3GPP TSG RAN WG1 #105-e R1-2105996

e-Meeting, May 19th – May 27th, 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 #105-e [3]-[29].

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

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

# 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. A systematic categorization will be used in this document to summarize the content of all contributions. This is done according to both the number of submitted proposals on the different aspects and on the relevance the latter have for designing the feature. Concerning the second criterion, its rationale is given by the natural relationship of consequentiality which exists between different aspects. In the remainder of the document, aspects are thus categorized as follows:

* **High priority aspects**
  + General framework for time domain resource determination
  + TOT definition
  + Single TBoMS structure
  + Rate matching (including how RVs are rate matched)
* **Mid priority aspects**
  + The use of the S slots
  + The use of non-consecutive slots for paired spectrum and SUL band
  + TBS determination: calculation
  + TBS determination: calculation
* **Low priority aspects**
  + FDRA
  + Relationship between TBoMS and PUSCH repetitions
  + TBoMS repetitions
  + Indication of the number of slots/symbols allocated to TBoMS
  + TDRA (other aspects)
  + Special TBS values for TBoMS
* **Other aspects**
  + *Advanced design aspects of TBoMS*
    - DM-RS
    - CB segmentation
    - Interleaving
    - Link adaptation
    - Frequency hopping
    - Transmission power determination
    - Rank of TBoMS transmission
    - Retransmissions
  + *Signaling and interaction with other signals/channels*
    - UCI multiplexing, SRS/DL collisions/cancellations
    - Multi-slot/single-slot activation/switch

The categorization above will determine the initial priority order for the discussions to be held for AI 8.8.1.2. In this context, sections 2.1 to 2.3 will focus on discussions which will (2.1) and may (2.2 and 2.3) be discussed during RAN1 #105-e. Section 2.4 will collect all other aspects.

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

## 2.1 High priority aspects

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

1. General framework for time domain resource determination
2. TOT definition
3. Single TBoMS structure
4. Rate matching (including how RV ids are rate matched)

Most companies have discussed at large about such aspects in the submitted contributions. Summary, discussion, and proposals on these aspects are provided in the following different sub-sections, 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. [14 companies]:
  + Fujitsu [10], vivo [6], OPPO [9], ZTE [5], Apple [16], Qualcomm [17], Lenovo/Motorola [27], LGE [28], Spreadtrum [7], Sierra Wireless [23].
  + Support of Type B like is FFS: CATT [8], CMCC [12], Panasonic [18], Nokia/NSB [21].
* **Option 2**. PUSCH repetition type B like TDRA, i.e., the number of allocated symbols in each slot can be different [3 companies]:
  + Huawei/HiSilicon [3], Xiaomi [13], Interdigital [14]
* **Option 3**. Both PUSCH repetition type A like TDRA and PUSCH repetition type B like TDRA should be supported [6 companies]:
  + NTT DOCOMO [26], Intel [15], Sharp [24], NEC [25], WILUS [29], Samsung [19].

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 of 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, e.g. the S slot in TDD. 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.

It is worth observing that the situation is extremely similar, if not identical, to what was observed during RAN1 #104-e and RAN1 #104-b-e.

Finding middle ground may not be possible. From FL’s perspective, and based on all the discussions RAN1 had on the two approaches during the first two meetings of the WI, only two options are viable at this stage:

1. Time domain resource determination for TBoMS can be performed only via Type A like TDRA.
2. Time domain resource determination for TBoMS can be performed via Type A like TDRA or via Type B like TDRA.
   * The use of Type B like TDRA for time domain resource determination is according to UE capability.

In this regard, the sub-bullet of bullet 2 would guarantee same conditions for as in Rel-16 UE w.r.t. the support of type B like TDRA.

The following proposal is then formulated.

***FL proposal 1. The following 2 options are considered for time domain resource determination for TBoMS, are considered for down-selection during RAN1 #105-e:***

* ***Option 1: Time domain resource determination for TBoMS can be performed only via Type A like TDRA.***
* ***Option 2: Time domain resource determination for TBoMS can be performed via Type A like TDRA or via Type B like TDRA.***
  + ***The use of Type B like TDRA for time domain resource determination is according to UE capability.***

#### 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.

Constructive attitude in this regard is highly recommended, hence please refrain from suggesting micro-optimizations if at least one of the options above is acceptable.

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### 2.1.2 [OPEN] TOT definition

Observations on the definition of a TOT are provided in different forms in several contributions, with reference to the working assumption made during RAN1 #104-bis-e. A high-level summary of companies’ preferences based on the contributions is as follows:

* Option 1. A TOT is constituted by multiple consecutive physical slots [6 companies]
  + ZTE [5] (for paired spectrum and SUL band)
  + vivo [6] (if Option 3 or 4 is adopted for a single TBoMS)
  + CATT [8], Nokia/NSB [21] (one slot or several consecutive physical slots)
  + China Telecom [11], NTT DOCOMO [26]
* Option 2. A TOT can be constituted by multiple non-consecutive physical slots [4 companies]
  + MediaTek [20], ZTE [5] (for unpaired spectrum)
  + vivo [6] (if Option 1 is adopted for a single TBoMS)
  + China Telecom [11]
* Option 3. A TOT constitutes a set of continuous uplink time domain resources spanning one or more slots [2 companies]
  + Huawei/HiSi [3], Qualcomm [17]

The following was also additionally proposed

* One company (LGE [28]) proposed that time resource for a TBoMS PUSCH composes a TOT.
* One company (Sharp [24]) proposed that at least for FDD, the gNB configures a TOT length in unit of slots.

FL’s comments

Companies’ views are rather heterogeneous. From FL’s perspective the difference between Option 1 and Option 2, at least, can be small if we consider that:

* + The concept of TOT may or may not be specified, and thus can be considered as a convenient concept to build the structure of a single TBoMS, for the time being. Further discussions on whether it should be also specified or not can be carried out later.
  + Resulting TBoMS signal according to the two options may be the same in case specific single TBoMS structure and rate-matching approaches are selected.

At the same time, it may be premature to transform the previous working assumption into a complete agreement, given that decisions on single TBoMS structure and rate matching have yet to be taken. All these matters are obviously related. FL’s suggestion is to refine the working assumption following majority view as follows, to then go back to it again at a later stage if necessary. Please note that this is done to simplify discussion in 2.1.3.

**Working assumption**

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

* **FFS: whether a TOT can also be constituted of non-consecutive slots for UL transmissions**
* **FFS: whether the TOT is constituted of a set of continuous uplink time domain resources**
* **FFS: whether such concept will be specified or not.**

#### 2.1.2.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about the **Working Assumption**. The goal is to further refine it to simplify further discussions on the single TBoMS structure.

Constructive attitude in this regard is highly recommended, hence please refrain from suggesting micro-optimization, unless strictly necessary.

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### 2.1.3 [OPEN] Single TBoMS structures

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

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| Option 1  [11 companies] | Option 2  [5 companies] | Option 3  [12 companies] | Option 4  [9 companies] |
|  |  | Huawei/HiSi [3] |  |
| ZTE [5] (if repetition of TBoMS is not supported) |  | ZTE [5] (if repetition of TBoMS is supported) | ZTE [5] (if repetition of TBoMS is supported) |
| vivo [6] |  | vivo [6] | vivo [6] |
| Spreadtrum [7] |  |  |  |
|  |  | CATT [8] | CATT [8] |
| CMCC [12] | CMCC [12] |  | CMCC [12] |
|  | Qualcomm [17] (if repetition of TBoMS is supported) |  | Qualcomm [17] (if repetition of TBoMS is not supported) |
| OPPO [9] |  |  |  |
| China Telecom [11] |  | China Telecom [11] |  |
| Interdigital [14] |  | Interdigital [14] |  |
| Intel [15] |  | Intel [15] |  |
| Fujitsu [10] |  | Fujitsu [10] |  |
|  |  |  | Apple [16] |
|  | NEC [25] |  |  |
|  |  |  | Samsung [19] |
|  | MediaTek [20] |  |  |
|  |  | NTT Docomo [26] |  |
| Lenovo/Motorola [27] |  |  |  |
| WILUS [29] |  | WILUS [29] |  |
|  | Sierra Wireless [23] |  | Sierra Wireless [23] |
|  |  | Sharp [24] | Sharp [24] |
|  |  | Nokia/NSB [21] |  |

FL’s comments

Options based on the use of single RV are preferred by most companies overall, with Option 3 being the one with the largest amount of preferences. However, there are many companies who expressed preference for Option 4, which is based on RV cycling. Fewer companies expressed preference for Option 2. It is also observed that:

* 7 out of 11 (i.e., 63%) companies in favor of Option 1, are also in favor of Option 3.
* 3 out of 5 (i.e., 60%) companies in favor of Option 2, are also in favor of Option 4.

Furthermore, from FL’s perspective it is rather evident that discussion on the single TBoMS structure would impact decisions on other aspects of the feature, e.g., repetitions of TBoMS, rate matching, collision handling and so on. For this reason, it is paramount to progress on the definition of the single TBoMS structure to facilitate any forthcoming discussion on other aspects.

For these reasons, it is proposed to start by down-selecting between Option 1 and Option 3, and between Option 2 and Options 4, and pick the one of each sub-sect with the largest amount of preferences. The following proposal is then formulated.

***FL proposal 2. The single TBoMS structure will be according to only one of these two options and based on how many RVs are used for the transmission of a single TBoMS:***

* ***Option 3, if a design based on single RV is adopted.***
* ***Option 4, if a design based on different RVs is adopted.***

***FFS: if repetition of a single TBoMS is supported***

***FFS: other details, e.g., rate-matching, TBS determination, interleaving, collision handling.***

#### 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 identify the preferred direction RAN1 should pursue for defining the structure of a single TBoMS.

Constructive attitude in this regard is highly recommended, hence please refrain from suggesting micro-optimizations.

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### 2.1.4 [OPEN] Rate matching (including how RV ids are rate matched)

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

* Three companies (Qualcomm [17], Nokia/NSB [21], Interdigital [14] (for Option 1)) proposed that rate-matching is performed per slot.
* Two companies (Huawei/HiSi [3], LGE [28]) proposed that rate-matching is performed per TOT.
* Two companies (Ericsson [22], IITH [4]) proposed supporting continuous rate-matching of encoded bits across all transmitted slots of the TBoMS, regardless of the number of TOT(s) for a TBoMS.
* One company (NEC [25]) proposed that RV index is refreshed at every jump between two non-contiguous resources.
* One company (Interdigital [14]) proposed that rate-matching across multiple TOTs is not supported for Option 3.
* One company (vivo [6]) proposed that if one of the multiple slots in a nominal TOT, is not available, following alternatives can be considered for RV mapping
  + Alt-1: The nominal TOT can be segmented to several actual TOTs, and RV is refreshed for each actual TOT;
  + Alt-2: UE does not expect a nominal TOT to be segmented to several actual TOTs, and a single RV is mapped to the consecutive slots in an actual TOT.
* One company (Qualcomm [17]) proposed that, 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 within a transmission occasion.
* One company (OPPO [9]) proposed that single RV scheme can be used across all the repetition slots in case of TB size over multi-slot and PUSCH repetition is configured.

FL’s comments

RV and rate matching could be considered as aspects to be discussed only after decisions on time domain resource allocation are taken. However, these aspects can be tied to other considerations affecting decisions and preferences companies have on time domain resource allocation itself. Indeed, an interplay exists between these aspects (and TBS determination). In this sense, discussing RV and rate matching could offer further opportunities to companies to converge to acceptable outcomes and middle ground.

From FL’s perspective, it may be good to start the discussion with a generic proposal that captures the three most popular options, as follows.

***FL proposal 3. The following three options for rate-matching for TBoMS are considered for down-selection during RAN1 #105-e, aiming at down-selecting only one option:***

* ***Option 1: Rate-matching is performed per slot;***
* ***Option 2: Rate matching is performed per TOT;***
* ***Option 3: Rate matching if performed continuously across all the allocated slots for TBoMS.***

#### 2.1.4.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about **FL proposal 3**.

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. Constructive attitude in this regard is highly recommended, hence please refrain from suggesting micro-optimizations if at least one of the options above is acceptable.

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## 2.2 Mid priority aspects

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

1. The use of the S slot
2. The use of non-consecutive slots for paired spectrum and SUL band
3. TBS determination: calculation
4. TBS determination: calculation

Significant attention has been given by several companies to such aspects in the submitted contributions. Although arguably less paramount at this stage of the discussion, they have been included here and will be discussed when need arises, regardless of how many high priority aspects are still being discussed. Summary, discussion, and proposals on these aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### 2.2.1 [OPEN] The use of the S slot

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.

* Three companies (MediaTek [20], China Telecom [11], CMCC [12]) proposed that UL symbols in the special slots should be used for TBoMS and the indication of these symbols should be supported.
* One company (ZTE [5]) proposed that no optimization specific for the use of special slot in TDD is pursued.
* One company (Panasonic [18]) proposed that if the special slot, where one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the semi-static symbol not intended for PUSCH transmission, needs to be supported, simple modification of PUSCH repetition Type A framework should be supported. Following options should be considered.
  + Option 1: SLIV for special slot is additionally configured for TDRA entry. In normal slot, current SLIV is used and in special slot, SLIV for special slot is used.
  + Option 2: Current SLIV is used even in special slot, while PUSCH resource for special slot is obtained from the symbols indicated by TDRA but not collided with non-UL symbols in the slot.
* One company (Ericsson [22]) proposed that the net gains and use cases of TBoMS support for special slot with different number of UL symbols than that in UL slot for the TB should be carefully studied prior to specifying it.
  + Such study should address how SRS and PUCCH can be transmitted as well as the performance of interference suppression when DMRS in a special or normal uplink slot is used for interference suppression in the other type of slot.
  + If specified, and performance gains are targeted for this case, a TB over consecutive UL symbols in special slot and the following UL slot can be based on PUSCH repetition type-B like TDRA.

FL’s comments

From FL’s perspective, and as argued during RAN1 #104-b-e, the use of S slot for TBoMS is not precluded by current agreements.

No company has argued against this understanding. At the same time, there is no clear consensus on whether the use of S slots can bring non-negligible performance gains, and whether use cases for it are relevant.

On other hand, all companies who commented on this aspect, but one (Panasonic [18]), stated that specifying solutions specifically targeting the use of S slots is not a preferred direction. In this context, and given what is being proposed in Section 2.1.1 for time domain resource determination, from FL’s perspective it seems reasonable to propose that no S-slot-specific optimization

***FL proposal 4. Allocating resources for TBoMS in the special slot in TDD will be possible according to the agreed time domain resource determination for TBoMS. No further optimization targeting the use of the S slot will be considered.***

#### 2.2.1.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about **FL proposal 4**.

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. Constructive attitude in this regard is highly recommended.

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### 2.1.2 [CLOSED] The use of non-consecutive slots for paired spectrum and SUL band

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

* Two companies (Ericsson [22], Nokia/NSB [21]) proposed that non-consecutive physical slots can be supported for TBoMS for paired spectrum.
* One company (CMCC [12]) proposed that:
  + For the non-consecutive physical slots for UL transmission in the unpaired spectrum, the semi-static configured uplink slots should be the starting point. The dynamic change of uplink and downlink slots and symbols should be for further discussion.
  + For the paired spectrum and SUL band, the consecutive slots transmission or allocations should be the baseline. And the insertion or interruption of PUCCH and SRS should be further studied.

FL’s comments

Number of contributors is not large hence further observations on the situation may not be so relevant at this stage. Further discussion is needed. FL suggests postponing discussions on this topic until need arises (during #105-e or later). Corresponding FL’s proposal would then follow.

### 2.2.2 [CLOSED] TBS determination: 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 during RAN1#104-e 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 [11 companies]:
  + Huawei/HiSi [3], China Telecom [11], ZTE [5], Spreadtrum [7], InterDigital [14], Intel [15], Samsung [19], MediaTek [20], Ericsson [22], Lenovo/Motorola [27],
  + CMCC [12] (Approach 1 should be further discussed based on the counting of slots).
* **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 [4]
  + may or may not be equal to the total number of slots allocated for TBoMS transmission:
    - Panasonic [18], NEC [25] (as starting point), LGE [28], WILUS [29] (as a baseline), OPPO [9];
    - CATT [8] (L is the number of symbols determined using the SLIV of PUSCH indicated via TDRA, and K is the number of allocated slots);
    - vivo [6] (K is number of slots in the first TOT/repetition);
    - Sharp [24] (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 [12]) 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 [26]) 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 [9]) proposed that 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. 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.
* One company (Sierra Wireless [23]) proposed that TBS determination procedure can follow legacy repetition procedures when option 2 or 4 is chosen.

FL’s comments

The two approaches received almost equal support, with slight preference for Option 1. From FL’s perspective, and differently from the discussion on , discussion on heavily depends on how the single TBoMS structure is designed according to the discussions in 2.1.4 and 2.1.4. For this reason, it is probably not so meaningful to provide a FL proposal at this stage. Further discussion should be carried out by companies in Sections 2.1.3 and 2.1.4 before.

### 2.2.3 [OPEN] TBS determination: calculation

Most contributions discussed this aspect, which has a direct 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 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 [12 companies].
  + - Huawei/HiSi [3], IITH [4] , vivo [6], ZTE [5], Spreadtrum [7], Apple [16], Qualcomm [17], Samsung [19], Ericsson [22], Lenovo/Motorola [27], LGE [28], WILUS [29] (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 [3 companies]:
  + - CMCC [12], CATT [8], Intel [15].

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

* One company (NTT Docomo [26]) 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.
* One company (Sierra Wireless [23]) proposed that TBS determination procedure can follow legacy repetition procedures when option 2 or 4 is chosen.

FL’s comments

Most companies prefer Option 1, while only 3 companies support Option 2. It is worth observing that discussion on is characterized by a much clearer trend as compared to the discussion on . This is not surprising, given that is typically accounted for per slot, whereas in TBoMS will be calculated depending on how the single TBoMS structure is designed.

Furthermore, the choice of Option 1 over Option 2 does not seem to be tightly related to how time domain resource determination is performed. Indeed, several companies supporting both Type A like and Type B like TDRA are in favor of Option 1. Indeed, also Rel-16 logic for considering the overhead in the TBS determination of both supported PUSCH repetition types is the same, i.e., it is slot-based. Therefore, Option 1 seems to guarantee compatibility with both considered approaches for time domain resource determination for TBoMS and to minimize specification impact.

In this context, given the large majority in favor of Option 1, and FL’s observations, it would seem rather fair to agree on Option 1 and achieve a good middle-ground progress on this aspect. The following proposal is thus formulated:

***FL proposal 5.*  *is assumed to be the same for all the slots over which the TBoMS transmission is allocated and is configured by* *xOverhead*.**

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

#### 2.2.3.1 First round of discussions

FL’s recommendation is to have a first round of discussion among companies about **FL proposal 5**.

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. Constructive attitude in this regard is highly recommended.

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## 2.3 Low priority aspects

Six low priority aspects are identified at the beginning of the meeting:

1. FDRA
2. Relationship between TBoMS and PUSCH repetitions
3. TBoMS repetitions
4. Indication of the number of slots/symbols allocated to TBoMS
5. TDRA (other aspects)
6. Special TBS values for TBoMS

Non-negligible attention has been given by several companies to such aspects in the submitted contributions. None of them qualifies as fundamental, as far as the main structure of the feature design goes. On the other hand, they are all at least partially related to some high or mid priority aspects. There are thus included in this section and will be discussed when need arises, provided that stability is reached in other more important discussions Summary, discussion, and proposals on these aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### 2.3.1 [CLOSED] FDRA

Several contributions discussed this aspect. Most of the observations therein focus on the major reason behind the performance increase observed in case of multi-slot TB transmissions as compared to their single-slot counterpart. 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.

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 [6 companies]:
  + - IITH [4], ZTE [5], Interdigital [14], Samsung [19], LGE [28], Xiaomi [13].
* **Option 2**. No explicit limitation on number of PRBs for TBoMS FDRA [2 companies]:
  + - Spreadtrum [7], CATT [8].

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. Furthermore, it is argued by several companies that the reason why this aspect should not be left to gNB’s implementation is unclear. From FL’s perspective, albeit very relevant in general, discussions on this aspect for TBoMS may not be as paramount as discussions on time domain resource allocation and single TBoMS structure. FL suggests postponing discussions on this topic until need arises (during #105-e or later).

### 2.3.2 [CLOSED] Relationship between TBoMS and PUSCH repetitions

The relationship between TBoMS and PUSCH repetitions was discussed in several contributions, which can be summarized as follows:

* Three companies (IITH [4], Nokia/NSB [21], Ericsson [22]) proposed that a TBoMS should be considered as a new feature and not as an enhancement of PUSCH repetition. RV cycling within a single TBoMS should not be considered.
* Three companies (OPPO [9], Qualcomm [17], vivo [6]) proposed that a TBoMS can be transmitted in repetition manner (e.g., in multiple TOTs/segments with RV cycling or considered as an enhancement of PUSCH repetition).

The following was also additionally proposed:

* One company (China Telecom [11]) proposed 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.

FL’s comments

From FL’s perspective, it is rather evident that the relationship between TBoMS and PUSCH repetitions depend on how the single TBoMS is structured:

* If a single TBoMS is structured as a feature independent of PUSCH repetition, e.g., a single RV is used for a single TBoMS, while still retaining some signalling structure of PUSCH repetition framework for its configuration, then a decision on whether supporting the repetition of the single TBoMS would need to be made. The corresponding discussion could occur once details related to the single TBoMS structure are worked out.
* If a single TBoMS is structured as a PUSCH repetition, i.e., according to Option 2 or Option 4 in Section 2.1.4, then the relationship between TBoMS and PUSCH repetition would be clear. No discussion would likely be needed in this case.

For all these reasons, FL’s suggestion is to focus on the most foundational aspects of TBoMS and to postpone discussion on the relationship between TBoMS and PUSCH repetitions until at least the structure of a single TBoMS is agreed on.

### 2.3.3 [CLOSED] Repetition of a single TBoMS

Observations on the support of the repetition of a single TBoMS are provided in different forms in several contributions. A high-level summary of companies’ preferences based on the contributions is as follows:

* **Option 1**. Support the repetition of a single TBoMS [8 companies]
  + - Huawei/HiSi [3], Apple [16], Panasonic [18], Samsung [19], Intel [15], LGE [28], NTT Docomo [26], Xiaomi [13].
* **Option 2**. Do not support the repetition of a single TBoMS [2 companies]
  + - CMCC [12], MediaTek [20].
* **Option 3**. Further discuss on whether to support the repetition of a single TBoMS (e.g., based on the outcome of the definition of a single TBoMS) [2 companies]
  + - CATT [8], Ericsson [22].

The following was also additionally proposed:

* One company (Huawei/HiSi [3]) proposed that the start position of bit selection in the circular buffer on the first TOT for each repetition is denoted by RV index and the RV index is cycled for each repetition in the sequence of {0, 2, 3, 1}.
* One company (ZTE [5]) proposed that if repetition of TBoMS is supported, both Option 3 and Option 4 for the single TBoMS structure can be considered.
* One company (Xiaomi [13]) proposed considering the configuration and indication signaling design when a single UE supports both repetition and TBoMS.

FL’s comments

Most companies who commented on this aspect prefer supporting repetitions of TBoMS. Two companies prefer not to support PUSCH repetitions for TBoMS. Two companies propose to further discuss this aspect when the definition of a single TBoMS is finalized.

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 agreements taken for the discussions in Sections 2.1.4 and 2.3.2 (if any), where the structure of a single TBoMS and the relationship between TBoMS and PUSCH repetitions are discussed, respectively. It is very likely that a decision on whether supporting repetitions of TBoMS or not will be an incremental effort once details related to these two aspects are worked out. Indeed, time-domain constraints, if any, and more precise characterization/estimation of the minimum effective coding rate achievable by TBoMS would be available by then.

For all these reasons, FL’s suggestion is to focus on the most foundational aspects of TBoMS and to postpone discussion on repetitions of TBoMS to a later time, until need arises (during #105-e or later).

### 2.3.4 [CLOSED] Indication of the number of slots/symbols allocated to 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 [3 companies]:
  + - Fujitsu [10], ZTE [5], Samsung [19].
* **Option 2**. Indication of number of slots via DCI [2 companies]
  + Number can be semi-statically configured by RRC:
    - China Telecom [11]
  + 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 [27].

FL’s comments

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. FL suggests postponing discussions on this topic until need arises (during #105-e or later).

### 2.3.5 [CLOSED] General TDRA framework (other aspects)

Other proposals related to TDRA of TBoMS, and not reported elsewhere in this section, were made. The content can be summarized as follows.

* One company (NEC [25]) proposed that some enhancement to reduce segment within a slot for PUSCH repetition type B like TDRA should be considered for TDRA of TBoMS.
* One company (IITH [4]) 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 [22]) proposed that TBoMS is designed as a new feature, rather than a Type A PUSCH repetitions enhancement. 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 (Apple [16]) proposed considering the maximum number of slots for TB transmission is 8.
* Once company (CMCC [12]) proposed that 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.
* One company (LGE [28]) proposed that a slot is determined as unavailable for TBoMS PUSCH transmission if at least one of the symbols indicated by TDRA in the slot overlaps with the symbol not intended for UL transmissions.

FL’s comments

Number of contributors is not large hence further observations on the situation may not be so relevant at this stage. Furthermore, from FL’s perspective, the aspects above are arguably subject to more fundamental decisions RAN1 has yet to take. In this context, RAN1 can afford discussing then when more paramount aspects of TBoMS have been agreed on. FL suggests postponing discussions on this topic until need arises (during #105-e or later).

### 2.3.6 [CLOSED] Special TBS values for TBoMS

Special TBS values for TBoMS were discussed in several submitted contributions, including maximum supported TBS for TBoMS. Content of such discussions, and related proposals, can be summarized as follows.

* One company (Huawei/HiSi [3]) proposed that further constraint on maximum TBS for TBoMS is not needed.
* Two companies (Qualcomm [17], LGE [28]) proposed to restrict TBoMS transmissions to TB sizes that permit single codeblock transmission.
* 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 that no new TBSs are introduced.
* One company (NEC [25]) proposed that the maximum supported TBS should not exceed legacy maximum supported TBS in Rel-15/16 for TBoMS.

FL’s comments

Number of contributors is not large hence further observations on the situation may not be so relevant at this stage. Furthermore, from FL’s perspective, the aspects above are arguably subject to more fundamental decisions RAN1 has yet to take. In this context, RAN1 can afford discussing then when more paramount aspects of TBoMS have been agreed on. FL suggests postponing discussions on this topic until need arises (during #105-e or later).

## 2.4 Others

As discussed at the beginning of Section 2, discussions on different aspects of TBoMS have been prioritized to ensure that constructive discussions and effective progress can be achieved during RAN1 #105-e. 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 structure of single TBoMS in general. 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.

These aspects may not be handled during RAN1 #105-e unless technical need arises during the discussion on other aspects. For this reason, no specific FL’s proposal or recommendation is formulated at this stage. Should discussions for 2.1 to 2.3, progress fast and converge to agreements, sections for specific aspects, currently in 2.4, may be open for discussions and corresponding FL’s proposals and recommendations may be made.

### [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 [22]) proposed RAN1 to discuss issues of DMRS after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.
* One company (Apple [16]) proposed that per slot DMRS allocation is considered for PUSCH repetition type B-like TDRA.

**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 TOT, or per slot).
* One company (Sharp [24]) proposed that joint channel estimation is not a prerequisite feature for TBoMS. When joint channel estimation is not configured for TBoMS, no DMRS enhancement is required. Discussion on DMRS enhancement should be discussed in line with joint channel estimation for a case where joint channel estimation is configured for TBoMS.

### [CLOSED] CB segmentation

One company (Ericsson [22]) proposed RAN1 to discuss issues of CB segmentation after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.

### [CLOSED] Interleaving

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

### [CLOSED] Link adaptation

One company (Ericsson [22]) proposed RAN1 to discuss issues of MCS after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.

### [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 (Panasonic [18]) proposed that inter-slot FH should be supported for TBoMS.
* Three companies (Xiaomi [13], Intel [15], Lenovo/Motorola [27]) 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, excluding the overhead of reference signals.
* One company (Ericsson [22]) proposed that the power control aspect is discussed after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.
* One company (Huawei/HiSi [3]) proposed that the transmission power determination of TBoMS should be based on the TOT.
* One company (CATT [8]) proposed that the transmitted power of a TBoMS remains unchanged during the transmission.
* One company (LGE [28]) proposed considering transmission power control for TBoMS PUSCH in units of slot or TOT.

### [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 [22]) proposed that the number of layers is discussed after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.
* 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 [12]) 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.

### [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.

* Six companies discussed the support of UCI multiplexing on TBoMS
  + One company (Huawei/HiSi [3]) proposed that in case of overlapped PUCCH and TBoMS transmissions, UCI multiplexing should be performed per TOT by rate matching.
  + One company (Huawei/HiSi [3]) proposed that, for latency-sensitive UCI, per-slot UCI multiplexing by puncturing should be allowed.
  + One company (vivo [6]) proposed that 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.
  + One company (Interdigital [14]) proposed further studying whether UCI is repeated on the multiple slots of TBoMS.
  + One company (Samsung [19]) proposed that parallel transmission of PUCCH and TBoMS PUSCH is not preferred due to power splitting during CE situation.
  + One company (Ericsson [22]) proposed that, if UCI multiplexing in TBoMS is supported, UCI can be multiplexed in the first slot of TBoMS, or repeated in all slots of TBoMS, if it has the same number of UL symbols in each slot.
  + One company (Ericsson [22]) proposed that the resource determination of UCI multiplexing on TBoMS should be done prior to transmission of TBoMS, according to Rel-15/16 timelines for the first transmission of a PUSCH repetition.
  + One company (Ericsson [22]) proposed that UE does not expect gNB to schedule a new UCI transmission which overlaps in time with the ongoing transmission of TBoMS.
  + One company (Sharp [24]) proposed that an encoding block should be defined per TOT. Processing timeline requirement (e.g., for UCI multiplexing) should be defined per TOT.
  + Three companies (ZTE [5], CATT [8], WILUS [29]) proposed further discussing UCI multiplexing rules for TBoMS.
* Seven companies discussed overlap between different UL transmission and TBoMS and, more in general, collision handling aspects for TBoMS:
  + Three companies (Fujitsu [10], ZTE [5], Huawei/HiSi [3]) proposed reusing repetition-like behaviour for collision handling between TBoMS and PUCCH.
  + One company (IITH [4]) proposed defining priority rules to handle cases where TBoMS transmission may overlap with other transmissions such as SRS and PUCCH.
  + One company (Intel [15]) proposed that TBoMS can be transmitted based on available UL slots. FFS how to handle overlaps between TBoMS and other uplink transmission.
  + One company (LGE [28]) proposed that TBoMS PUSCH transmission is punctured in the overlapped slot(s).
  + One company (LGE [28]) proposed that UE behaviour for the collision between TBoMS PUSCH and PUCCH without repetition should be discussed.
  + One company (LGE [28]) proposed to consider allowing collision between TBoMS PUSCH and SRS resource and to prioritize SRS transmission in the overlapped slot.
  + One company (Sharp [24]) proposed that collision with a high priority channel or indication of cancellation for a part of TBoMS by DCI format 2\_0 should be handled per TOT.

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

Activation indication of TBoMS feature, i.e., indication on whether a PUSCH transmission should follow TBoMS or legacy PUSCH transmission, was discussed in three contributions. Corresponding proposals are summarized as followsL

* One company (IITH [4]) proposed to support semi-static switching between TBoMS and single-slot PUSCH transmission.
* One company (China Telecom [11]) proposed that dynamic switching between TBoMS and single slot transmission can be differentiated by the indication of number of slots in DCI.
* One company (Interdigital [14]) proposed to support dynamic enabling/disabling of TBoMS 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. R1-2104242 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2104297 On TB processing over multiple slots for PUSCH, IITH
5. R1-2104331 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2104377 Discussion on PUSCH TB processing over multiple slots, vivo
7. R1-2104436 Discussion on TB processing over multi-slot PUSCH, Spreadtrum Communications
8. R1-2104538 Discussion on TB processing over multi-slot PUSCH, CATT
9. R1-2104793 Issues for TB over multi-slot PUSCH, OPPO
10. R1-2105064 Views on TB processing over multi-slot PUSCH, Fujitsu
11. R1-2104847 Discussion on TB processing over multi-slot PUSCH, China Telecom
12. R1-2104626 Discussion on TB processing over multi-slot PUSCH, CMCC
13. R1-2105576 TB processing over multi-slot PUSCH, Xiaomi
14. R1-2104860 TB processing over multi-slot PUSCH, InterDigital, Inc.
15. R1-2104920 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
16. R1-2105120 Discussion on TB processing over multi-slot PUSCH, Apple
17. R1-2104686 TB processing over multi-slot PUSCH, Qualcomm Incorporated
18. R1-2105147 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
19. R1-2105326 TB processing over multi-slot PUSCH, Samsung
20. R1-2105968 Discussion on TB Processing over multi-slot PUSCH, MediaTek Inc.
21. R1-2105902 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
22. R1-2105653 TB Processing over Multi-Slot PUSCH, Ericsson
23. R1-2105510 Design Considerations for TB Processing over Multi-Slot PUSCH, Sierra Wireless
24. R1-2105641 TB processing over multi-slot PUSCH, Sharp
25. R1-2105256 Discussion on TB processing over multi-slot PUSCH, NEC
26. R1-2105712 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.
27. R1-2105774 Enhancements for TB processing over multi-slot PUSCH, Lenovo, Motorola Mobility
28. R1-2105489 Discussions on TB processing over multi-slot PUSCH, LG Electronics
29. R1-2105878 Discussion on TB processing over multi-slot PUSCH, WILUS Inc.

# Appendix A: Proposals from contributions aggregated by topic

## A.1 TDRA

**TDRA determination**

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 2****: Repetition type B like TDRA should be supported for TBoMS, where the existing DMRS allocation mechanism can be reused under the limitation of that the PUSCH within one slot cannot be divided by invalid symbols into two or more non-continuous segmentations.*   * *Repetition type B like TDRA is defined as that only the TDRA indication of repetition type B is utilized for TBoMS, but the other features of repetition type B are not utilized, such as DMRS allocation, RM, RV, etc.*   **R1-2104331 ZTE**  ***Proposal 1:*** *For time domain resource determination of TBoMS, PUSCH repetition type A like TDRA should be supported.*   * *No optimization specific for the use of special slot in TDD is pursued.*   **R1-2104377 vivo**  **Proposal 1**:PUSCH repetition Type-A like TDRA is adopted for resource allocation for TBoMS, i.e. the available resource for TBoMS is determined per slot basis.  **R1-2104436 Spreadtrum Communications**  ***Proposal 2****. Support PUSCH repetition type A like TDRA.*  **R1-2104538 CATT**  **Proposal 3**: For time domain resource determination for TBoMS, at least PUSCH repetition type A like TDRA is supported, where the number and location of the allocated symbols in each slot for TBoMS is the same.   * Whether/How to handle special slots for time domain resource determination of TBoMS, e.g., based on PUSCH repetition type A like TDRA or type B like TDRA, is to be discussed.   **R1-2104626 CMCC**  **Proposal 1**: The repetition Type A like TDRA should be supported as the baseline for the time domain resource indication for TBoMS.  **Proposal 2**: The indication of uplink symbol in the special slots should be supported, either based on repetition Type A or Type B like indication.  **R1-2104686 Qualcomm**  **Proposal 2:** PUSCH repetition Type A serves as a starting point for time domain resource determination of TBoMS.  **R1-2104793 OPPO**  ***Proposal 2****: At least PUSCH repetition type A like TDRA is used for TBoMS.*  *The existing PUSCH repetition type A TDRA can be the starting point.*  **R1-2104860 Interdigital**  **Proposal 6**: In TDD mode, the UE can use special slots for TBoMS transmission.  **R1-2104920 Intel**  **Proposal 2**   * *Both repetition type A and type B based TDRA mechanisms are supported for TBoMS.*   **R1-2105064 Fujitsu**  **Proposal 2**: For time domain resource determination for TBoMS, at least PUSCH repetition type A like TDRA, according to which the number and location of allocated symbols for TBoMS is the same in each slot, is supported.  **R1-2105120 Apple**  **Proposal 4**: PUSCH repetition type A-like resource determination scheme is supported.  **R1-2105147 Panasonic**  **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 special slot, such that one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the semi-static symbol not intended for PUSCH transmission, is used.     - 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.   **R1-2105256 NEC**  ***Proposal 3****: Support both PUSCH repetition type A and PUSCH repetition type B like TDRA for TBoMS.*  **R1-2105326 Samsung**  ***Proposal 1****: both PUSCH repetition type A and type B like TDRA are supported.*  **R1-2105653 Ericsson**  ***Proposals:***   1. Reuse resource determination and signaling of Rel-15/16 PUSCH repetition as much as possible to avoid specifying duplicate functionality.   **R1-2105712 NTT DOCOMO**  **Proposal 3**: Both PUSCH repetition type A and type B like TDRA should be considered as TDRA for TBoMS.  **R1-2105878 WILUS**  ***Proposal 2****: 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.*   **R1-2105489 LGE**  ***Proposal 1:*** *Adopt PUSCH repetition type A like TDRA configuration for TBoMS PUSCH.*  **R1-2105510 Sierra Wireless**  Proposal 3: The starting point to design the time domain resource determination for TBoMS is:   * PUSCH repetition type A like TDRA, i.e., the number of allocated symbols is the same in each slot.   **R1-2105576 Xiaomi**  **Proposal 1:** PUSCH repetition type B like TDRA is preferred for TB processing over multi-slot PUSCH.  **R1-2105641 Sharp**  ***Proposal 5:*** *For TBoMS, repetition type B like TDRA should be supported.*  ***Proposal 6:*** *For TBoMS, repetition type A like TDRA should be supported.*   * + *Counting on the basis of available slots should be supported.*   **R1-2105902 Nokia/NSB**  **Proposal 6.** For time-domain resource allocation for a single TBoMS, RAN1 to support the number of allocated symbols is the same in each slot. Whether the number of allocated symbols can be different across slots can be further considered after a basic framework on TBoMS is finalized.  **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 2****: 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.* |

**The use of the S slot**

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| **R1-2104331 ZTE**  ***Proposal 1:*** *For time domain resource determination of TBoMS, PUSCH repetition type A like TDRA should be supported.*   * *No optimization specific for the use of special slot in TDD is pursued.*   **R1-2104626 CMCC**  **Proposal 2**: The indication of uplink symbol in the special slots should be supported, either based on repetition Type A or Type B like indication.  R1-2104847 China Telecom  **Proposal 4**: For TBoMS, the special slots for unpaired spectrum should be utilized for UL transmission.  **R1-2105147 Panasonic**  **Proposal 2:**   * If the special slot, where one of the symbols indicated by TDRA for a PUSCH in the slot overlaps with the semi-static symbol not intended for PUSCH transmission, needs to be supported, simple modification of PUSCH repetition Type A framework should be supported. Following options should be considered.   + Option 1: SLIV for special slot is additionally configured for TDRA entry. In normal slot, current SLIV is used and in special slot, SLIV for special slot is used.   + Option 2: Current SLIV is used even in special slot, while PUSCH resource for special slot is obtained from the symbols indicated by TDRA but not collided with non-UL symbols in the slot.   **R1-2105147 MediaTek**  ***Proposal 1****: UL symbols in the special slots to be used for TBoMS jointly with the following U slots and form TOT.*  **R1-2105356 Ericsson**  **Proposals:**   1. The net gains and use cases of TBoMS support for special slot with different number of UL symbols than that in UL slot for the TB should be carefully studied prior to specifying it.    1. Such study should address how SRS and PUCCH can be transmitted as well as the performance of interference suppression when DMRS in a special or normal uplink slot is used for interference suppression in the other type of slot.    2. If specified, and performance gains are targeted for this case, a TB over consecutive UL symbols in special slot and the following UL slot can be based on PUSCH repetition type-B like TDRA. |

**The use of non-consecutive slots**

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| **R1-2104626 CMCC**  **Proposal 3:** For the non-consecutive physical slots for UL transmission in the unpaired spectrum, the semi-static configured uplink slots should be the starting point. The dynamic change of uplink and downlink slots and symbols should be for further discussion.  **Proposal 4:** For the paired spectrum and SUL band, the consecutive slots transmission or allocations should be the baseline. And the insertion or interruption of PUCCH and SRS should be further studied.  **R1-2105356 Ericsson**  **Proposals:**   1. Non-consecutive physical slots can be supported for TBoMS for paired spectrum.   **R1-2105902 Nokia/NSB**  Proposal 7. RAN1 to further support non-consecutive physical slots for UL transmission for TBoMS in paired spectrum. |

**Indication of the number of slots/symbols allocated for TBoMS**

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| **R1-2104331 ZTE**  ***Proposal 2:*** *For TBoMS, the number of slots is jointly coded with the TDRA table.*  R1-2104847 China Telecom  **Proposal 6**: 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.    R1-2105064 Fujitsu  **Proposal 3**: The number of slots is indicated/configured by using a row index of a TDRA list which is configured by RRC.  **R1-2105120 Apple**  **Proposal 3**: The number of slots for scheduled TB is dynamic indicated via DCI.  **R1-2105326 Samsung**  ***Proposal 2****: 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.*   **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 2****: 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.*   **R1-2105576 Xiaomi**  **Proposal 2:** Redesign or reinterpret “repetition number” and/ or “L” field in TDRA for multi-slot PUSCH. |

**Others**

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| **R1-2104297 IITH**  Proposal: If N\_prb used for TBoMS is not restricted, then a restriction on the number of slots aggregated for TBoMS is required.  **R1-2105256 NEC**  ***Proposal 4****: Some enhancement to reduce segment within a slot for PUSCH repetition type B like TDRA should be consider TDRA for TBoMS.*  **R1-2105356 Ericsson**  **Proposals:**   1. TBoMS is designed as a new feature, rather than a Type A PUSCH repetitions enhancement. 2. If TBoMS with more than 2 slots is to be supported, TBoMS configuration uses the number of available slots, otherwise physical slots are used. 3. As a starting point, consider 2 or 4 slots as the candidate numbers of slots for a TBoMS.   **R1-2105120 Apple**  **Proposal 1**: Considering the maximum number of slots for TB transmission is 8.  **R1-2104626 CMCC**  **Proposal 6**: 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.  **R1-2105489 LGE**  ***Proposal 2:*** *A slot is determined as unavailable for TBoMS PUSCH transmission if at least one of the symbols indicated by TDRA in the slot overlaps with the symbol not intended for UL transmissions.* |

## A.2 TOT definition

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| R1-2104242 Huawei/HiSilicon  ***Proposal 3****: A TOT constitutes a set of continuous uplink time domain resources spanning one or more slots.*  R1-2104331 ZTE  ***Proposal 5:*** *A TOT can contain multiple non-consecutive physical slots for UL transmission for TBoMS for unpaired spectrum, and a TOT contains multiple consecutive physical slots for UL transmission for TBoMS for paired spectrum and SUL band.*  R1-2104377 vivo  **Proposal 2**:TOT should be composed of consecutive slots if option-1 is adopted.  **Proposal 4**: TOT is limited to consecutive physical slots, if option 3/4 is adopted.  R1-2104538 CATT  **Proposal 1**: A TOT is constituted of time domain resources which may span one or multiple consecutive physical slots.  R1-2104686 Qualcomm  **Proposal 3:** A transmission occasion of a TBoMS (TOT) constitutes a set of contiguous resources (symbols) spanning one or more slots. A TBoMS transmission can constitute transmissions across one or more transmission occasions. PUSCH Type A repetitions 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.   R1-2104847 China Telecom  **Proposal 1**: A TOT can be composed of consecutive or non-consecutive physical slots for UL transmissions.  **R1-2105147 MediaTek**  ***Proposal 2****: TOT is defined to span across multiple slots. TOT can span over non-consecutive slots atleast for un-paired spectrum.*  **R1-2105712 NTT DOCOMO**  **Proposal 1**: A transmission occasion for TBoMS (TOT) should mean consecutive slots where TBoMS is applied.  **R1-2105489 LGE**  ***Proposal 4:*** *Time resource for a TBoMS PUSCH compose a TOT.*  **R1-2105641 Sharp**  ***Proposal 8:*** *At least for FDD, the gNB configures a TOT length in unit of slots.*  **R1-2105902 Nokia/NSB**  **Proposal 3.** For the definition of a transmission occasion for TBoMS (TOT), a TOT is constituted by one slot or several consecutive physical slots. |

## A.3 Single TBoMS structure

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| R1-2104242 Huawei/HiSilicon  ***Proposal 4****: A single TBoMS can include one or more TOTs.*  R1-2104331 ZTE  ***Proposal 6:*** *If repetition of TBoMS is not supported,* *Option 1 is supported, i.e., one TOT is determined for TBoMS and the TB is transmitted on the TOT using a single RV.*  ***Proposal 7:*** *If repetition of TBoMS is supported, both Option 3 and Option 4 can be considered.*  R1-2104377 vivo  **Proposal 3**: Option 2 is not supported for TBoMS definition.  **Proposal 5**: Option 3 can be considered for TBoMS definition, with the following restrictions   * TB size is determined based on all slots/symbols in a TOT, and * the RV is refreshed for each of the multiple TOTs.   **Proposal 6**: Option 4 can be considered for TBoMS definition.  **Proposal 7**: Option 1/3/4 can be considered for TBoMS definition, with the following restrictions   * TOT is composed of consecutive slots, and * TB is transmitted in a TOT using a single RV, and TB size is determined based on all slots/symbols in a TOT, and * RV is refreshed across different TOTs.   R1-2104436 Spreadtrum Communications  ***Proposal 1****. Support option-1, where only one TOT is determined for a TBoMS and the TB is transmitted on the TOT using a single RV.*  R1-2104538 CATT  **Proposal 2**: A TBoMS can include one or more TOTs.   * Multiple TOTs belonging to the same TBoMS should be consecutive in terms of the logical slots that can be used for UL transmission. * Within one TOT, the RV remains unchanged and un-refreshed.   R1-2104626 CMCC  **Proposal 5:** Support option 1, 2 and 4 for further study.  R1-2104686 Qualcomm  **Proposal 4:** If repetition of TBoMS is allowed, then Option 2 is preferred to define a single TBoMS. Else, Option 4 is chosen to define a single TBoMS.  R1-2104793 OPPO  ***Proposal 3****: TBoMS support one TOT mapped over non-consecutive/consecutive physical slots for UL transmission****.***  R1-2104847 China Telecom  **Proposal 2**: Down selection on option 1 or option 3 for TBoMS.   * Option 1: Only one TOT is determined for a TBoMS. The TB is transmitted on the TOT using a single RV. * Option 3: Multiple TOTs are determined for a TBoMS. The TB is transmitted on the multiple TOTs using a single RV.   R1-2104860 Interdigital  **Proposal 3**: For the definition of a single TBoMS, one or multiple TOTs are determined for a TBoMS. The TB is transmitted on the one or multiple TOTs using a single RV (Option 1 and Option 3).  R1-2104920 Intel  **Proposal 1**   * *For the definition of a single TBoMS, Option 1 and 3 are supported.* * *Repetition is supported for the transmission of TBoMS.*   R1-2105064 Fujitsu  **Proposal 1**: A single RV is used for a TBoMS (i.e. support option 1 or 3).  **R1-2105120 Apple**  **Proposal 8**: Option 4 is adopted as TBoMS scheme, i.e., multiple TOTs are determined for a TboMS, the TB is transmitted on the multiple TOTs using different RVs.  **R1-2105147 Panasonic**  **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 .   + TB is transmitted on the TOT using different RVs.     - FFS: RV index is adjusted after each slot boundary or at every jump between two contiguous resources.     - FFS: RV index sequence is refreshed at each frequency/spatial hop.   **R1-2105256 NEC**  ***Proposal 1****: Select Option 2, i.e. only one TOT is determined for a TBoMS. The TB is transmitted on the TOT using different RVs.*  **R1-2105326 Samsung**  ***Proposal 7****: Option 4 is slightly preferred for the definition of a single TBoMS.*  **R1-2105147 MediaTek**  ***Proposal 4****: Support Option 2: Only one TOT is determined for a TBoMS. The TB is transmitted on the TOT using different RVs, e.g., after each slot boundary or at every jump between two non-contiguous resources.*  **R1-2105653 Ericsson**  ***Proposals:***   1. TBoMS is transmitted using a single RV   **R1-2105712 NTT DOCOMO**  **Proposal 2**: A single RV should be transmitted over one or more TOT in a single TBoMS (Option 3) to differentiate PUSCH repetitions.  **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 1****: For one TB processing over multi-slot PUSCH in NR coverage enhancements in Rel-17, only one TOT is determined for a TBoMS and the TB is transmitted on the TOT using a single RV.*  **R1-2105878 WILUS**  ***Proposal 1****: For the single TBoMS, the TB is transmitted on the TOT (option 1) or the multiple TOTs (option 3) using a single RV.*   * + *FFS: Handling for issues on rate-matching, such as UCI multiplexing.*   **R1-2105510 Sierra Wireless**  **Proposal 1:** TBoMS is an enhancement to repetition where RV cycling of repeats is re-used (i.e. Option 2 or 4 is chosen)  **R1-2105641 Sharp**  ***Proposal 1:*** *Multiple TOTs are determined for a TBoMS. Down select from the following two options*   * *The TB is transmitted on the multiple TOTs using single RVs (i.e., Option 3).* * *The TB is transmitted on the multiple TOTs using different RVs (i.e., Option 4).*   **R1-2105902 Nokia/NSB**  **Proposal 1.** For the definition of a single TBoMS, RAN1 strives to down-select only one from the four identified options for the sake of progress.  **Proposal 2.** For definition of a single TBoMS, Option 3 and Option 4 are retained for further down-selection regardless of whether a TOT is constituted of consecutive or non-consecutive physical slots.  **Proposal 4.** For definition of a single TBoMS, Option 3 should be adopted and rate-matching for TBoMS is to be performed per slot. |

**Relationship between TBoMS and PUSCH repetitions**

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| R1-2104297 IITH  ***Proposal:*** *Do not consider RV cycling, repetitions within TBoMS framework.*  ***Proposal:*** *Enhance PUSCH repetition type-A framework to support transmission over non-contiguous slots while considering that TBoMS is an entirely new feature.*  R1-2104793 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.*  R1-2104847 China Telecom  **Proposal 3**: 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 repetition for PUSCH repetition type A in Rel-17. * Option 2: PUSCH repetition on top of TBoMS is supported.   R1-2104920 Intel  **Proposal 1**   * *For the definition of a single TBoMS, Option 1 and 3 are supported.* * *Repetition is supported for the transmission of TBoMS.*   **R1-2105902 Nokia/NSB**  **Proposal 5.** RAN1 should specify TBoMS as an independent feature according to WID. It should not be considered as an enhancement of either PUSCH repetition type A or type B, regardless of how time domain resource determination is indicated.  R1-2104686 Qualcomm  **Proposal 1:** 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.  **R1-2105356 Ericsson**  **Proposals:**   1. TBoMS is designed as a new feature, rather than a Type A PUSCH repetitions enhancement.   **R1-2104377 vivo**  **Proposal 9**: TBoMS can be transmitted in repetition manner in multiple TOTs, and each TOT is used to transmit a repetition for TBoMS. |

## A.4 Rate-matching

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| R1-2104242 Huawei/Hi Silicon  ***Proposal 5****: RM is performed per TOT, where the start position of bit selection in the circular buffer on TOT is defined as*  *where denotes the end position of bit selection in the circular buffer on TOT , , denotes the length of coded bits in the circular buffer, is the LDPC lifting size, and denotes the TOT number, .*  R1-2104686 Qualcomm  **Proposal 6:** Adopt per-slot rate matching for TBoMS.  R1-2104860 Interdigital  **Proposal 4**: For Option 1, support rate matching per slot  **Proposal 5**: For Option 3, do not support rate matching across multiple TOTs  **R1-2105653 Ericsson**  ***Proposals:***  Support continuous rate-matching of encoded bits across all transmitted slots of the TBoMS, regardless of the number of TOT(s) for a TBoMS.  **R1-2105902 Nokia/NSB**  **Proposal 4.** For definition of a single TBoMS, Option 3 should be adopted and rate-matching for TBoMS is to be performed per slot. |

**How RVs are rate matched**

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| R1-2104297 IITH  *Proposal: A single RV is rate matched across all the slots considered for TBoMS*  R1-2104377 vivo  **Proposal 8**: If one of the multiple slots in a nominal TOT, is not available, following alternatives can be considered for RV mapping   * Alt-1: The nominal TOT can be segmented to several actual TOTs, and RV is refreshed for each actual TOT; * Alt-2: UE does not expect a nominal TOT to be segmented to several actual TOTs, and a single RV is mapped to the consecutive slots in an actual TOT.   R1-2104686 Qualcomm  **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 within a transmission occasion.   R1-2104793 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 TB and RE processing in each slot, e.g., restricting TB size.*  *Consider an offset factor for bit selection.*  **R1-2105256 NEC**  ***Proposal 2****: RV index is refreshed at every jump between two non-contiguous resources.*  **R1-2105489 LGE**  ***Proposal 3:*** *Apply continuous rate-matching across slots within a TOT and RV cycling between TOTs.* |

## A.6 TBS determination

***N*Info calculation**

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 6****: is calculated based on all REs determined across the slots over which the TBoMS transmission is allocated. is configured by xOverhead, which can be the same on each slot.*  **R1-2104297 IITH**  ***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.*  **R1-2104331 ZTE**  ***Proposal 8****:**Approach 1 is supported for determination of NInfo for TBoMS.*  **R1-2104377 vivo**  **Proposal 10**:Approach 2 is adopted for *N*Info determination i.e. *N*Info is scaled by *K*, where *K* is number of slots in the first TOT/repetition.  **R1-2104436 Spreadtrum Communications**  ***Proposal 4****. Support to count all available REs for calculating the value of .*  **R1-2104538 CATT**  **Proposal 4**: For TBoMS, for the case of PUSCH repetition type A like TDRA, *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 L is the number of symbols determined using the SLIV of PUSCH indicated via TDRA, and K is the number of allocated slots.   1. FFS the case of PUSCH repetition type B like TDRA, if adopted.   **R1-2104626 CMCC**  **Proposal 8**: The Approach 1 should be further discussed based on the counting of slots.  **Proposal 9**: Considering the process delay, the slot number in Approach 1 and the K value in Approach 2 should be limited.  **R1-2104686 Qualcomm**  **Proposal 7:** When determining for TBoMS, is the number of resource elements available in a transmission occasion of TBoMS.  **Proposal 8:** When determining for TBoMS, introduce a new scale factor (taking values greater than or equal to 1) 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.  **R1-2104793 OPPO**  ***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.*  **R1-2104847 China Telecom**  **Proposal 5**: For TBS calculation, *N*Info for TBoMS is calculated Based on all REs determined across the symbols or slots over which the TBoMS transmission is allocated.  **R1-2104860 Interdigital**  **Proposal 7**: *N*Info for TBoMS is calculated based on all REs determined across the symbols or slots over which the TBoMS transmission is allocated.  **R1-2104920 Intel**  **Proposal 5**   1. *For calculation of NInfo for TBoMS, approach 1 is adopted.*   **R1-2105120 Apple**  **Proposal 6**: The same PUSCH mapping type and SLIV are applied to slots for TB transmission.  **R1-2105147 Panasonic**  **Proposal 3:**   1. Support following approach for TBS determination and rate matching process for TBoMS.    1. TBS is calculated based on the number of REs determined in the first *L* symbols over which the TBoMS transmission is allocated, scaled by .    2. TB is transmitted on the TOT using different RVs.       1. FFS: RV index is adjusted after each slot boundary or at every jump between two contiguous resources.       2. FFS: RV index sequence is refreshed at each frequency/spatial hop.   **R1-2105256 NEC**  ***Proposal 6****: Using approach 2 as a starting point to decide Ninfo as approach 2 can easily get the same TBS for initial transmission and retransmission.*  **R1-2105326 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.*  **R1-2105147 MediaTek**  ***Proposal 3****: TBS is calculated using the total number of REs across the symbols on which TBoMS is defined.*  **R1-2105356 Ericsson**  **Proposals:**   1. Approach 1 is used to calculate . 2. When the number of symbols in each slot is the same for TBoMS,    1. If the number of physical slots is configured, use TDD UL/DL configuration for TBS determination    2. If the number of available slots is configured, TBS determination is according to the number of available slots.   **R1-2105712 NTT DOCOMO**  **Proposal 5**: *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.  **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 4****: 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.*  **R1-2105878 WILUS**  ***Proposal 3****: 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.*   **R1-2105489 LGE**  ***Proposal 7:*** *Ninfo for TBoMS PUSCH is obtained as where NRE is based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated and S is a scaling factor.*  **R1-2105510 Sierra Wireless**  Proposal 2: TBS determination procedure can follow legacy repetition procedures when option 2 or 4 is chosen.  **R1-2105641 Sharp**  ***Proposal 9:*** *For Ninfo calculation, at least the following two scenarios should be possible:*   * + *Resource amount for a TBoMS (i.e., all resources indicated by TDRA) is targeted for Ninfo calculation*   + *Resource amount for a TOT is targeted for Ninfo calculation*   ***Proposal 10:*** *A TBS scaling factor K is indicated through a DCI format for scheduling the PUSCH or RRC signaling.* |

**NohPRB calculation**

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| **R1-2104297 IITH**  ***Proposal****: Same overhead is assumed for all the slots over which TBoMS transmission is performed.*  **R1-2104331 ZTE**  ***Proposal 9****:**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.*  **R1-2104377 vivo**  **Proposal 11**: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.  **R1-2104436 Spreadtrum Communications**  ***Proposal 5****.* *is assumed to be the same for all the slots.*  **R1-2104538 CATT**  **Proposal 5**: For TBoMS, for the case of PUSCH repetition type A like TDRA, the total overhead for TBS determination in TBoMS is calculated depending on the number of allocated PRBs, *xOverhead* (i.e., , configured as in Rel-15/16) and on the number of allocated slots of TBoMS.   * FFS the case of PUSCH repetition type B like TDRA, if adopted.   **R1-2104626 CMCC**  **Proposal 10**: 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   **R1-2104686 Qualcomm**  **Proposal 10**: For TBoMS, is assumed to be the same across an entire TBoMS transmission occasion and is configured via xOverhead as in Rel-15/16.  **R1-2104920 Intel**  **Proposal 6**   * *For determination of NohPRB for TBoMS, Option 2 is adopted.*   **R1-2105120 Apple**  **Proposal 7**: xOverhead is applied to all the slots for TBS determination.  **R1-2105326 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.*  **R1-2105356 Ericsson**  **Proposals:**   1. Option 1 is used to determine *NohPRB*, given the lower standardization effort needed.   **R1-2105712 NTT DOCOMO**  **Proposal 5**: *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.  **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 5****: 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.*  **R1-2105878 WILUS**  ***Proposal 4****: 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.*   **R1-2105489 LGE**  ***Proposal 8:*** *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.*  **R1-2105510 Sierra Wireless**  Proposal 2: TBS determination procedure can follow legacy repetition procedures when option 2 or 4 is chosen. |

**Specific TBS values for TBoMS**

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| **R1-2102314 Huawei/HiSilicon**  Proposal 4: Further constraint on maximum TB size for TBoMS is not needed.  **R1-2102331 ZTE**  ***Proposal 10:*** *The maximum TBS can be limited by the conditions of date rate limitations DataRate and DataRateCC.*  **R1-2104686 Qualcomm**  **Proposal 9:** For TBoMS, no new TB sizes are introduced.  **Proposal 11:** 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.  **R1-2105256 NEC**  ***Proposal 5****: Limit Ninfo upper bound to make sure that the maximum supported TBS not exceeds legacy maximum supported TBS in Rel-15/16 for TBoMS.*  **R1-2105489 LGE**  ***Proposal 10:*** *It is considerable to reduce the maximum TB size so that CB segmentation does not occur.* |

## A.5 FDRA

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| R1-2104297 IITH  ***Proposal:*** *N\_prb used for TBoMS should be limited to satisfy the TB constraints.*  R1-2104331 ZTE  ***Proposal 4:*** *The maximum number of PRBs can be limited when TBoMS is enabled.*   * *FFS how to determine the maximum number of PRBs.*   R1-2104436 Spreadtrum Communications  ***Proposal 3****. No need to introduce RB number constraint for frequency domain resource.*  **R1-2104538 CATT**  **Proposal 7**: For TBoMS, no restriction is specified except for the maximum TBS.  R1-2104860 Interdigital  **Proposal 2**: Frequency domain allocation for TBoMS is limited to small number of PRBs.  **R1-2105326 Samsung**  ***Proposal 5****: The maximal number of PRB allocated in time domain is reduced for TB over multi-slot.*  **R1-2105489 LGE**  ***Proposal 9:*** *It is considerable to apply TB processing over multi-slot PUSCH when a PUSCH has a small number of PRBs.*  **R1-2105576 Xiaomi**  **Proposal 3**: Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling. |

## A.7 TBoMS repetitions

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 7****: The start position of bit selection in the circular buffer on the first TOT for each repetition is denoted by RV index and the RV index is cycled for each repetition in the sequence of {0, 2, 3, 1}.*  **R1-2104331 ZTE**  ***Proposal 7:*** *If repetition of TBoMS is supported, both Option 3 and Option 4 can be considered.*  **R1-2104538 CATT**  **Proposal 9**: Discuss whether to support repetition of TBoMS further based on the outcome of the relationship between TOT and TBoMS.  **R1-2104626 CMCC**  **Proposal 7**: There is no need to support the repetition of TBoMS.  **R1-2105120 Apple**  **Proposal 2**: For TB transmission over consecutive UL slots, repetition can be supported on top of TBoMS.  **R1-2105147 Panasonic**  **Proposal 4**: Additional repetition procedure of TBoMS is considered depending on TBS determination approach 1 or 2.  **R1-2105326 Samsung**  ***Proposal 3****: Repetition is supported for TB over multi-slot.*  R1-2104920 Intel  **Proposal 1**   * *For the definition of a single TBoMS, Option 1 and 3 are supported.* * *Repetition is supported for the transmission of TBoMS.*   **R1-2105147 MediaTek**  ***Proposal 5****: No repetitions for TBoMS.*  **R1-2105489 LGE**  ***Proposal 5:*** *Repetition of TBoMS PUSCH is supported.*  **R1-2105653 Ericsson**  ***Proposals:***   1. The need for repetition of TBoMS is further considered   **R1-2105712 NTT DOCOMO**  **Proposal 4**: Support a repetition of TB processing over multi-slot PUSCH.  **R1-2105576 Xiaomi**  **Proposal 5:** Consider the configuration and indication signalling design when a single UE supports both repetition and TBoMS.  **Proposal 6:** TB processing over multi-slot can be transmitted in conjunction with repetitions. |

## A.8 DM-RS

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| **R1-2105120 Apple**  **Proposal 5**: Per slot DMRS allocation is considered for PUSCH repetition type B-like TDRA.  **R1-2105326 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 determined per TOT* * *DMRS time domain location is determined per slot*   **R1-2105653 Ericsson**  ***Proposals:***   1. RAN1 to discuss issues of DMRS, MCS, number of layers, CB segmentation and power control after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.   **R1-2105641 Sharp**  ***Proposal 7:*** *Joint channel estimation is not a prerequisite feature for TBoMS. When joint channel estimation is not configured for TBoMS, no DMRS enhancement is required. Discussion on DMRS enhancement should be discussed in line with joint channel estimation for a case where joint channel estimation is configured for TBoMS.* |

## A.9 Transmission power determination

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 8***: *The transmission power determination of TBoMS should be based on the TOT.*  **R1-2104331 ZTE**  ***Proposal 12:*** *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.*  **R1-2104538 CATT**  **Proposal 8**: The transmitted power of a TBoMS remains unchanged during the transmission.  **R1-2105653 Ericsson**  ***Proposals:***   1. RAN1 to discuss issues of DMRS, MCS, number of layers, CB segmentation and power control after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached.   **R1-2105489 LGE**  ***Proposal 6:*** *Consider to perform transmission power control for TBoMS PUSCH in units of slot or TOT.* |

## A.10 Rank of TBoMS transmission

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| R1-2104377 vivo  **Proposal 13**: PUSCH with TB processing over multiple slots should be limited to single transmission layer.  R1-2104686 Qualcomm  **Proposal 11:** 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.  **R1-2105653 Ericsson**  ***Proposals:***   1. RAN1 to discuss issues of DMRS, MCS, number of layers, CB segmentation and power control after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached. |

## A.11 Link adaptation

***MCS index***

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| **R1-2105653 Ericsson**  ***Proposals:***   1. RAN1 to discuss issues of DMRS, MCS, number of layers, CB segmentation and power control after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached. |

## A.12 Interleaving

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| **R1-2105326 Samsung**  ***Proposal 8****: slot based interleaving is supported for TBoMS.* |

## A.13 Frequency hopping

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| **R1-2104920 Intel**  **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*   **R1-2105147 Panasonic**  **Proposal 5**: Inter-slot frequency hopping and/or precoder cycling with joint channel estimation should be supported for TBoMS.  **R1-2105774 Lenovo, Motorola Mobility**  ***Proposal 3****: 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*   **R1-2105576 Xiaomi**  **Proposal 4:** Support intra-TB frequency hopping for TB processing over multi-slot PUSCH. |

## A.14 CB segmentation

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| **R1-2105653 Ericsson**  ***Proposals:***   1. RAN1 to discuss issues of DMRS, MCS, number of layers, CB segmentation and power control after agreements of Type-A or Type-B like TDRA and TOT for rate matching are reached. |

## A.15 Retransmissions

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| **R1-2104626 CMCC**  **Proposal 11**: Per slot retransmission should be considered for the retransmission of multiple slot PUSCH transmission.  **R1-2104860 Interdigital**  **Proposal 9**: Support enhanced retransmission mechanisms to avoid the retransmission of the entire TBoMS. |

## A.16 UCI multiplexing, SRS/DL collisions/cancellations

**UCI multiplexing**

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 9****: In case of overlapped PUCCH and TBoMS transmissions, perform UCI multiplexing per TOT by rate matching.*  ***Proposal 10****: For latency-sensitive UCI, allow performing per-slot UCI multiplexing by puncturing.*  **R1-2104331 ZTE**  ***Proposal 11***: *Further discuss UCI multiplexing rules for TBoMS.*  **R1-2104377 vivo**  **Proposal 12**: 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.   **R1-2104538 CATT**  **Proposal 6**: For TBoMS, further study UCI multiplexing based on the outcome of definition of TOT.  **R1-2104860 Interdigital**  **Proposal 8**: Support UCI multiplexing with TBoMS. FFS whether UCI is repeated on the multiple slots of TBoMS  **R1-2105326 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 Rel-17 CE, RAN1 further study the details.*  **R1-2105653 Ericsson**  ***Proposals:***   1. If UCI multiplexing in TBoMS is supported, UCI can be multiplexed in the first slot of TBoMS, or repeated in all slots of TBoMS, if it has the same number of UL symbols in each slot. 2. The resource determination of UCI multiplexing on TBoMS should be done prior to transmission of TBoMS, according to Rel-15/16 timelines for the first transmission of a PUSCH repetition. UE doesn’t expect gNB to schedule a new UCI transmission which overlaps in time with the ongoing transmission of TBoMS.   **R1-2105878 WILUS**  ***Proposal 5****: It should be further discussed how to determine the number REs for UCI multiplexing, and UL transmission power in case of TB processing over multi-slot PUSCH.*  **R1-2105641 Sharp**  ***Proposal 2:*** *An encoding block should be defined per TOT.*  ***Proposal 3:*** *Processing timeline requirement (e.g., for UCI multiplexing) should be defined per TOT.* |

**Collision handling**

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| **R1-2104242 Huawei/HiSilicon**  ***Proposal 1****: TBoMS overlapping SRS can be handled by repetition type B like TDRA with a dropping rule, where the PUSCH symbols overlapped by SRS are dropped.*  **R1-2104297 IITH**  ***Proposal:*** *Define priority rules to handle cases where TBoMS transmission may overlap with other transmissions such as SRS and PUCCH.*  **R1-2104331 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.*  **R1-2104920 Intel**  **Proposal 3**   * *TBoMS can be transmitted on the basis of available UL slots.*   **Proposal 7**   * *FFS how to handle overlaps between TBoMS and other uplink transmission.*   **R1-2105064 Fujitsu**  **Proposal 4**: Reuse repetition-like behaviour (option B in Figure 1) for collision handling between TBoMS PUSCH and PUCCH  **R1-2105489 LGE**  ***Proposal 11:*** *For the overlapping between TBoMS PUSCH and PUCCH with repetitions, TBoMS PUSCH transmission is punctured in the overlapped slot(s).*  ***Proposal 12:*** *UE behavior for the collision between TBoMS PUSCH and PUCCH without repetition should be discussed.*  ***Proposal 13:*** *Consider to allow collision between TBoMS PUSCH and SRS resource and prioritize SRS transmission in the overlapped slot.*  **R1-2105641 Sharp**  ***Proposal 4:*** *Collision with a high priority channel or indication of cancellation for a part of TBoMS by DCI format 2\_0 should be handled per TOT.* |

## A.17 Multi-slot/Single-slot switch/indication

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| **R1-2104297 IITH**  ***Proposal****: Support semi-static switching between TBoMS and single slot transmission.*  R1-2104847 China Telecom  **Proposal 6**: 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.  R1-2104860 Interdigital  **Proposal 1**: Support dynamic enabling/disabling of TBoMS transmission. |

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

Agreement:

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

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

Working Assumption

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

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

Agreements**:**

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

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

Agreement:

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

Agreement:

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

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

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

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

Agreement:

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

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

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

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