slots, and the overall number of slot for TBoMS with repetition should be limited.  **R1-2102498 ZTE**  Proposal 4: Discuss whether to support PUSCH repetition together with TBoMS.  **R1-2102993 Xiaomi**  Proposal 6: TB processing over multi-slot can be transmitted in conjunction with repetitions.  **R1-2103043 Intel Corporation**  Proposal 3   * Repetition is supported for TBoMS.   **R1-2103117 Apple**  Proposal 3: For TB transmission over consecutive UL slots, repetition can be supported on top of TBoMS.  **R1-2103179 Qualcomm Incorporated**  Proposal 4: A transmission occasion of a TBoMS transmission constitutes a set of contiguous resources (symbols) spanning one or more slots. A TBoMS transmission can constitute transmissions across one or more transmission occasions. The PUSCH repetition type A and RV cycling framework in R15/R16 is repurposed for TBoMS transmission across multiple transmission occasions.   * FFS: limits on maximum duration of a transmission occasion of a TBoMS.   **R1-2103252 Samsung**  Proposal 2: Repetition is supported for TB over multi-slot.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 1. RAN1 should specify TBoMS as an independent feature according to WID. It should not be considered as an enhancement of neither PUSCH repetition type A nor type B, regardless of how time domain resource determination is indicated.  **R1-2103445 Ericsson**  Proposal 11: The need for repetition of TBoMS is further considered.  **R1-2103461 Sierra Wireless**   1. Repetition of TBoMS should be specified.   R1-2103480 Sharp  Proposal 3: Repetition based TBoMS scheme should be supported.  Proposal 4: Repetition of a PUSCH crossing the slot boundary should be considered for utilizing non-consecutive physical slot allocation.  R1-2103625 LG ELECTRONICS  Proposal 8: Repetition of TBoMS PUSCH is supported. |

## A.5 DM-RS

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| **R1-2103252 Samsung**  Proposal 4: Further study the following method for time domain location of DMRS considering the joint channel estimation over multi-slot and transmissions:   * + DMRS time domain location is determinted per PUSCH transmission   + DMRS time domain location is determinated per slot   **R1-2103445 Ericsson**  Proposal 10: The same DMRS configuration, MCS index and number of layers are used in all slots of TBoMS.  **R1-2103480 Sharp**  Proposal 5: If cross slot channel estimation is not configured for TBoMS transmission, DMRS is configured per slot irrespective of PUSCH structure. DMRS configuration for length larger than 14 should be studied in joint channel estimation AI.  **R1-2102691 MediaTek Inc.**  Proposal 5: DMRS location can be slot specific as legacy operation. |

## A.6 CB segmentation, redundancy version, rate-matching and interleaving

CB segmentation

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| **R1-2103117 Apple**  Proposal 8: The terminology of TB processing over multiple slots needs to be clarified. It can down-select between TB segmentation and slot bundling.  **R1-2103179 Qualcomm Incorporated**  Proposal 1: RAN1 prioritizes design considerations for TBoMS that help prevent or reduce small payload segmentation.  **R1-2103445 Ericsson**  Proposal 12: CB segmentation can be considered for TBoMS.  **R1-2103625 LG ELECTRONICS**  Proposal 5: It is considerable to reduce the maximum TB size so that CB segmentation does not occur.  **R1-2103179 Qualcomm Incorporated**  Proposal 9: Restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock). Furthermore, restrict TBoMS transmission to single layer transmissions. |

Redundancy version/ Rate-matching and Interleaving

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| **R1-2102861 China Telecom**  Proposal 1: For TBoMS, TBS is determined based on multiple slots and different segment is transmitted in each slot.  **R1-2102314 Huawei, HiSilicon**  Proposal 3: Bit to resource mapping using RV cycling mechanism and continuous mapping mechanism need to be studied.  **R1-2102408 OPPO**  Proposal 6: Single RV scheme can be used across all the repetition slots in case of TB size over multi-slot and PUSCH repetition is configured.  Reducing the complexity of RE generation in each slot, e.g., restricting TB size.  **R1-2103179 Qualcomm Incorporated**  Proposal 5: Depending on the duration of the transmission occasion spanning contiguous resources, RV index for a transmission within a transmission occasion is chosen based on one of the following two options:   * A single RV index is used across the entire transmission occasion. * An updated RV index is used each time a slot boundary is crossed.   **R1-2103252 Samsung**  Proposal 7: Further study the rate matching operation by considering the continuous RM and RV based segmented RM.  Proposal 8: slot based interleaving is supported for TBoMS.  **R1-2103381 Nokia, Nokia Shanghai Bell**  Proposal 8: For rate-matching the encoded bits on the resource across multiple slots for TBoMS, the encoded bits are rate-matched on the total resource allocated for TBoMS across multiple slots.  **R1-2103445 Ericsson**  Proposal 14: Unless some strong benefit can be shown for more than one RV per TBoMS transmission, one RV is used across all slots of a TBoMS.  Proposal 15: The transmission occasion of TBoMS for RV cycling and UL transmission power determination can be different.  **R1-2103480 Sharp**  Proposal 2: If a single PUSCH crossing slot boundaries without repetition is supported for TBoMS transmission, some reserved resources (e.g., DL region) which overlaps with the single PUSCH should be punctured or rate matched.  **R1-2102691 MediaTek Inc.**  Proposal 1: The conditions to apply TBoMS should be studied for the gain compared to the RV cycling repetition.  **R1-2103208 Panasonic Corporation**  Proposal 3: Support following approach for TBS determination and rate matching process for TBoMS.   * + TBS is calculated based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated, scaled by .   + Multiple rate matching output bit sequence can be generated for TBoMS. Different RV is applied across slot or one PUSCH transmission occasion. |

## A.7 Link adaptation

***MCS index***

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| **R1-2103445 Ericsson**  Proposal 10: The same DMRS configuration, MCS index and number of layers are used in all slots of TBoMS. |

## A.8 Frequency hopping

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| **R1-2103208 Panasonic Corporation**  Proposal 5: Inter-slot frequency hopping with joint channel estimation should be supported for TBoMS.  **R1-2102993 Xiaomi**  Proposal 4: Support intra-TB frequency hopping for TB processing over multi-slot PUSCH.  **R1-2103043 Intel Corporation**  Proposal 4   * Inter-slot frequency hopping and inter-slot frequency hopping with inter-slot bundling are supported for TBoMS.   + FFS: intra-slot frequency hopping for TBoMS   R1-2103616 Lenovo, Motorola Mobility  Proposal 2: For one TB processing over multi-slot PUSCH in NR coverage enhancements in Rel-17, support multi-slot frequency hopping and multi-slot DM-RS bundling for joint channel estimation for entire hop:   * Association between frequency hop duration and DM-RS bundle duration should be supported |

## A.9 Transmission power determination

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| **R1-2102498 ZTE**  Proposal 11: For TBoMS, the transmission power determination should be based on the total number of REs within multiple slots for TB processing with excluding the overhead of reference signals.  **R1-2103445 Ericsson**  Proposal 15: The transmission occasion of TBoMS for RV cycling and UL transmission power determination can be different.  Proposal 16: Considering the standardization effort, a transmission occasion of one slot is preferred for TBoMS transmission power determination.   * Further discuss whether the power is fixed or how it can vary across slots of a TBoMS transmission |

## A.10 Rank of TBoMS transmission

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| R1-2102535 vivo  Proposal 6: PUSCH with TB processing over multiple slots should be limited to single transmission layer.  **R1-2103445 Ericsson**  Proposal 10: The same DMRS configuration, MCS index and number of layers are used in all slots of TBoMS.  **R1-2103179 Qualcomm Incorporated**  Proposal 9: Restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock). Furthermore, restrict TBoMS transmission to single layer transmissions. |

## A.11 Retransmissions

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| **R1-2102894 CMCC**  Proposal 9: Per slot retransmission should be considered for the retransmission of multiple slot PUSCH transmission.  **R1-2103008 INTERDIGITAL, INC.**  Proposal 5: Support enhanced retransmission mechanisms to avoid the retransmission of the entire TBoMS.  **R1-2103445 Ericsson**  Proposal 13: TB-based retransmission is considered for TBoMS, rather than CBG-based retransmission. |

## A.12 UCI multiplexing, SRS/DL collisions/cancellations

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| **R1-2102718 Fujitsu**  Proposal 4: Reuse repetition-like behaviour (option 2 in Figure 2) for collision handling between TBoMS PUSCH and PUCCH.  R1-2102535 vivo  Proposal 5: For UCI multiplexing on PUSCH with TB processing over multiple slots, the number of modulated symbols in the PUSCH for UCI multiplexing is determined based on   * the number of symbols for PUSCH in a slot, which is overlapping with the PUCCH.   **R1-2102314 Huawei, HiSilicon**  Proposal 6: Study multiplexing UCI and UCI multiplexing mechanism in case of overlapped PUCCH and TBoMS PUSCH transmissions.  **R1-2102498 ZTE**  Proposal 3: For collision handling of TBoMS, legacy collision handling rules for PUSCH repetition type A could be reused by replacing a repetition to a slot of the multiple slots for TB processing.  Proposal 10: Further discuss UCI multiplexing rules for TBoMS.  **R1-2102644 CATT**  Proposal 6: For TBoMS, further study UCI multiplexing based on the outcome of TDRA.  **R1-2103043 Intel Corporation**  Proposal 7   * FFS how to handle overlaps between TBoMS and other uplink transmission.   **R1-2103252 Samsung**  Proposal 9: Parallel transmission of PUCCH and TBoMS PUSCH is not preferred due to power splitting during CE situation.  Proposal 10: UCI multiplexing in TBoMS PUSCH is supported in Rel17 CE, RAN1 further study the details.  **R1-2103445 Ericsson**  Proposal 9: When the number of symbols in each slot is the same for TBoMS,   * If the number of physical slots is configured, reuse the Rel-15 PUSCH repetition collision rules for TBS determination * If the number of available slots is configured, TBS determination is according to the number of available slots.   **R1-2103445 Ericsson**  Proposal 17: RAN1 to decide how to multiplex UCI on TBoMS  **R1-2103625 LG ELECTRONICS**  Proposal 9: UE behavior for the overlapping between TBoMS PUSCH and PUCCH resource should be discussed.  **R1-2103700 WILUS INC.**  Proposal 4: It should be further discussed how to determine the number REs for UCI multiplexing in case of TB processing over multi-slot PUSCH. |

## A.13 Multi-slot/Single-slot switch/indication

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| **R1-2102861 China Telecom**  Proposal 7: The number of aggregated slots for TBoMS can be semi-statically configured by RRC and dynamically indicated by DCI. Dynamic switching between TBoMS and single slot transmission can be differentiated by the indication of number of slots in DCI.  **R1-2102913 INDIAN INSTITUTE OF TECH (H)**  Proposal: Support semi-static switching between TBoMS and single slot transmission.  R1-2102993 Xiaomi  Proposal 5: Consider configuration and/or indication procedures when both repetition and TBoMS are supported for a single UE.  R1-2103008 INTERDIGITAL, INC.  Proposal 2: Support dynamic enabling/disabling of TBoMS transmission.  R1-2103381 Nokia, Nokia Shanghai Bell  Proposal 9. RAN1 to specify an indication method for enabling multi-slot TB transmission per PUSCH scheduling/configuration.   * FFS: Details of the indication method, including introducing a new field or reusing the available field in the scheduling DCI (or RRC parameter in case of configured grant configuration), e.g. some rows in the TDRA table are used to configure for multi-slot TB transmission. |

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

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.