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: $N\_{info}$ calculation
	+ TBS determination: $N\_{oh}^{PRB}$ 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.

|  |  |
| --- | --- |
| Company | Comments |
| InterDigital | We support the FL’s proposal. |
| Intel | We are fine with the proposal. |
| Qualcomm | Support. |
| Sharp | We support FL proposal. |
| TCL | Support |
| Samsung  | Fine. |
| ZTE | Fine with the proposal.  |
| Xiaomi | Fine with the proposal |
| NTT DOCOMO | We are fine with the proposal. |
| CATT | We are fine with the proposal. |
| Apple | General ok with this proposal. We just want to clarify what is the DMRS assumption for type B like TDRA. |
| Vivo | Fine with the proposal |
| China Telecom | For option 1, we would like to clarify how to handle special slots. In our understanding, separate TDRA for special slots in addition to type A like TDRA should be considered for option 1. |
| Panasonic | We are fine with the proposal. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Support |
| MediaTek | Fine. It is beneficial to clarify what is “like” or what could be “unlike” for these two options, especially if the special slot is supported. Section 2.2.1 on the use of the S slot can be discussed at first.Besides, is it down-selected in this meeting R1-105e？ |
| Spreadtrum | We support FL proposal. |
| Fujitsu | We are fine with the proposal. |
| LG | We are fine with the proposal. |
| CMCC | Fine with the proposal. |
| Huawei/HiSilicon | According to our analysis in [3], repetition type B like TDRA can utilize special slot and handle TBoMS overlapping SRS in an efficient way to improve the uplink coverage. Its implementation complexity can be reduced by using the existing DMRS allocation mechanism under the limitation of that the PUSCH over one slot is not expected to be divided by invalid symbols into two or more non-continuous segmentations, this does not depend on UE capability. Therefore, we think the proposal should be revised as following：***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.~~***
 |
| Lenovo, Motorola Mobility | We support the FL proposal |
| WILUS | We support the FL’s proposal. |
| OPPO | We are fine with the Alternatives with the changing the term: Type A like TDRA -> PUSCH repetition type A like TDRA, which was used previously in the summary. |
| Nokia/NSB | We support the FL’s proposal. |
| Sierra Wireless | Support FL’s proposal |
| Ericsson | We support the FL’s proposal, but think it should be clarified since capability can refer to TBoMS capability or to a capability on top of TBoMS capability. Suggest to clarify that the Type B capability is an additional capability for a TBoMS capable UE, i.e.:***The use of Type B like TDRA for time domain resource determination is according to an additional UE capability for a TBoMS capable UE*** |
|  |  |

**FL’ comments on April 21st**

Thank you for the received comments. Several iterations have already been carried out via email and during GTW. Suggestions for modifications were given and will be considered in the next version of the proposal. Before I provide the new proposal, I would like to state the following:

We cannot keep jumping from one discussion to another with the excuse that interplay exists between different aspects. This is obvious. On the other hand, we either proceed sequentially or we do not proceed at all, hence please let us all remind that eventually middle ground must be found, regardless of how many discussions we have open. You can rely on the fact that I plan to discuss **all aspects**. However, I need us all to be constructive for this to be possible.

Now, we have two contentious issues left:

1. FFS point on Option 1, i.e., the addition of the FFS ***FFS: how to support TBoMS in the special slot***, as proposed by Intel.
2. The bullet in Option 2 related to capability, which very few companies would like to remove.

My analysis follows.

**Issue 1**

The point of the differentiation of the two options is very simple.

Option 1 implies that PUSCH repetition Type A like TDRA is adopted. In other words, we start by the assumption that the same number of symbols is allocated in each slot for TBoMS. This Option implies that no special care is given to the use of S slots, which is possible according to current specification, and will not be optimized any further. This must stay in this form, since otherwise the whole point of having agreed on the definition of PUSCH repetitions type A like and PUSCH repetitions type B like TDRA becomes void. Please accept that if Option 1 is down-selected then no optimization will be performed for the S slots. In this context, we should note, in fact, that any optimization would result in similar effects of PUSCH repetition type B like TDRA, with a lot of aspects to be worked out such as: DMRS position, rate matching for L<=14 and L>14 and so on. This can become extremely complicated is clearly not justifiable, given that the goal of the AI is to enable transmissions over multi-slot PUSCH of TB whose size is calculated considering resources of multiple slots.

Option 2 implies that both PUSCH repetitions type A like and PUSCH repetitions type B like TDRA are adopted, where the use of the latter is subject to UE capability (as for R16). This Option implies that S slots can be used more efficiently, and again no optimization to make use of the S slots are performed. This will certainly bring additional work for RAN1 but could help addressing concerns of some companies, while not mandating any support to PUSCH repetitions type B like TDRA (this would be discussed during the UE features session).

The bottom line is that the question should be: will RAN1 make sure the most effective use of the S slot is possible via TBoMS or note? If the answer if yes, then Options 2 is the way to go, otherwise Option 1 without FFS is the way to go. Let us keep it this way and start discussing down-selection please.

**Issue 2**

Here the situation is, in my view, simple. There is a number of companies willing to accept discussing about PUSCH repetitions type B like TDRA even if clearly not preferred by them, for the sake of progress, if no implicit assumption on UE capabilities is made. In my view, this is a rather constructive approach which may actually be worked on to converge on Option 2 eventually. I do not see any reason why the bullet on the capability should be removed, given that it does not remove any “optimization power” to Option 2 and simply considers concerns of many companies, while not preventing other companies to be happy with the use of S slots. I warmly invite everyone to be constructive here.

**Final general comment before the proposal**

From FL’s perspective, the fairest, even though more challenging, approach is to go for Option 2 with the bullet on the UE capability. It is clearly the easiest way to find a middle ground and we should not keep wasting time on this aspect, given all the other discussions that need to be carried out and completed. Current proposal does not even ask companies to take this decision yet. However, this is something we should all try to agree on before the end of this meeting, since it is **very important** to move forward. If you do not agree with the proposal please refrain from keeping proposing the same modifications which cannot be accepted, this is not very respectful of the efforts we are all making.

New proposal follows.

***FL proposal 1-v3***

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

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

**Note: For *PUSCH repetition Type A like TDRA And PUSCH repetition Type B like TDRA, the following definitions apply:***

* + ***PUSCH repetition type A like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission is the same.**
		- **The allocated symbols per slot are consecutive.**
	+ ***PUSCH repetition type B like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission can be different.**
		- **Allocated symbols per slot can be consecutive or non-consecutive.**

Please add your position to the table below. Constructive attitude in this regard is, as usual, highly recommended

|  |  |
| --- | --- |
| Position | Company name |
| Support | Sharp, Nokia/NSB, Sierra Wireless, Qualcomm, Lenovo, Motorola Mobility, vivo, samsung, Panasonic, DOCOMO, ZTE, Intel (with some modification below), LG, Huawei, Hisilicon, Fujitsu, WILUS,TCL, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, CATT, MediaTek |
| Do not support | Ericsson |

If you really cannot accept the proposal and can propose an alternative which **does not** simply ask to reintroduce FFS bullet in Option 1 or to remove the sub-bullet from Option 2, you can add your alternative below. Once again, Please refrain from suggesting micro-optimizations if at least one of the options above is acceptable for you.

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | While we are OK with the proposal’s general intent, the new bullets on allocated symbols being consecutive or non-consecutive is new, and for us the motivation is not immediately clear, and we would like further discussion before agreeing. We are OK with using the prior definitions of Type-A and -B like TDRA, and so suggest the following. ***The following 2 options for time domain resource determination for TBoMS are considered for down-selection during RAN1 #105-e:**** ***Option 1: Time domain resource determination for TBoMS can be performed only via PUSCH repetition Type A like TDRA.***
* ***Option 2: Time domain resource determination for TBoMS can be performed via PUSCH repetition Type A like TDRA or via PUSCH repetition Type B like TDRA.***
	+ ***The use of PUSCH repetition Type B like TDRA for time domain resource determination is according to an additional UE capability for a TBoMS capable UE.***

**Note: For *PUSCH repetition Type A like TDRA And PUSCH repetition Type B like TDRA, the following definitions apply:**** + ***PUSCH repetition type A like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission is the same.**
		- **~~The allocated symbols per slot are consecutive.~~**
	+ ***PUSCH repetition type B like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission can be different.**
		- **~~Allocated symbols per slot can be consecutive or non-consecutive.~~**
 |
| Intel | Our understanding is that for PUSCH repetition type B like TDRA scheme, “the allocated symbols per slot are consecutive”. We suggest to change this similar to repetition type A like TDRA. The suggestion from Ericsson is also fine with us.  |
| Apple | Try to understand the proposal better. First comment on the Note, the allocated symbols per slot are consecutive, we understand the type A TDRA can be less than 14symbols, but considering the TBoMS resource allocation, then total 14symbols are indicated in TDRA. So it’s ok that the allocated symbols per slot are consecutive. For repetition type B like TDRA, we are not clear whyAllocated symbols per slot can be consecutive or non-consecutive? Currently, repetition type B TDRA indicates the starting symbol and length of transmission, and the nominal repetitions. The **Allocated symbols** per slot are consecutive, the **actual transmissions** repetition typeB could be non-consecutive, due to invalid symbols. For TBoMS, the **Allocated symbols** per slot are consecutive.Second comment, before we go with option 2, we try to understand what the PUSCH repetition type B-like TDRA looks like, what is the implementation and standard impacts. For now at least from our understanding, the DMRS pattern is open, as the DMRS pattern is related to the actual transmission, which is not applied to TBoMS. The DMRS pattern is really impacting the UE implementation complexity, e.g., supporting repetition type B or not. The proposal can be updated.***The following 2 options for time domain resource determination for TBoMS are considered for down-selection during RAN1 #105-e:**** ***Option 1: Time domain resource determination for TBoMS can be performed only via PUSCH repetition Type A like TDRA.***
* ***Option 2: Time domain resource determination for TBoMS can be performed via PUSCH repetition Type A like TDRA or via PUSCH repetition Type B like TDRA.***
	+ ***The use of PUSCH repetition Type B like TDRA for time domain resource determination is according to an additional UE capability for a TBoMS capable UE.***
	+ ***FFS DMRS pattern for PUSCH repetition Type B like TDRA***

**Note: For *PUSCH repetition Type A like TDRA And PUSCH repetition Type B like TDRA, the following definitions apply:**** + ***PUSCH repetition type A like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission is the same.**
		- **The allocated symbols per slot are consecutive.**
	+ ***PUSCH repetition type B like TDRA*:**
		- **The number of allocated symbols in each slot allocated for TBoMS transmission can be different.**
		- **Allocated symbols per slot can be consecutive ~~or non-consecutive~~.**
 |
|  |  |

#### 2.1.1.2 Second round of discussions

**FL’ comments on April 24th**

Thanks a lot for your comments. Proposal 1-v3 is supported by a large majority of companies. From FL’s perspective, received comments can be accepted since they do not change the structure of the proposal, and given that understanding is the same across companies. Keeping micro-optimizing the phrasing is not necessary. I think Ericsson’s comment can address the concern expressed by Apple as well. The FFS on the DM-RS could be a bit redundant in my view, but since it is an FFS I suggest keeping it and moving forward. We need to discuss down-selection as soon as possible.

For these reasons, I will assume the following proposal is ok with everyone and start the discussion on down-selection right after the proposal. I will also copy the proposal in the email thread for simplicity.

***FL proposal 1-v4***

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

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

**Note: For *PUSCH repetition Type A like TDRA And PUSCH repetition Type B like TDRA, the following definitions apply:***

* + ***PUSCH repetition type A like TDRA*:**
		- **The number of allocated symbols in each slot ~~allocated~~ for TBoMS transmission is the same.**
		- **~~The allocated symbols per slot are consecutive.~~**
	+ ***PUSCH repetition type B like TDRA*:**
		- **The number of allocated symbols in each slot ~~allocated~~ for TBoMS transmission can be different.**
		- **~~Allocated symbols per slot can be consecutive or non-consecutive.~~**

Please note that the repetition of the word “allocated” in the Note has been removed for both bullets. This does not change the meaning of the sentence (I guess we can all agree on that) and may avoid comments to modify the text during GTW.

My intention is to avoid commenting on this proposal online, since it may not be a very wise use of our time.

For completeness, I am adding a table to report **very important concerns with the current formulation of FL proposal 1-v4**, if any. Do not add comments if you can live with it. Hopefully the table will still by empty by the time the GTW begins.

|  |  |
| --- | --- |
| Company name | Comment |
|  |  |
|  |  |

**Down-selection process**

I would now like to start discussion on down-selection. I am adding two tables: the first one is for adding your name aside your preferred option, the other is to add comments, if any. Concerning, the first table, I would like to add a couple of remarks:

* From FL’s perspective, I cannot be sure we’ll achieve consensus on either one of two options. I would certainly hope we can, but I prefer considering all the possibilities for the time being. In this context, I would like to ask everyone to be constructive. If a very large majority gathers around one of the two options, we should be able to accept the situation and move forward for the sake of progress. I think we all agree that this discussion can unblock several other discussions we must have as soon as possible. We should strive to down-select one the two options by the end of RAN1 #105-e, to ensure we can start focusing on other aspects in RAN1 #106-e. Please consider this aspect very carefully. We need to be able to design at least a baseline feature that can work. Time is a precious resource to achieve this goal. I invite everyone to understand that we must ensure we bring the AI to a constructive end.
* Given the above, I would kindly suggest not to signal 1st preference and 2nd preference for this round. Just pick one option. We need to understand where the majority is. We can start fine tuning the selection if the situation is 50%-50% (or similar).

|  |  |
| --- | --- |
| Preference | Company name |
| **Option 1** |  |
| **Option 2** |  |

If you want to add further comments to explain your position, you can use the table below. However, I would ask you to use it only to discuss technically about your position (e.g., implementation impact, specification impact, relevance of the use case and so on). Indeed, your name would have already been added above, hence adding comments like “We support Option1/Option2” would not bring any informative content and only interrupt possible technical discussions going on between other companies. Let’s preserve efficiency of the communication. Thank you.

|  |  |
| --- | --- |
| Company name | Comment |
|  |  |
|  |  |

### 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.

|  |  |
| --- | --- |
| Company | Comments |
| Intel | We are fine with the working assumption. |
| QC  | Support. We are okay to drop the second FFS (since it was attributed to our tdoc). |
| Sharp | We support FL proposal. |
| TCL | Support. |
| Samsung  | To clarify, by saying “**one slot or multiple consecutive physical slots**”, it is still for further down selection on only one slot and could be multiple slots, or it means it already includes both cases, which eventually means TOT will include multiple slots? |
| ZTE | We are fine with the working assumption in general. We suggest deleting the first FFS point, otherwise a TOT could still be consecutive or non-consecutive, i.e., no fundamental difference compared to the original WA. We’d also like to offer another direction for definition of TOT: Define one ‘nominal’ TOT for a single TBoMS without repetition. This single ‘nominal’ TOT contains multiple **consecutive** physical slots for UL transmission for both TDD and FDD. But for TDD, it can split into multiple ‘actual’ TOT, and for each actual TOT it also contains one or more **consecutive** physical slots for UL transmission. This is similar as the definition specified for PUSCH repetition type B. That is, if I understand correctly, the TOT proposed in the WA is an ‘actual’ TOT defined by this way. With such assumption, we think Option 1 is sufficient for a single TBoMS without repetition, if the one TOT in Option 1 is a ‘nominal’ TOT. |
| Xiaomi | We are fine with the working assumption. |
| NTT DOCOMO | Support the working assumption. |
| CATT | We can support the proposal. To clarify, we think ‘multiple consecutive physical slots for UL transmission’ is the basic logic. However, due to some reason (e.g. TDD structure that cannot find consecutive physical slots for UL transmission), there may be only 1 slot left to constitute a TOT, so it will be hard to preclude the case of 1 slot. |
| Apple | We are fine with this working assumption |
| vivo | Support the proposal |
| China Telecom | This issue is relevant to section 2.1.3. We have agreed “Non-consecutive physical slots for UL transmission can be used to transmit TBoMS at least for unpaired spectrum.” We are not sure if option 3 and 4 are deemed as repetition of TBoMS, and the first bullet of this proposal is not finally agreed, whether it is aligned with the agreement. Our proposal is :* **A transmission occasion for TBoMS (TOT) is constituted of one slot or multiple consecutive or non-consecutive physical slots for UL transmissions for unpaired spectrum.**
* **A transmission occasion for TBoMS (TOT) is constituted at least of one slot or multiple consecutive physical slots for UL transmission for paired spectrum.**
	+ **FFS: whether a TOT can also be constituted of non-consecutive slots for UL transmissions**
 |
| Panasonic | Although we are fine with the working assumption, we think the first FFS point should be concluded before discussing Section 2.1.3, since the design of single TBoMS structure (e.g., whether only one or multiple TOTs is determined for a single TBoMS) would depend on whether TOT is constituted with non-consecutive slots or not. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Support. 2nd FFS seems not required.  |
| MediaTek | Are all symbols within ToT consecutive as well?Are both one and multiple slots are supported or for further down-selection? |
| Spreadtrum | We support FL proposal. |
| Fujitsu | We support the main bullet. The difference between the main bullet and the second FFS is not clear for us. |
| LG | We are ok with the proposal. |
| CMCC | Fine with the proposal.We share the similar view that the TOT could be single or multiple consecutive uplink slots. And the non-consecutive though is very common in the TDD system, it could make the discussion more complicated. Then we are fine to put the non-consecutive slots in the FFS.And whether there is a need to explicit specify TOT could be for further discussion. |
| Huawei/HiSilicon | General support the working assumption.2nd FFS is reasonable, because the starting and ending symbol of TBoMS would be at the middle of the slot no matter the time domain resource determination for TBoMS is performed via Type A like TDRA or via Type B like TDRA, it is not reasonable to constrict TOT is always constituted of one slot or multiple consecutive physical slots. Considering this reason, we think following wording is better:**Working assumption****A transmission occasion for TBoMS (TOT) is constituted of ~~at least of one slot or multiple consecutive physical slots for UL transmission~~ a set of continuous uplink time domain resources spanning one or more slots.*** **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.** |
| Lenovo, Motorola Mobility | We support the FL proposal and okay to remove the second FFS |
| WILUS | We are generally fine with the WA. However, we are not clear with the 2nd sub-bullet. Is there any difference between “consecutive physical slots for UL transmission” in the main-bullet and “continuous uplink time domain resources” in the 2nd sub-bullet? |
| OPPO | We are fine with the proposal. |
| Nokia/NSB | We support the proposed WA from the FL. |
| Sierra Wireless | We are fine with the FL’s proposal |
| Ericsson | **While we would like to be supportive of the proposal to help progress, we are concerned that it may degrade performance. We would suggest further evaluations rather than concluding on this aspect at this time.**The proposal may not be consistent with TBoMS Option 1 for TDD, since then there would be multiple TOTs in a TBoMS if the TBoMS spans downlink slots. Such a case could lead to repetition of a single RV or RV cycling rather than a single RV split among multiple slots. As we show in R1-2105653, RV cycling can perform notably worse (on the order of a dB) than a single RV split among the slots of a TBoMS, e.g. in reasonable MCS for coverage scenarios or when the number of slots for a TBoMS exceeds the number of RVs.When we do settle down toward a TOT definition, we would also suggest adding "TOTs for different purposes can be defined separately." A TOT can be used for rate matching, power control, UCI multiplexing, and one TOT definition may not be suitable for all purposes. |

**FL’ comments on April 21st**

Situation for this discussion is complex. Suggested alternative proposals do not seem to take any step forward w.r.t. the current agreed working assumption. From FL’ perspective, it is clear that to progress in this discussion:

* Some of the FFS points need to be dropped;
* A decision on whether a TOT is constituted of consecutive or non-consecutive slots/time domain resources must be taken.

If we do not take these two steps, then it is pointless to keep updating the working assumption. However, according to some comments made by companies during the first round, this may hinder further discussion on the structure of a single TBoMS (i.e., with no repetitions of the TBoMS, which may eventually be supported or not). Additionally, if the definition of TOT is not clarified than discussions on rate-matching may also be hard to carry out.

Again, this is a typical chicken and egg problem which we cannot keep facing at every meeting. At least if we aim at completing at least a basic design of the feature.

Please note that is really **a paradox**. The concept of TOT should be used to simplify our discussions, if it is not useful, then we should just drop it and focus only on slots. It must not become an obstacle to progress. If it does, then we drop it to never resume it again in the WI. I hope this is clear to everyone.

For this reason, I would like to submit two questions to all companies, before I propose further modifications (if any) to the working assumption. The goal of these questions is to understand how we want to move from here on.

**Q1-2.1.2**

**Do you think the concept of TOT should be kept or should slot be the only “time unit” used for TBoMS?**

|  |  |
| --- | --- |
| Company | Comments |
| Sharp | We prefer to keep TOT for discussion. First, a TOT is a transmission occasion. Therefore, if we don’t find any motivation to change from Rel-16, we should keep the functionality of the transmission occasion in Rel-16 repetition type A. That is, the transmission occasion should be a unit of encoding (including rate-matching), channel generation and OFDM signal generation. Specifically, once a transport block is delivered to the encoding unit, the encoding unit generates the sequence of bits from the transport block to map in the TOT, a PUSCH is generated by the sequence of bits, and the OFDM signal is generated by the PUSCH. In that sense, we prefer one TOT comprised of one or more consecutive physical slots. |
| Nokia/NSB | Given all the efforts that the group have spent to formulate the four options which related to the definition of TOT, we still think the concept of TOT can be kept. Otherwise the four options are useless. However, we prefer to define a TOT as consecutive UL symbols per slot. |
| Sierra Wireless | As the FL stated, the concept of a TOT is intended to simplify the later discussion points. At this stage in the discussions, it is clear that this goal has not been achieved and the TOT has only led to further confusion and division among stakeholders. Discussion in terms of slots should be less ambiguous and may lead to more progress. Although equally controversial, instead, RAN1 should decide on the definition of a single TBoMS structure as having a single RV or multiple different RVs. For now all we need to agree on is that a TOT is a “time unit”. |
| Qualcomm | A TOT defined as spanning UL symbols in a slot works for us. TOT defined as spanning consecutive physical uplink slots works for us.There seems to be consensus in restricting a TOT to span only consecutive physical slots We could try to frame it around this principle. It may help us clarify the situation in the next section. |
| Lenovo, Motorola Mobility | We think that the concept of TOT should be kept. And defining TOT as spanning UL symbols in a slot or UL slots is fine for us. |
| vivo | Fine with both. |
| Samsung  | Fine with both. |
| Ericsson | While we think TOT’s can be further discussed, we agree with Sierra Wireless, that while it is indeed controversial, whether we have one or multiple RVs per TBoMS needs to be decided. Given the simulation results from multiple companies that show single RV performs notably better, and since TBoMS itself does not often have gain in our understanding, we should address the number of RVs per TBoMS with high priority.  |
| Panasonic | We prefer to keep the concept of TOT and to define a TOT as one or more consecutive physical slots. |
| NTT DOCOMO | We believe that the concept of TOT should be kept for the sake of discussions. |
| ZTE | Fine with both.  |
| Intel | It depends on the discussion and which options will be decided for basic framework of TBoMS. If option 1 or 2 is agreed, we do not think concept of TOT is necessary. We can simply use TBoMS for discussion.For the time being, we are fine to keep this concept for discussion. We can further discuss whether this is needed.  |
| InterDigital | The concept of TOT should be kept. It is important to clarify mapping between RV and transmission occasion. For example, for Option 3, there could be difference in interpretation of single RV and multiple TOTs : each TOT contains the same RV or different parts of RV are mapped to multiple TOTs. Thus, the definition of TOT and how an RV can be mapped to TOTs (e.g., for option 3) is needed. In addition, we agree with others that options for unit of TOT should include symbols. |
| LG | We think the concept of TOT is necessary. In our understanding, transmission occasion for PUSCH is used as the unit of transport block processing for UL-SCH. Thus, TOT should be defined as the unit of rate-matching for TBoMS. |
| Huawei, Hisilicon | The ToT is for discussion on the time unit of rate matching redundancy versions. For the time being no decision is made on the two aspects, from this point of view we think that the concept could be kept for discussion, and decided later whether it is used.  |
| Fujitsu | Fine with both. |
| Apple | We prefer to keep the TOT, we spent lots of time to discuss the TOT and four options are based on TOT. To go back to the starting point is really unfortunate. |
| WILUS | Fine with both. |
| TCL | Fine with both.  |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Fine with both. |
| CATT | Fine with both. |
| Xiaomi | Fine with both. |

**Q2-2.1.2**

**If your answer to Q1-2.1.2 is that TOT concept should be kept, FL’s understanding is that it should be the only unit of time used to discuss about single TBoMS structure. In this context:**

* **Should the concept of TOT be fully clarified before discussing the single TBoMS structure?**
* **Should the single TBoMS structure be fully defined before fully clarifying the concept of TOT?**

**Note: aspects of the clarification of the concept of the TOT pertain the FFS points and deciding if a TOT is composed of consecutive or non-consecutive slots/time domain resources.**

|  |  |
| --- | --- |
| Company | Comments |
| Sharp | As commented above, the concept of TOT should be clarified. |
| Nokia/NSB | The concept of TOT should be fully clarified before discussing the single TBoMS structure. With different understandings of TOT, there could be different understandings for each Option of single TBoMS. |
| Sierra Wireless | As commented above, no we would like to discuss the single TBoMS structure without agreeing to TOT other than a TOT being a “time unit” |
| Qualcomm | We think its good to have some basic understanding of TOT. Even if we don’t come with an air-tight definition, if it can at least let companies imagine its shape/span that will be helpful. |
| Lenovo, Motorola Mobility | In our view, it makes sense to fully clarify and align everyone’s understanding on the concept of TOT |
| vivo | Prefer clarification of TOT before discussing TBoMS structure. Suggest to support the ToT composed of consecutive slots. And TBoMS over non-consecutive slots can also be supported if the multiple TOTs can be non-consecutive. Companies preference on TBoMS channel structure seems to be covered by option 3 and option 4 together with certain RV mapping method, even if ToT is only composed of consecutive slots. |
| Samsung  | Ideally, it might be clarified as what has been asked from FL suggested question. However, we are afraid that the preference/understanding on the TOT is very related to the actual operations, e.g., these options for RM and interleaving. So the practical way might be discuss them both and hopeful we can make a discussion a certain level and proceed step by step. |
| Ericsson | We think the discussions of TOT may be helpful, but not so essential, as discussed above. Again, in our view there are anyway multiple aspects to a TOT beyond RVs and rate matching, such as power control and/or UCI multiplexing. |
| Panasonic | We think the concept of TOT should be concluded before discussing the single TBoMS structure since the design of single TBoMS structure would depend on whether TOT is constituted with non-consecutive slots or not. |
| NTT DOCOMO | As TOT was introduced to facilitate the discussion of TBoMS, it is reasonable to define TOT first before defining the discussing the single TBoMS structure.  |
| ZTE | We are fine to first clarify the concept of TOT if possible. On the other hand, as Samsung commented, the preference/understanding on the TOT is very related to the actual operations. If we can fully clarify the concept of TOT, it would most possibly automatically mean we have determined the single TBoMS structure. In this sense, we would be also fine to directly summarize companies’ view on single TBoMS structure into different options by using slot unit. Or, we can even proceed by both ways in parallel.  |
| Intel | We are also fine to clarify the concept of TOT to align understanding among companies. The original proposal is a good starting point. We also think it is good to consider one TOT with one or more consecutive physical slots to simplify the design.  |
| InterDigital | We have the same opinion as Sharp and Nokia. We should clarify the concept of TOT to prevent misunderstandings in the future. |
| LG | It seems better to define TOT as the unit of rate-matching for TBoMS. |
| Huawei, Hisilicon | It is better to clarify the concept of ToT first for the discussion of the structure of the TBoMS. But if the concept of the ToT cannot be converged. We may proceed with slot concept for the definition of the TBoMS. |
| Fujitsu | It is needed to have a clear definition of TOT as far as it is used for the discussion. |
| Apple | Maybe we can combine the TOT discussions with TBoMS schemes, i.e., four options. For example, for option1 and option 2, one TOT could be one or more consecutive slots. For option 3 and option 4, one TOT includes more than one slots including non-consecutive slots. |
| WILUS | A TOT was introduced to assist the discussion on TBoMS in RAN1#104-e. Therefore, clarifying the concept of TOT may help discussing the single TBoMS structure. However, it is also fine to discuss by using slot unit unless clarification of TOT is made as ZTE commented. |
| TCL | Share the same view as Samsung. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | TOT definition may first be clarified to further aid defining rate matching etc.  |
| CATT | Prefer to have clear clarification of TOT first. But in the worst case, if definition of TOT is got into gridlock, maybe we can discuss other aspects first, or have parallel discussion. |
| Mediatek | We think that full clarification on TOT should be the priority. Once we have the understanding of TOT and the TDRA including how to use s slots within the TOT, then defining TBOMS structure should become straight forward. |
| Xiaomi` | We share the same view with many companies that TOT definition may be clarified first. |

#### 2.1.2.2 Second round of discussions

**FL’ comments on April 24th**

Thank you for all your comments. The purpose of my question was indeed to check if all companies have the same understanding of the role I envisioned for the TOT in this discussion. As I explained earlier, the TOT was introduced to simplify the discussion. If it becomes a complication then we drop it, regardless of the efforts we all put in this discussion. Your comments tell me that some misunderstanding exists in this sense, hence I will try clarifying the situation in a more straightforward way:

1. The concept of TOT has been introduced to be a **time unit** which may or may not different from **one slot**, given the multi-slot nature of the TBoMS.This could be useful when discussion aspects such as rate-matching, collision handling and, ultimately, bit-to-RE mapping to have more options to pick from, if applicable. We needed a name for this concept, and I provided it. **There is nothing more to it for the time being**.
2. The concept of TOT has **not** been introduced to be specified. It may be specified or not, and the decision will be taken based on whether it is needed or not. Let’s not make it a blocking factor for our discussion. It does not make any sense, especially in a slot-based architecture like NR, where ultimately, we will have to adopt the slot logic to formulate most of the concepts. Again, it aims at being a useful concept to discuss.
3. Agreeing on a TOT being composed of consecutive or non-consecutive slots is **irrelevant** for TBoMS, given that we have not agreed to specify the concept of TOT. The reason is very simple:
	1. If we agree that TOT is composed of consecutive slots, then certain decisions will be taken on the structure of single TBoMS.
	2. If we agree that TOT is composed of non-consecutive slots, then other decisions will be taken on the structure of single TBoMS.

However, would this really change how the signal will look like, and how implementation will work? Not at all. What will impact the signal, and the implementation, will depend on how rate-matching, power control, collision handling (and others) are performed. Those are the important decisions and indeed if TOT is composed of consecutive or non-consecutive slots will simply determine how certain decisions will be taken, but **not the impact those decisions will have on the signal structure and implementation**.

In other words, the definition of TOT may determine whether Option 1 or Option 3 is considered for single RV TBoMS, and whether Option 2 or Option 4 is considered for multi RV TBoMS. However, will the choice of these options affect how the signal will look like? Absolutely not! **This will depend on rate-matching, power control, bit-to-RE mapping and so on**. What we are trying to do to begin with, is to identify a reference model we can use to take all other decisions. Those decisions can be taken completely independently of the TOT, since if the TOT becomes a useless concept after those decisions are taken, we simply drop it. It is as simple as that. I hope this is clear.

To clarify situation even further, let me quickly talk about the proposal I made in Section 2.1.4, on rate-matching. That proposal was indeed listing three options to consider for rate matching: per slot, per TOT, continuously across slots. The rationale therein was exactly the same. The TOT is just a time unit, nothing more. Eventually it may be dropped if it is unnecessary!

Finally, I will provide more concrete examples of the impact of different decisions on the TOT on the structure of the single TBoMS:

1. Assume a TOT composed of consecutive slots. Since we need to support non-consecutive slots at least for unpaired spectrum, this implies that only Option 3 and Option 4 can be considered. However:
	1. Does this mean rate matching cannot be done continuously across slots in Option 3? **NO**.
	2. Does this mean rate matching cannot be done per slot in Option 3? **NO**.
	3. Does this mean rate matching cannot be done per group of consecutive slots in Option 3, if any? **NO**.

 Indeed, all possibilities would still be open for Options 3. What about Option 4?

1. Does this mean rate matching cannot be done per slot in Option 4? **NO**.
2. Does this mean rate matching cannot be done per group of consecutive slots in Option 4, if any? **NO**.

 Similar logic applies to other aspects like power control and so on.

1. Assume now a TOT composed of non-consecutive slots. In that case, this implies that potentially all options can be considered. However, for the sake of the argument let us consider only Option 1 and Option 2, for completeness. In this case:
	1. Does this mean rate matching cannot be done continuously across slots in Option 1? **NO**.
	2. Does this mean rate matching cannot be done per slot in Option 1? **NO**.
	3. Does this mean rate matching cannot be done per group of consecutive slots in Option 1, if any? **NO**.

 Indeed, all possibilities would still be open for Options 1. What about Option 2?

1. Does this mean rate matching cannot be done per slot in Option 2? **NO**.
2. Does this mean rate matching cannot be done per group of consecutive slots in Option 2? **NO**.

 Similar logic applies to other aspects like power control and so on.

Given all the above, I do think we should just pick one direction, choose the single TBoMS structure supported by majority and then discuss about all the aspects that indeed matter **for signal structure and implementation impact**. As I said above, regardless of which option we pick, and which definition we pick, we only need a reference model to take all other decisions. We cannot keep debating about the reference model, if its impact on the actual final signal design and implementation is null.

The Working assumption is then rewritten as follows, where the direction of defining a TOT as constituted at least of multiple consecutive physical slots for UL transmission is taken for simplicity (it is arguably a bit more intuitive also to picture it in one’s mind). Of course, proposals in Section 2.1.3 will be drafted accordingly (following the logic above). Furthermore, it is worth observing that a an FFS point has been added to explicitly capture that agreeing on this definition of TOT does not preclude any direction for all the TBoMS aspects which RAN1 still has to design. This may be considered redundant to some extent but I prefer adding it for the sake of completeness, to ensure no misunderstanding exists.

**Working assumption**

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

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

Companies can input their views in the table below. **Constructive attitude in this regard is highly recommended**.

I hope you can agree on the fact that how the TOT is defined is only useful to have a reference model, which may or may not become relevant for the design of other aspects.

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

### 2.1.3 [OPEN] Single TBoMS structure

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:

|  |  |  |  |
| --- | --- | --- | --- |
| 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] |  |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks |  | IITH, IITM, CEWIT, Reliance Jio, Tejas Networks |  |
| LG |  |  | LG |
| Ericsson |  |  |  |

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.

|  |  |
| --- | --- |
| Company | Comments |
| InterDigital | We support the FL’s proposal |
| Intel | We are not sure whether Option 3 would cover Option 1. Option 1 indicates only TOT is included in a TBoMS while Option 3 has multiple TOTs. We also share similar view as other companies that if repetition is supported, Option 3 or Option 4 can be considered. We suggest to discuss these two issues jointly.  |
| Qualcomm | Suggest discussing this a little bit more before downselecting to these two options.I would like to know if the repetition framework (not including the RV cycling aspect) is planned to be reused to support multiple TOTs. If not, I am afraid that depending on our choice of TOT, it could lead to a large specification overhead.I suspect that viewing Options 3 or 4 as a single TOT with repetitions may find majority support. The single TOT acts as a base TDRA unit that’s repeated K times.If possible, can we try to find consensus around something like this? (I know that you have Section 2.3.3 to discuss this, so sorry for jumping the gun on this).**Proposal:** Option 3 is interpreted to be Option 1 with repetitions and Option 4 is interpreted to be Option 2 with repetitions. If not, might be good to know what other companies have in mind for the multiple TOT scenarios. |
| Sharp | We would like to clarify that the single TBoMS is composed of time resources indicated by repetition type A or type B like signalling. We support FL proposal if the intention is to partition the time resources indicated by the signalling into one or multiple TOTs. |
| Samsung  | Although the FL’s proposal looks fine. But we do have concerns on how possibly company could understand the connections between options. It is just one understanding that Option 3 is option 1 with “repetitions”, whether called it repetition is debatable, since if single RV is used, we thought it should continuous RM, rather than start from 0 over and over again.  |
| ZTE | We are also not sure whether the ‘multiple TOTs’ include the case of one TOT. For FDD, there could be only one TOT for TBoMS. With the assumption proposed in section 2.1.2.1. If we take one TOT as one nominal TOT, it seems clearer that Option 1/2 is for single TBoMS without repetition and Option 3/4 is for repetition case.  |
| NTT DOCOMO | Support the proposal. As the systematic bits in circular buffer should not be missed, a single RV for a single TBoMS is preferred when TBS is calculated based on multiple slots. Also, since the repetition of Option 3 TBoMS can turn out to be Option 4, the starting point should be Option 3. |
| CATT | If different RVs is adopted, we think using Option 4 to cover Option 2 is fair, since there seems less interest to use RV cycling within a TOT. But for the case of single RV, we feel that Option 1 and Option 3 cannot cover each other. |
| Apple | We are fine with FL’s proposal.I assume the discussion is based on agreed four options. So current definition of Option 3 is not relevant to repetition, how it can be considered as Option 1 with repetition? The difference between option 1 and option 3 is the TOT length and supporting one or multiple TOT. if we can agree on new working assumption on TOT in section 2.1.2 (**A transmission occasion for TBoMS (TOT) is constituted at least of one slot or multiple consecutive physical slots for UL transmission**), then it ‘s natural to consider option 3 and option 4, due to option 1 and option 2 have only one TOT, it could not support non-consecutive UL transmission without repetition |
| vivo | We are also not sure companies have the same understandings on these options. Option 3 is acceptable to us if the RV is refreshed across the TOTs for TBoMS, i.e., mapping from the starting bit of the single RV repeatedly. Current option 4 is preferable to us if it is considered together with the proposed working assumption above. The fundamental difference is how the RV is rate matched for these cases. If consensus can not be reached, we are fine to keep both options, e.g. based on UE capability. |
| China Telecom | It seems companies have different understanding of option 3 and option 4. Maybe we need to align the understanding first. In our understanding, option 4 can be deemed as repetition on top of TBoMS, which is a separate issue. We need to make down selection on the other 3 options. |
| Panasonic | In our view, the design which has majority support seems- Single TOT is determined for a TBoMS and repetition of TBoMS is supported, or- Multiple TOTs are determined for a TBoMS and TB is transmitted in a TOT using a single RV, RV is cycled across different TOTs.We agree with Qualcomm that single TOT acts as a basic TDRA unit. To have multiple TOT can be seen as repetition. Therefore, we support Qualcomm’s proposal on the interpretation of Option 3 or Option 4. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Firstly, I added our names to capture support for Option 1 and 3. Further, we have similar comments as Samsung.  |
| MediaTek | This could be discussed later after the agreement of general framework and TOT definition. Alternatively，the key question could be：whether to have rate matching on the consecutive sources (within one slot or across multiple slots) or non-consecutive resources (within one slot or across multiple slots).  |
| Fujitsu | In our view, the 1st FFS point of the working assumption in section 2.1.4 should be discussed first. If it can be agreed without “FFS”, then option 1 is covered by option 3. Otherwise, there will be different understanding on the relation between option 1 and option 3.  |
| LG | We prefer to apply different RVs in the unit of rate-matching. In this perspective, we support Option 1 with repetitions or Option 4 where RV value is cycled per TOT.We added our name in the above table. |
| CMCC | We are generally fine with the proposal. As we discussed in the paper, the option 1 and 3 are similar. And the option 2 and 4 have some similarities. For the proposal, the mapping between TOT and RVs needs more discussion or clarification to make progress. Since in the option 3, it could be interpreted that all the TOT using a single RV in total, or each TOT could have the same RV or its own RV with same RV id.  |
| Huawei/Hisilicon | From our understanding, whether repetition is supported or not is determined by the overall coding rate of the transmission for that, if the TB size is calculated based on all the resources in for the transmission, then repetition is not supported because no lower coding rate is achieved compared with the MCS table, regardless single or multiple RV are used. So these options may not be interpreted to each other.  |
| Lenovo, Motorola Mobility | We are not fine with the proposal. Option 1 and option 3 cannot be consider as similar options. Therefore, we suggest keeping option 1.Following possible compromise could be considered for combining option 1 and option 3:**Option X: If a design based on single RV is adopted, then one TOT is determined for a TBoMS:****FFS if multiple ToTs can also be determined for a TBoMS** |
| WILUS | We support the FL’s proposal. In our understanding, it is more related with the rate-matching issue in section 2.1.4. Thus, even a single TBoMS over multiple TOTs can be continuously rate-matched with single RV. In this case, a TOT would not be interpreted as a unit for repetition. |
| OPPO | Not sure if the Option 3 or Option 4 include TOT definition.If this is to further clarify the possible ways of rate matching, change:Option 3 -> The TB is transmitted on the slots using a single RV, FFS: how the single RV is rate matched across slots,Option 4 -> Whether and how RV index is refreshed within one TOT. |
| Nokia/NSB | We support the FL’s proposal. |
| Sierra Wireless | We support the FL’s proposal but would like to see some clarification in the proposal on what a “Single TBoMS” is defined as otherwise there might be different interpretations (e.g. “as defined by a single TDRA”). |
| Ericsson | **We can support Option 1, and have added our view to the Table.** **While we would like to be supportive of the FL proposal, we are not at this stage.** We are concerned about performance, and suggest to proceed instead by deciding if there is one RV with different coded bits per slots of a TBoMS vs. multiple RVs TBoMS.We are open to considering Option 3, if the performance can be OK. For example, we expect that repeating an RV in all slots of a TBoMS would perform worse than Option 1 where slots of a TBoMS contain different bits of a single RV, and so we wouldn’t be supportive of Option 3 in that case.Moreover, for us the main decision point is performance. If we can decide on if there is a significant performance difference for a single RV per TBoMS vs. multiple RVs per TBoMs, we might make better progress. If we find no significant performance gain from an alternative, then we can focus on complexity; whereas if performance is impacted we may need to go with the more complex approach for the UE. |
|  |  |

**FL’ comments on April 21st**

Thank you all for the comments. Unfortunately, the situation is complicated by different understandings companies seem to have on terminology and understandings of different options and implications of definition of TOT.

First of all, while I certainly appreciate all efforts companies made on testing performance of different options, I am afraid that discussing about performance differences is very hard, and possibly not so useful. I do not like stating this, of course, but reality is that we do not have a common set of assumptions and use cases to test different options for TBoMS. In this context, different companies test different configurations, hence results are not comparable as such. Indeed, some may even claim that the relevance and validity of the scenario tested by a given company is debatable, which would make the whole discussion about opinions and not facts anymore, i.e., unmanageable. Therefore, from FL’s perspective we should strive not take decisions based on performance, although FL agrees that this would be a sensible course of action in absolute terms, if the same assumptions and use cases were considered by all companies (which is not the case).

Now, Qualcomm proposed to clarify interpretations on the role of PUSCH repetitions on the differentiation between Option 3 and Option 1 for the single RV case, and between Option 4 and Options 2 for the multi RV case. While I acknowledge that this could be a good idea in principle (regardless or how I originally structured this document) I am afraid that this may not fully solve the problem, unless we agree on some preliminary concepts to simplify the discussion.

To this end, and similarly to what has been done for Section 2.1.2, I would like to ask a couple of questions to companies before proceeding. The goal of these questions is to simplify further discussion on single TBoMS structure and rate-matching (hopefully).

**Q1-2.1.3**

**The implications of the adoption of single RV for TBoMS are unclear due to ambiguity of the terminology for some companies. We need to define what single RV implies. According to 38.212, Table 5.4.2.1-2, it is quite clear that if current R16 specification is considered, then single RV implies that the size of the output bit sequence after rate matching (i.e., E) is smaller than or equal to the total number of coded bits available for transmission of the transport block (G) for a given transmission. Therefore, if we do not modify how current R16 specification works, then rate-matching for single RV TBoMS can only be continuous over the resource allocated for the given transmission. In other words, one TOT in Option 1 and all the TOTs in Option 3. Do you agree with this? If not, please provide and explain alternative interpretation in detail.**

|  |  |
| --- | --- |
| Company | Comments |
| Sharp | We are not sure how the above works. Specifically, for Option 3 with multiple TOTs, how to perform bit selection procedure? The point should be that the starting position k0 for bit selection procedure should be appropriately selected for each TOT to enable contentious mapping with single RV.In our view, the single RV for TBoMS for **single code block transmission** implies that;E=G where G is the number of coded bits available for transmission of the transport block **in one TOT**. For Option 3 where multiple TOTs (index 0 to N-1) are provided, each TOT is indexed in ascending order in time domain. For nth TOT (n being within 0 to N-1), the starting position kn0 for bit selection procedure is determined by mod (k0+*delta*, N), N being the number of coded bits output from LDPC encoder. Here, k0 is the starting position of 0th TOT for bit selection procedure, which is determined by rvid as in Rel-16. The bit offset factor *delta* is determined such that the resulting coded bit mapping for TBoMS transmission is continuous or quasi-continuous.We believe that the above concept would make the specification impact smaller. Most of existing structure of encoding chain can be reused. |
| Nokia/NSB | The above explanation from the FL could be one option for single RV definition. However, this option may result in some potential complexity for interleaving and collision handling as pointed out by many companies in their contributions. Other alternatives exist for the definition of single RV in this context.Firstly, we would like to clarify that a “time unit” (e.g. a TOT, a slot, a set of consecutive symbols, etc) is only needed if we rate-match within the “time unit”. In this context, rate-matching means we take out a number of encoded bits from the circular buffer and map them to the resource within the “time unit”. Otherwise, we don’t even need to define any finer time unit within the total resource that allocated for TBoMS.Now, assuming that we agree to do rate-matching per a “time unit” (regardless of whatever it is, and can be discussed together with the definition of a TOT, e.g., rate-matching is done per TOT and then we can work out on what is the definition of a TOT), there could be two possibilities to understand “Single RV mapping”:* Alt. 1: The legacy RV index definition is kept (i.e., starting of RV index in the circular buffer doesn’t change), RV is refreshed across the “time units”. This option would mean that exactly the same encoded bits will be repeated per “time unit”.
* Alt. 2: The legacy RV index definition is not kept. The starting position for taking encoded bits out of the circular buffer and map to one “time unit” is right after the ending position for taking encoded bit out of the circular for the previous “time unit”. For the initial “time unit” within the time resource allocated for TBoMS, the starting bit position is the first bit in the circular buffer. This option would mean that the encoded bits in the circular buffer are taken out part by part, which are back-to-back (thus can be referred to as “single RV”), and each part is mapped to a “time unit”.

From the above two alternatives, it can be observed that Alt. 2 is more suitable for the definition of “single RV”. This is due to the fact that we may need to puncture a lot of systematic bits to fit the resource per one “time unit”, then repeating exactly the same only a portion of systematic bits as per Alt.1 is counterintuitive. Furthermore, this also shows why single RV with understanding as per Alt.2 is superior to multi RV case, where systematic bits may be punctured since E can be larger (or much larger) than G, as pointed out by several companies already. |
| Sierra Wireless | In general, agree with the FL understanding. This points to Nokia’s Alt2 definition above and to the concept that a TOT is just a “time unit”.  |
| Qualcomm | More aligned with Nokia’s Alt 2.A single RV in interpreted to only govern the start location of the coded bits used for TBoMS. This single RV can determine the coded bits transmitted over a single slot, a single TOT, or multiple TOTs.Once the start location is determined, rate matching can occur at different granularities as well --- per slot, single TOT or multiple TOT.Granularity of RV refreshing will of course have to be greater than or the same as the granularity over which rate matching is performed.We are viewing RV determination and rate matching as two separate issues/steps. 38.212 will likely be impacted, and we are open to changes here since this is a core aspect of TBoMS. |
| Lenovo, Motorola Mobility | Yes, we agree with FL’s explanation on the need for new definition for RV. And also, we agree with Nokia’s Alt 2 definition for RV |
| vivo | Agree that the clarification of single RV for option 1 and option 3 by FL, it can make these options clearer. RV refreshing is also reflected in other options anyway. |
| Samsung  | Alt.2 seems more aligned with our understanding for single RV, which is single RV based continuous RM. If it’s refreshed RM output based single RV determined starting point, it’s could be quite bad and has no benefits from coding gain. |
| Ericsson | Agree with the FL understanding. Nokia’s Alt 2 may preclude non-contiguous slots in a TOT, and therefore preclude Option 1, because multiple time units are required in their view that case. Moreover, whether a new RV definition is needed is not clear to us at this stage. |
| Panasonic | We agree with FL’s understanding and our interpretation of single RV is aligned to Nokia’s Alt.2. |
| NTT DOCOMO | We have the same understanding. When it comes to the RV refreshing point, we prefer Nokia’s Alt 2 approach. Since no refreshing point in one RV, bit selection in Alt2 can be seen as being performed per multiple slots. On the other hand, the bit interleaving should be performed per slot, due to UE capability.  |
| ZTE | Agree with Nokia’s Alt 2 definition for single RV for TBoMS. |
| Intel | We share similar view as Nokia, and there could be two interpretation of single RV. It highly depends on how rate-matching is performed across TOT or TBoMS. * Alt. 1: this can be viewed as single RV with repetition
* Alt. 2: this can be viewed as single RV with consecutive rate-matching.

We agree with Nokia’s Alt. 2., i.e. single RV with consecutive rate-matching to ensure the performance. Compared to Alt. 1, if the number of slots for TBoMS is relatively or if the code rate is relatively high, the resulting code rate in one slot or TOT can be very high. In some cases, the systematic bits cannot be fully transmitted, which indicates that the transmission in a TOT or one slot is not decodable. |
| InterDigital | Regarding the definition of “single RV”, we have the same understanding as Nokia’s Alt 2. For example, in Option 3, different parts of single RV are mapped to TOT(s). |
| Sharp2 | Our understanding is also similar with Nokia’s Alt.2. |
| LG | Under the assumption that TOT is the unit of rate-matching, we understand the difference between Option 1 and Option 3 is the unit of rate-matching (bit selection and scrambling). Rate-matching is performed based on the entire resource of the TBoMS in Option 1, whereas rate-matching is performed in the unit of TOT in Option 3. If the current specification for bit-selection is kept, since the same RV is applied for TOTs in a TBoMS, the same coded bits will be repeatedly transmitted for each TOT.  |
| Fujitsu | Our understanding is also aligned with Nokia’s Alt.2. |
| Apple | Agree with FL’s explanation on single RV. Option 1 and option 3 are more aligned with current RV determination.  |
| WILUS | We agree with FL’s understanding. Also, our understanding of single RV is aligned with Nokia’s Alt 2. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Our understanding is aligned with Nokia Alt-2, and Intel’s wording makes it simpler.  |
| CATT | Agree with FL and fine with Nokia’s Alt.2.  |
| Mediatek | In our understanding, single RV is the continuously rate matched bits to fit the resources defined over TBoMS. In this process, encoded TB is rate matched at the first slot of TBoMS where the bits are rate matched till the end of resources defined for TBoMS. The rate matched bits are selected in a continuous manner and insert in the resources defined for TBoMS. The output will be equivalent to the Nokia’s Alt-2. The resources shall include all the consecutive and non-consecutive resources. |
| Xiaomi | Agree with FL and fine with Nokia’s Alt.2. |

**Q2-2.1.3**

**Do you agree that PUSCH repetitions imply the use of multiple RV ids for the transmitting a TB over multiple transmissions?**

**Note: the multiple transmissions can be performed over multiple slots or multiple sets/groups of consecutive symbols, e.g., similarly to Type A/Type B PUSCH repetitions for the sake of the argument.**

|  |  |
| --- | --- |
| Company | Comments |
| Nokia/NSB | Agree |
| Sierra Wireless | The question and its purpose are not clear.  |
| Qualcomm | No, we are interpreting repetitions only in the TDRA sense: a sequence of time domain resources for TBoMS. It lets us reuse the existing TDRA tables with little to no changes. How often we refresh RVs is a separate debate and can be discussed separately.  |
| Lenovo, Motorola Mobility | No, we don’t agree that the usage of PUSCH repetitions for transmitting a TB over multiple transmissions imply the use of multiple RV IDs. This should be a separate discussion.  |
| vivo | Agree. Repetition can be support by supporting multiple RVs in a TOT, or RV refreshing across TOTs. |
| Samsung  | Although the statement in the question could be technically true, it confuses me what is the connection to the actual problem here. Since without repetition, we are still discussing the Mult-RV based operation for RM. Even with one complete TBoMS transmission, we are still discussing the TBoMS transmission repetition. |
| Ericsson | While complete repetitions of a TBoMS could benefit from multiple RVs if the code rate is sufficiently high, RV refreshing does seem a separate discussion to us as well.  |
| Panasonic | Agree. |
| NTT DOCOMO | This question is confusing to us. If it means the multiple RV ids are expected to be transmitted in repetitions of TBoMS, I agree with FL’s understanding. During the repetitions of TBoMS, it is not necessary to transmit the exact same encoded bits with the same bit selection starting points on each repetition. As regular repetition is performed, RV cycling can be applied between repetitions even in TBoMS.  |
| ZTE | Yes, otherwise it’s not clear to us why we define multiple repetitions for TBoMS instead of allocating more resources for one repetition.  |
| Intel | We think this depends on the configuration of RV sequence. In case when RV sequence {0, 0, 0, 0} is configured, this is single RV with repetition. For other cases, we agree it is multiple RV. |
| InterDigital | Agree. Although we agree that the intention of the question can be clarified, the intention may be to differentiate (Option 1/3) and (Option 2/4). |
| Sharp | Repetition is a unit of physical layer transmission. One UL grant within a bundled UL grant for a PUSCH repetitions triggers one repetition. We think that “repetition” doesn’t imply multiple RVs. Continuous coded bit mapping can be done by using repetition framework. |
| LG | We think PUSCH repetitions should be supported and performed using multiple RV ids, but the relationship between PUSCH repetitions and RV mapping seems separate discussion point. |
| Huawei, Hisilicon | We have different understanding as stated earlier. The repetition means lower coding rate. Whether it is repetition or not depends on the number of REs used for the TBs calculation. |
| Apple | Not fully understand the question. Does it mean the option 2 and option 4 are kind of repetition of TBoMS? If yes, we share the views of Qualcomm. |
| WILUS | If PUSCH repetitions imply the time domain resource determination, a single RV id can be mapped over multiple time domain resources for a single TBoMS transmission.If PUSCH repetitions imply the repetition of TBoMS, multiple RV ids can be mapped per repetition of TBoMS transmission. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | We prefer to not introduce any repetition or multiple RVs in this discussion to begin with. Our understanding is that : repetition is only indicating to either same RV being sent again across the time resources used for TBoMS or even different RVs being sent across the resources used in TBoMS. Hence, we prefer to avoid bringing this into the discussion.  |
| CATT | We think so. If a TBoMS will have only one RV, repetition of TBoMS means repeated TBoMS with different RV IDs. If one TBoMS will have more than one RV (e.g. due to multiple TOT and different TOT may have different RV), then repetition of TBoMS means repeated TBoMS with different ‘starting’ RV ID. |
| MediaTek | Some confusing on the questions. Does it mean RV cycling applies for the TOT level repetition or different segments within a TOT (if it consists of non-consecutive resources)?It would be nice to discuss whether TOT consists of consecutive or non-consecutive symbols at first. |
| Xiaomi  | We share the same view with LG. |

#### 2.1.3.1 Second round of discussions

**FL’ comments on April 24th**

Thank you for your answers. Situation for **Q1-2.1.3** seems clear. Majority of companies agree with FL’s understanding and are aligned with Nokia’s Alt. 2.

Situation for **Q2-2.1.3** is a bit more complicated. The purpose of my question was to understand whether different interpretations of the concept “PUSCH repetitions” exist in the room. I have to say most companies answered in the context of TBoMS, with comments on TOT and so on, whereas I was aiming at discussion plain PUSCH repetitions. My goal was to find a way to simplify our discussion since terminology is used differently by different companies. I tried to interpret the answers in view of this objective, since my idea was to add some statements on Option 1 vs. Option 3 and Option 2 vs. Option 4. Unfortunately, regardless of whether I use the TBoMS version of the comments, or the (interpreted) PUSCH repetitions version, there does not seem to be homogeneity in the views expressed by different companies. I think we can classify such views according to these two alternatives:

1. The concept of PUSCH repetitions is related to the time domain resource determination. It can be carried out by repeating the same resource allocation per slot over multiple slots as per existing TDRA tables, then it is a PUSCH repetition, regardless of how. The way RVs are refreshed does not concur to the definition of repetitions.
2. PUSCH repetitions are performed using multiple RVs.

In this context, I think it is safe to say that it does not seem possible to state concepts like:

* Option 3 is Option 1, with repetitions.
* Option 4 is Option 2, with repetitions.

Indeed, to do so one would need to assume specific time resource durations, specific rate-matching and RVs refreshing approaches, if applicable, in the two cases, and so on.

For this reason, I strongly recommend not to refer to any of the options as the “this other option with repetition on top”. Different companies clearly have different views on this. We need to find a way to achieve a global reference model which can give us a solid homogenous bulk over which we build the reaming parts of the feature. Referring to repetitions is not the way to go. Of course, it should be noted that this does not preclude discussions on repetitions in general, but rather ensures we all use the same words to refer to same concepts. I would like to invite everyone to respect this indication.

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Now, moving to the matter at hand in this section, I would like to build up my analysis in Section 2.1.2.2. Therein it is argued and proposed to agree on a working assumption according to which a TOT is constituted of multiple consecutive physical slots for UL transmission. I elaborated quite in detail about why this decision does not preclude any specific signal generation or does not impact implementation in a deterministic way. Indeed, impact in this regard will come from decisions on rate-matching, power control, bit-to-RE mapping and so on. I will not repeat all the arguments here. I will simply recall that the bottom line was that, once a definition of TOT is provided, and given that this concept is still useful as of today (and not a specification direction), having one or more TOT over which a TBoMS is transmitted does not matter at all. The way rate-matching, power control, bit-to-RE mapping are performed matters in this sense, and these discussions are yet to be had, given that we do not have a reference model to discuss about.

For this reason, I propose to agree as quickly as possible on the reference model, given all the arguments provided in Section 2.1.2, in a pragmatic way. In compliance with the proposal I made on the TOT in that section, I would then propose a reformulated version of FL proposal 2, as follows. Please note that the proposal now refers to “structure of TBoMS” instead of “single TBoMS structure” to ensure no implicit/explicit reference to repetitions is used, due to the possibly ambiguity this creates (and as also suggested by Sierra Wireless).

***FL proposal 2-v1. The structure of TBoMS 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: other details, e.g., rate-matching, TBS determination, collision handling.***

***Note: the concept of TOT as per Working assumption is used to define Option 3 and Option 4, and may or may not be used to design other details, e.g., rate-matching, TBS determination, collision handling and so on.***

Companies are invited to input their views in the table below. Please consider carefully what has been written in Section 2.1.2 before adding your views. At this stage, it is not about nominal preference but actual impact of one decision or another. I hope I managed to explain why going for one option or another can lead to the same signal general, and the real impact is given by rate-matching, power control, bit-to-RE mapping and so on. **In this context, stating that you prefer Option 1 instead of Option 3 (for instance), without providing an actual counter-example of why the structure by itself prohibits a specific rate-matching solution the be agreed on (for instance), would not be very helpful.** Please refrain from doing so.

**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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| --- | --- |
| Company | Comments |
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### 2.1.4 [PAUSED] 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 is~~f~~ 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.

|  |  |
| --- | --- |
| Company | Comments |
| InterDigital | We are ok with the FL’s proposal. Since option 2 is about TOT, an agreement in 2.1.2 (whether a TOT consists of consecutive slots or not) may be needed to make agreement here. |
| Intel | We are fine with the proposal.  |
| Qualcomm | Support. We prefer Option 1 as it seems to offer the only path to preserving several existing spec features (UCI multiplexing, etc). |
| Sharp | We support FL proposal. We agree with Qualcomm’s additional view. |
| TCL | The proposal is fine. |
| Samsung  | In first option, because there still could be the case that two sets of consecutives UL symbols in one slot are determined, does the first option include the possibility of this case? If not, we suggest to add following:Option 1-2: ***Rate-matching is performed per consecutive UL symbols in one slot;*** |
| ZTE | First, we’d like to clarify that is a correct understanding rate-matching is performed per X means RV is refreshed per X? If that is the case, we are fine with the proposal, and our preference is Option 2, and Option 3 (for single TBoMS case) . |
| Xiaomi | We are fine with the proposal. |
| NTT DOCOMO | Support the proposal |
| CATT | We are fine with the proposal. On ‘rate-matching is perform’ we have the same understanding with ZTE (if incorrect we hope to see some detail clarification).Samsung’s suggestion seems have a point. But since TBoMS is about TB over ‘multiple slots’, considering ‘slot’ as the minimum RV refreshing unit sounds fair… is it really beneficial to frequently refresh the RV, even within a slot? |
| Apple | We are fine with this proposal. |
| vivo | Similar question as ZTE. If per slot rate-matching means RV refreshing per slot, we are fine with Option 1, and option 2 if TOT is composed of consecutive slots. |
| Panasonic | We are fine with the proposal. Our preference is Option 1 as it provides following merit.- Easier support of non-consecutive physical slot including potential interaction between UL/DL direction- The handling of UCI multiplexing, the interaction of higher priority transmission, the reservation for SRS/PUCCH symbol in a slot are easier. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Support the proposal.  |
| MediaTek | It is unclear yet on the TOT definition on whether it supports the non-consecutive symbols. And we also share the similar view as Samsung.Similar to the early comments, the options could be as below: (decoupled with TOT definition since it is not agreed yet): Option 1: rate matching is performed on only one set of consecutive symbols for PUSCH transmission within a slot. Option 2: rate matching is performed on only one set of consecutive symbols for PUSCH transmission across multiple slotsOption 3: rate matching is performed on non-consecutive symbols for PUSCH transmission across multiple slots.  |
| Spreadtrum | We support FL proposal. |
| Fujitsu | We are fine with the proposal. |
| LG | We are fine with the proposal. |
| CMCC | Fine with the proposal |
| Huawei/Hisilicon | In the current specification, the rate matching section includes bit selection (i.e. redundancy version determination and coded bits selection, taking the redundancy version as a parameter) and interleaving. It seems that this proposal is related to the proposal 2. May need to clarify that the for the rate matching the starting bit position is determined by proposal 2 |
| Lenovo, Motorola Mobility | We support the FL proposal |
| WILUS | We support the FL’s proposal. |
| OPPO | OK with the proposal. We actually consider one TBoMS reuse most of the repetition configuration, we don’t mean TBoMS itself repeat multiple times. |
| Nokia/NSB | We support the FL’s proposal. |
| Sierra Wireless | We support FL proposal.  |
| Ericsson | Support the FL proposal.  |
|  |  |

**FL’ comments on April 21st**

Thank you all for the comments. This discussion is paused for the time being, until answers and clarifications on the role the TOT is supposed to have in this discussion are given in section 2.1.2 (at least).

## 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: $N\_{info}$ calculation
4. TBS determination: $N\_{oh}^{PRB}$ 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.

|  |  |
| --- | --- |
| Company | Comments |
| InterDigital | We support the FL’s proposal. |
| Intel | We are fine with the proposal in principle. We suggest to remove the last sentence. It is not clear to us the meaning of 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~~.*** |
| Sharp | We support FL proposal. |
| TCL | The proposal is fine. |
| Samsung  | It may not preclude, but our understanding is to target better using these symbols. If both repetition type A and B are supported, we think it may not be an issue. But if only repetition type A-like resource determination is supported, and with this agreement, it means the gnb could only schedule the min{symbols in special slot, symbols in normal ul slots} for the L? which we think it will quite limit the usage of UL symbols. We think it may need to discuss together with TDRA.  |
| ZTE | Support the proposal.  |
| Xiaomi | We share the same view with Samsung.  |
| NTT DOCOMO | Support the proposal. |
| CATT | OK. |
| Apple | We support this proposal. |
| Vivo | Support the proposal. |
| China Telecom | We share the same view with Samsung that how to handle special slots need to be discussed together with TDRA. In our understanding, either type B like TDRA or separate TDRA for special slots in addition to type A like TDRA should be supported. |
| Panasonic | We are fine with the proposal. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | Fine with proposal and support Intel’s modification. |
| MediaTek | Maybe this should be prioritized for discussion. Then we may decide type A like or type B like repetition. |
| Fujitsu | We support this proposal. |
| LG | Support the proposal.  |
| CMCC | Support Intel’s updates. |
| Huawei/HiSilicon | Support Intel’s updates. And suggest it to be discussed after proposal 1.  |
| Lenovo, Motorola Mobility | We support the FL proposal |
| WILUS | We support the FL’s proposal. |
| OPPO | We may further discuss this. Our understanding is the we need decide how the TDRA of repetition is supported. |
| Nokia/NSB | We support the FL’s proposal. |
| Sierra Wireless | Support proposal. |
| Ericsson | We do not support the proposal. As discussed in the joint channel estimation agenda point, we expect essentially no gain from the use of the special slot. Gains reported there were at most about 0.5 dB for a more reasonable baseline of 2 DMRS/slot, and assume that SRS or PUCCH is not transmitted, since the special slot is always used. If the number of repetitions is adjusted to allow some resource availability for SRS and/or PUCCH, the gains vanish as we show in our contribution R1-2105654.We do appreciate the attempt for compromise, but if a UE really only uses a small number of symbols in every slot for a TBoMS, does that make sense in general, let alone for coverage? |
| Ericsson RE:***FL proposal 4-v1*** ***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~~.*** | Removing the red text goes further away from the compromise in the original proposal 4 above, and so we are even less OK with proposal 4-v1 than with 4.My current thinking is to discuss further to have a more clear quantification of the benefits of special slot showing significant gain before agreeing to it. The baseline DMRS configurations should be chosen to be the best performing ones, which does not often seem to be the case. Furthermore, issues of how where SRS and PUCCH are transmitted should be clarified. |
| TCL | We support the proposal. |

**FL’ comments on April 21st**

Again, we have a chicken and egg problem which requires a more compartmentalized approach to decisions. We cannot keep bouncing the problem of the S slots back and forth. It is obvious that mutual implications exist between companies’ positions for the discussions in 2.1.1 and 2.1.4. However, eventually we need to follow an order to discuss aspects and keep following consistently/ From FL’s perspective, the most linear course of action is to agree on the very clear implications of Option 1 and Option 2 as per discussion in Section 2.1.1 and then decide on the S slot accordingly. In this context, the original version of FL’s proposal 4 seems the most appropriate one.

Indeed, if Option 1 is selected in 2.1.1, RAN1 would decide that no special focus is to be given to S slots for TBoMS. This can be reflected in Proposal 4 for consistency to ensure we can progress steadily and focus on other aspects of the design.

Similarly, if Option 2 is selected in 2.1.1, RAN1 would decide that S slots for TBoMS are to be used in the context of PUSCH repetition Type B like TDRA, which is the most natural setting for this. Again the original version of Proposal 4 would reflect this concept, and for consistency should be agreed as in its original formulation.

Please, accept the fact that we cannot keep multiple options open in all discussions. Eventually some options will have to be trimmed for the sake of progress. If we keep a plethora of options always open we will never advance. In this context, the goal of proposal 4 is to ensure consistency with any decision we will take in 2.1.1 and avoid losing further time. Let’s not forget that the use of the S slots is not the core aspect of TBoMS, and much more paramount aspects deserve the level of attention this discussion is having…

For all the above reason, the following new version of the proposal is restoring original proposal 4.

***FL proposal 4-v2. 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.***

I hope we can all demonstrate constructive spirit here. The handling of S slots is receiving is an **extremely fair treatment** and many companies are already compromising quite a lot w.r.t. their original positions.

Further comments can be added in the following table, and I invite only companies with strong concerns to express them, accompanying them with counter-proposals (which should not coincide for FL’s Proposal 4-v1, given that we already know it being unacceptable for some companies).

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | We continue to think it is premature to agree to any support for special slots in a TBoMS. Furthermore, we are concerned that special slot support for TBoMS will not be simple to specify, and that it may consume time that is instead needed to complete a basic TBoMS before the end of the release. As such we would ask that the proposal be a working assumption, so that if time does run short, we can spend the time on the core TBoMS functionality. |
| Apple | We support this proposal. We don’t see the necessity to change the PUSCH repetition type A like TDRA to support special slot.  |
|  |  |
|  |  |

#### 2.2.1.2 Second round of discussions

**FL’ comments on April 24th**

Only one company expressed concerns (Ericsson). From FL’s perspective Proposal 4 does not agree to any specific support for special slots in a TBoMS, but simply does not contradict current specification which allows configuration of the S slots for PUSCH. Proposal 4 instead aims at saying that support for S slots will not be “enhanced” or “optimized” and existing tools will be used, depending on what is agreed for Proposal 1. In my view this is a rather clean proposal which should be endorsed as is, also given the fact that I think it does not invalidate the merit or the relevance of Ericsson’s position on the S slot (on which comments have been given above, and in their submitted contribution).

I would also avoid making the “Working assumption” our escape door in all situations but limit its utilization only to cases where we need to keep doors open for future changes, if needed, while agreeing on something at the same time.

For these reasons, I would confirm Proposal 4 in its -v2 version and I hope Ericsson can reconsider:

***FL proposal 4-v2. 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.***

### 2.1.2 [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: $N\_{info}$ 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 $N\_{info}$ 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]:
	+ $K$ is equal to the total number of slots allocated for TBoMS transmission:
		- IITH [4]
	+ $K$ 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] ($N\_{RE}$ is the number of resource elements available in a transmission occasion of TBoMS. A new scaling factor S is introduced to scale the $N\_{RE}$ when computing $N\_{info}$).

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 $N\_{oh}^{PRB}$, discussion on $N\_{info}$ 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 [PAUSED] TBS determination: $N\_{oh}^{PRB}$ 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**. $N\_{oh}^{PRB}$ 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**. $N\_{oh}^{PRB}$ 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 $N\_{oh}^{PRB}$ is characterized by a much clearer trend as compared to the discussion on $N\_{info}$. This is not surprising, given that $N\_{oh}^{PRB}$ is typically accounted for per slot, whereas $N\_{info}$ 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.*** $N\_{oh}^{PRB}$ ***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.

|  |  |
| --- | --- |
| Company | Comments |
| Intel | We do not support this proposal. It is not clear to us how Option 1 can work. If repetition type A like TDRA is supported for TBoMS, total overhead should be determined based on the xOverhead and the number of slots for allocated TBoMS.  |
| Sharp | We support FL proposal. |
| NTT Docomo | We support the proposal.  |
| CATT | Just ask for a clarification. If repetition type B like TDRA is agreed to be adopted, will the wording of Option 1 be adjusted to accommodate type B TDRA accordingly? Or just keep it as the current form? |
| Apple | We support FL proposal. |
| vivo | Support the proposal. |
| Panasonic | We are fine with the proposal. |
| MediaTek | Maybe this can be discussed later. |
| Spreadtrum | We support FL proposal. |
| Fujitsu | We support the proposal. |
| LG | Support the proposal. |
| Lenovo, Motorola Mobility | We support the FL proposal |
| WILUS | We support the FL’s proposal. |
| OPPO | Agree |
| Nokia/NSB | We support the FL’s proposal. |
| Ericsson | Support the proposal. |
|  |  |

## 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.*
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**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.
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**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 $K\geq 1$.
	+ 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* $i$ *is defined as*$$k\_{i}=\left\{\begin{matrix}0,&i=0\\\left⌊{l\_{i-1}}/{Z\_{c}}\right⌋Z\_{c},&i=1,2,…\end{matrix}\right.$$*where* $l\_{i-1}$ *denotes the end position of bit selection in the circular buffer on TOT* $i-1$*,* $l\_{i}=0,1,…,N\_{cb}$*,* $N\_{cb}$ *denotes the length of coded bits in the circular buffer,* $Z\_{c}$ *is the LDPC lifting size, and* $i$ *denotes the TOT number,* $i=0,1,…$*.*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****:* $N\_{info}$ *is calculated based on all REs determined across the slots over which the TBoMS transmission is allocated.* $N\_{oh}^{PRB}$ *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* $N\_{info}$*.***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 $N\_{info}$ for TBoMS, $N\_{RE}$ is the number of resource elements available in a transmission occasion of TBoMS. **Proposal 8:** When determining $N\_{info}$ 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 $K\geq 1$.
	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 $N\_{info}$.
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* $N\_{info}$ *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* $N\_{info}=S∙N\_{RE}⋅R⋅Q\_{m}⋅υ$ *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****.*$ N\_{oh}^{PRB}$ *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., $N\_{oh}^{PRB}$, 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, $N\_{OH}^{PRB}$ 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.
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## 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.
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## 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.
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## 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$N\_{info}$ 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.