3GPP TSG RAN WG1 #106bis-e R1-2110528

e-Meeting, October 11 – October 19, 2021

**Agenda item: 8.8.1.2**

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

**Title: FL summary #2 of TB processing over multi-slot PUSCH (AI 8.8.1.2)**

**Document for: Discussion and Decision**

# Introduction

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

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

Section 2 summarizes the key aspects of TB processing over multi-slot PUSCH based on companies’ contributions submitted under AI 8.8.1.2 to RAN1 #106-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.

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

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

* **High priority aspects**
	+ Time domain resource determination
		- Use of the TDRA table
		- Candidate values for N
		- Candidate values for M
	+ Rate matching
		- Time unit of the bit interleaving
		- Starting bit in each slot for the single TBoMS
	+ TBoMS repetitions
		- Whether and how RVs are cycled across M repetitions of a single TBoMS
	+ CB segmentation
* **Mid priority aspects**
	+ TBS determination
		- Whether 1<K<N is supported
		- Whether maximum TBS should be limited
	+ UCI multiplexing rules
	+ Dropping rules
	+ Transmission power determination
	+ Frequency hopping
	+ Rank of TBoMS transmission
	+ Additional indicators and configuration options
* **Other aspects**
	+ Time domain resource determination
		- Time domain resource determination for TBoMS for CG-PUSCH
		- Time domain resource determination for single TBoMS in TBoMS repetition
		- Use of non-consecutive physical slots for paired spectrum
	+ Rate matching
		- The definition of the parameter G
		- Bit interleaving in case of multiple CBs
	+ TBoMS repetitions
		- Slot mapping for TBoMS repetitions
	+ FDRA
	+ Retransmissions
	+ Timeline requirements for UCI multiplexing
	+ Interleaved TBoMS transmissions

The categorization above will determine the initial priority order for the discussions to be held for AI 8.8.1.2. In this context, sections 2.1 and 2.2 will focus on discussions which will (2.1 and some parts of 2.2) and may (remaining parts of 2.2) be discussed during RAN1 #106-bis-e. Section 2.3 will collect all other aspects.

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

## High priority aspects

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

1. Time domain resource determination
2. Use of the TDRA table
3. Candidate values for N
4. Candidate values for M
5. Rate matching
6. Time unit of the bit interleaving
7. Starting bit in each slot for the single TBoMS
8. TBoMS repetitions
	1. Whether and how RVs are cycled across M repetitions of a single TBoMS
9. CB segmentation

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. Sub-section numbers follow the list above, for simplicity.

### [OPEN] Time domain resource determination

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

#### [PAUSED] Use of the TDRA table

Companies’ preferences concerning the indication of the number of allocated slots for the single TBoMS, i.e., *N*, and the repetition factor for the single TBoMS, i.e., *M*, are as follows:

* An enhanced TDRA table is used where one column is added to indicate the number of slots allocated for TBoMS **[20]**:
	+ *Only one column is added* **[20]**:
		- Huawei/HiSi [3], Spreadtrum [23], vivo [6], CATT [8], China Telecom [11], CMCC [12], TCL Communication [4], Xiaomi [13], Panasonic [18], Samsung [19], NTT DOCOMO [26], Nokia/NSB [21], Ericsson [22], LGE [29], Apple [16], Sharp [24], WILUS [7], Qualcomm [17], Lenovo Motorola Mobility [27], OPPO [9]
	+ *Open to solution based on two additional columns* **[3]**:
		- China Telecom [11], (LGE) [28], vivo? [6]
* A dedicated TDRA table is used for TBoMS, different from the TDRA table used for PUSCH repetitions **[4]**:
	+ Intel [15], ZTE [5], (LGE) [28], Interdigital [14]
* Number of slots in TDRA table and RRC configuration of the repetition factor **[1]**:
	+ (Lenovo Motorola Mobility) [27]

One option is preferred by almost all companies, which also seem to agree on the fact that the existing column used to indicate the number of PUSCH repetitions in Rel-15, e.g., *numberOfRepetitions,* can be used to indicate the number of repetitions of the single TBoMS. Concerning this last aspect, one company explicitly proposes to use this column to indicate the product $M×N$, and derive *M* indirectly using the indicated value of *N*.

FL’s comments on October 11

From FL’s perspective, the situation is extremely clear:

* A solution supported by an overwhelming majority of companies exists. It is extremely hard to imagine that the situation could change significantly after additional discussions.
* Available time during this meeting, and before the end of the release is very limited. Resources should be dedicated to find convergence on more controversial aspects, if possible.
* Discussion on RRC parameters can benefit significantly from an early agreement on this aspect.

For all these reasons the following proposal is made.

**FL’s proposal 1**

**The number *N* of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via *PUSCH-TimeDomainAllocationList*. The existing column for configuring the number of repetitions in the TDRA for PUSCH repetition Type A, i.e., *numberOfRepetitions,* is used for indicating the number of repetitions *M* of a single TBoMS, when TBoMS transmission is enabled.**

**FFS: supported values of *N* and *M.***

**FFS: how to enable the TBoMS transmission**

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

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 1**. The content of the proposal reflects the proposals of a very large majority of companies, hence a fast converge is desirable. If you do not support the content of the proposal, it is very much appreciated if you can provide alternative formulations which can address your concern while respecting the core of the proposal. A suitable table is added to this end before the first one.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 1** | Lenovo, Motorola Mobility, QC, vivo, Panasonic, Sharp, DCM, Spreadtrum, Samsung, CATT,TCL, Xiaomi, WILUS, NEC, Huawei, Hisilicon, China Telecom, Ericsson, Nokia, NSB, MediaTek |
| **Do not support FL’s Proposal 1** | ZTE, Intel, InterDigital, Apple |

|  |  |
| --- | --- |
| Company | Additional comments, if any. |
| ZTE | In our view, there are three cases:Case 1: PUSCH repetition is enabled. This is the legacy case and legacy Rel-16 TDRA table is used. Case 2: Single TBoMS is enabled. For this case, we agree that a new column should be added in the TDRA table to indicate the number of slots for TBoMS. * In our view, N=1 can be included in the new TDRA table. This is, the TDRA table could be used for scheduling both regular PUSCH with N=1 and single TBoMS with N>1.

Case 3: Repetition of single TBoMS is enabled. For this case, two columns should be added, where one for M and one for N. We would like to highlight that current Rel-16 TDRA table also supports NR-U configuration. If we don’t want to jointly support TBoMS and multiple PUSCH transmissions in NR-U, a cleaner way is to be based on Rel-15 TDRA table (i.e.,*PUSCH-TimeDomainAllocationList*). In this sense, we cannot reuse *numberOfRepetitions* which only exits in Rel-16 TDRA table. In summary, two new columns, e.g., *numberOfRepetitionsForTBoMS* and *numberOfSlotsForSingleTBoMS* should be added in Rel-15 TDRA table for this case. With said above, we suggest the following changes. **For single TBoMS, the number *N* of allocated slots for TBoMS is indicated via a new column added to the TDRA table configured via *PUSCH-TimeDomainAllocationList*. For repetition of single TBoMS, the number *N* of allocated slots for TBoMS and the number M of repetitions of a single TBoMS are indicated via two new columns respectively added to the TDRA table configured via *PUSCH-TimeDomainAllocationList.* ~~The existing column for configuring the number of repetitions in the TDRA for PUSCH repetition Type A, i.e.,~~ *~~numberOfRepetitions,~~* ~~is used for indicating the number of repetitions~~ *~~M~~* ~~of a single TboMS, when TboMS transmission is enabled.~~****FFS: supported values of *N* and *M.*****FFS: how to enable the TboMS transmission**FL: The need for two new columns is acknowledged only by few companies, who express it as a preference more than a technical need. As far as I am concerned, the use of a single enhanced Rel-17 TDRA table, used by several features provide a compact/elegant way of addressing the problem you raise, without resorting to differentiation of many cases. With this, it is just a matter of deciding which values N can take (i.e., if 1 is included or not) and define corresponding simple UE’s behaviour. I hope you can reconsider your position |
| CMCC | We are fine with the FL’s proposal except the 1st sentence. From our view, the slot number of TBOMS indicated through a column of TDRA could be limited by the size of TDRA table. The Ues which support TBOMS should be indicated to enable or disable TBOMS flexibly without RRC reconfigurations. Then both N=1 and N>1 could be indicated by gNB depend on the UE’s situation. But if all the candidate slot numbers and combined with repetition numbers are support, the number of combinations could be large. We should not preclude the case that the TBOMS slot number could be indicated through other RRC configurations or filed besides one column of the TDRA table. For the repetition factor, we have no problem to reuse Rel-17 new introduced repetition factors. FL: From my perspective, we have already precluded other indicators to be used when we agreed the following:Agreement:Number of slots allocated for TBoMS is determined by using a row index of a TDRA list, configured via RRC.* FFS: details.
 |
| QC | Support. Allowing both TBOMS and legacy PUSCH to share a TDRA table would be preferred.There are enhancements to multi PUSCH operation in R17 as well (an offset parameter for each SLIV is likely to be introduced to support non-contiguous transmissions). We are open to harmonizing this design in conjunction with the other R17 Wis. |
| Intel | We share similar view as ZTE that a dedicated TDRA table would be a cleaner solution for differentiation of single-slot PUSCH with repetition, single TboMS transmission, TboMS transmission with repetition. In any case, if TboMS transmission with repetition is configured, additional column is needed to indicate the number of slots for a single TboMS transmission. FL: The notion of cleaner solution is relative. Most companies indeed think that a cleaner solution is to use only one Rel-17 TDRA for several features, to reduce overhead and have a more harmonized approach. It is indeed a matter of opinions. As such, I hope you can reconsider your position. |
| InterDigital | Share similar view as Intel.FL: similar comment as for Intel. |
| Vivo | Single TDRA table is preferred. With new parameters N and existing RepetitionNumber(M), RRC configuration can provide and reconfig the TDRA table to any forms including type-A repetition only, TBoMS only, combination of both. |
| Sharp | TBoMS should be configured with Rel-17 TDRA table. Therefore, we think no issue exists for the proposal. NR-U configuration can be deleted from the Rel-17 TDRA table, subject to RRC parameter discussion. |
| Spreadtrum | One additional comments for N only valid when PUSCH mapping type is A. if PUSCH mapping type B is used for a row, N could not be configured.FL: From my perspective, no technical reason has been brought forward to justify the introduction of this limitation. |
| Samsung | Support.The issue raised by ZTE is not actually the target of these proposals.This proposal is to tackle the signalling of N, which is by a new column and in existing table. In order to solve the cases that ZTE mentioned, it matters to define the UE operation regarding receiving a specific configuration. |
| CATT | Support. We share similar views of vivo. New parameter for N (number of slots) is needed, but M (number of repetitions) is the same with current one. |
| TCL | We are fine with the FL’s proposal. In our view, adding a new column to indicate the number of slots for TBoMS is preferred. For enabling the TBoMS transmission, it’s indicated by the number of slots for TBoMS implicitly is a good way, e.g. if the number of slots for TBoMS is larger than 1, which means the TBoMS transmission is enabled. |
| OPPO | OK with the proposal, if the intention is reusing the TDRA, then the value M should naturally the number of repetitions. There is additional question to be clarified the “numberOfRepetitions”, could also be the Rel-17 enhanced Type A repetition. We haven’t decided if there will be the totally new parameter. Anyway, this should not be the existing one. I suggest to say it is Rel-17 TDRA of type A repetition.Fl: ok |
| Apple | We share the views with ZTE, Intel, InterDitigal. In Rel.17, the *PUSCH-TimeDomainResourceAllocation-r17* could indicate the scheduling is single slot transmission, or repetition, or TBoMS with repetition. In addition, the TBoMS re-transmission scheme is not clear. To make the spec and implementation clarity, two new parameters can be introduced for TBoMS, e.g., the TBoMS repetition number and slots for single TBoMS.FL: The need for two new columns is acknowledged only by few companies, who express it as a preference more than a technical need. As far as I am concerned, the use of a single enhanced Rel-17 TDRA table, used by several features provide a compact/elegant way of addressing the problem you raise, without resorting to differentiation of many cases. With this, it is just a matter of deciding which values N can take (i.e., if 1 is included or not) and define corresponding simple UE’s behaviour. I am not sure that aspects of the retransmission scheme will determine how the TDRA table is used, especially if we go for the most popular option for retransmissions, as of today, which is the use of legacy approaches. I will add an FFS, hoping to address your concern. I hope you can reconsider your position |
| Xiaomi | Support. Explicit signalling can be used to inform that some columns are invalid to support different functions: PUSCH repetition only, TBoMS only, TBoMS combining with repetition. |
| NEC | OK with the proposal. Even though ZTE’s proposal is more flexible, it may also increase RRC configured list size. FL’s proposal seems to be an trade-off between overhead and flexibility. |
| Huawei, Hisilicon | SupportThis proposal reuse the current specification as much as possible and reduce potential scheduled combination of N and M to the table size. This simplifies the complexity. |

FL’s comments on October 12

Thank you for your comments. I have provided a feedback to each company who expressed negative opinion on the FL’s proposal 1. Overall, it is fair to say that no technical need acknowledged by a majority of companies exists to justify the introduction of two columns in the TDRA table.

Conversely, efficient alternatives based on the additional of a single column exist, as explained by most companies. Proposals in this sense have been made, and further details are still FFS. In this context, it is worth observing that this approach would work well even if the supported values of M for TBoMS were different from the supported number of Type A PUSCH repetitions in Rel-17. No ambiguity would exist in this sense, given that the activation of the TBoMS would always be given by NW (as per FFS). The important consequence of this approach is that a single Rel-17 TDRA table would be used by several features, yielding an efficient and low-overhead tool to realize configuration of TBoMS and suitable indications.

While I am not sure I understand the concern expressed by Apple, I will add an FFS to the Proposal to address it, and will keep the general structure, given that all but 4 companies agreed already with the first version, and FL’s comments have been added since then.

**FL’s proposal 1-v2**

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

**FFS: supported values of *N* and *M.***

**FFS: how to enable the TBoMS transmission**

**FFS: details of retransmission of TBoMS**

Companies are invited to express their views in the tables below. Constructive attitude is highly appreciated. Please remember that quick converge on this discussion is very important to advance on RRC parameters discussion.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 1-v2** | QC, Sharp, Panasonic, DCM, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, Huawei, Hisilicon, LG |
| **Do not support FL’s Proposal 1-v2** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 1-v2, if any. |
| ZTE | It is quite weird for us to reuse a Rel-16 parameter in a Rel-17 TDRA table, while define a different meaning and value range for this parameter in Rel-17. In such case, why don’t we simply define this as a Rel-17 parameter? We could live this direction if at least the value range of M configured by *numberOfRepetitions* is the same as Rel-16, i.e., the first bullet of Proposal 13 below.  |
| OPPO | Generally OK with the proposal1 v2. One minor change make it less ambiguity we can remove exsiting as: “**~~existing~~ column**”. We would like to have it share some parameter of the Rel-17 type A repetition. But it may not be existing one considering we support at least 32. |
| Intel | We would like to better understand the shared TDRA table for single-slot PUSCH and TBoMS, w/ and w/o repetitions. Is it possible for the UE that supports TBoMS, only TBoMS is configured in the shared TDRA table, while single-slot PUSCH is not configured? Or for the above case, if N = 1 is configured for TBoMS, this would indicate that TBoMS is treated as single-slot PUSCH?  |

FL’s comments on October 13

Thank you all your supporting the proposal.

@ZTE: As far as I am concerned, RAN2 does not need RAN1 to decide whether the parameter will be called *numberOfRepetitions* or *numberOfRepetitions-r17*. This is something RAN2 will decide autonomously, based on the parameter description provided by RAN1. In other words, two possible scenarios exist:

* the value range of M supported in Rel-17is the same as the value range of *numberOfRepetition* in Rel-16, i.e., the first bullet of Proposal 13 below. As of today, this seems a very likely outcome. In this case, RAN2 may decide to keep *numberOfRepetitions.*
* the value range of M supported in Rel-17is different from the value range of *numberOfRepetition* in Rel-16. In this case, Ran2 may decide to introduce *numberOfRepetitions-r17.*

In both cases, the proposal above would be ok. I hope you can agree with this logic.

@OPPO: I think your modification can be accepted without altering the meaning of the proposal.

@Intel: This proposal does not specify which values of N and M are supported. This is the goal of FL’s proposal 12 and 13 below. Therefore, I do not think any further element should be added about N=1 here, and this proposal is completely independent of the N=1 discussion. Now, the answer to your question, which I provide here for completeness (please do not use this to ask to change the Proposal), depends on what will be agreed for the activation (deactivation) of TBoMS for FL’s proposal 11. If it is decided that N=1 is used to deactivate TBoMS, and N>1 is used to activate it, then fallback single slot PUSCH configurations would be found in all the rows with N=1 (as you commented in Section 2.1.1.2 below). Conversely, if it is decided that another indicator is used to activate (deactivate) TBoMS, then N=1 will not be supported in Rel-17 and the single slot PUSCH configuration will depend on the value of this “other indicator”. I hope this clarifies.

FL’s proposal 1 is modified as follows:

**FL’s proposal 1-v3**

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

**FFS: supported values of *N* and *M.***

**FFS: how to enable the TBoMS transmission**

**FFS: details of retransmission of TBoMS**

Companies are invited to add additional comments in the table below, **only if strong concerns exist**. Do not comment if your position has not changed and you still support the proposal. Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 1-v3, if any. |
|  |  |
|  |  |
|  |  |

FL’s comments on October 14

This proposal seems now stable, and no objections have been raised for the last 40 hours. I will copy it in the reflector for starting the email approval process. I believe this increases our efficiency. On the other hand, I think that if discussion during tomorrow’s GTW progresses smoothly, we may have time to agree on Proposal 1-v3 online to speed things up. The discussion is Paused.

#### [OPEN] Candidate values for N

Companies’ preferences concerning the candidate values for the number of allocated slots for the single TBoMS are as follows.

|  |  |
| --- | --- |
|  | Company name |
| **1 [3]** | ZTE [5], Qualcomm [17], (Nokia/NSB) [21]  |
| **2 [8]** | ZTE [5], Huawei/HiSi [3], vivo [6], CATT [8], TCL Communication [4], Nokia/NSB [21], Apple [16], Ericsson [22] |
| **3 [4]** | ZTE [5], TCL Communication [4], Nokia/NSB [21], Apple [16], |
| **4 [8]** | ZTE [5], Huawei/HiSi [3], vivo [6], CATT [8], TCL Communication [4], Nokia/NSB [21], Apple [16], Ericsson [22] |
| **5 [1]** | Apple [16] |
| **6 [2]** | TCL Communication [4], Apple [16] |
| **7 [3]** | ZTE [5], Nokia/NSB [21], Apple [16], |
| **8 [5]** | ZTE [5], Huawei/HiSi [3], CATT [8], Apple [16], Ericsson [22] |
| **12 [1]** | ZTE [5] |
| **16 [1]** | ZTE [5], China Telecom [11] |

FL’s comments on October 11

From FL’s perspective, given the way TBoMS is being designed, it is evident that a certain relationship should exist between *N* and *M*. Their product indeed determines the total amount of allocated slots of TBoMS with repetitions, should repetitions be configured by NW. Additionally, their product may or may not coincide with any value supported in Rel-17 for PUSCH repetitions. This aspect could become relevant for the final decision and is worth mentioning here, given that it may be useful to ensure that the existing agreement on the maximum value of the product $N\*M$ is respected, i.e., it shall never exceed 32.

At this stage, it would seem advisable to approach the discussion in a modular way:

* First a sub-set of possible candidate values for *N* and *M* are identified separately. Some values in the table above have less than 4 expressed preferences. Those could be considered weaker candidates and discarded due to lack of support, as soon as the first check is complete (please see below). For instance, the candidates which satisfy this rule would currently be {2,4,8}. In this context, it is worth observing that the candidate N=1 is been proposed by few companies to activate TBoMS/PUSCH repetitions via TDRA table directly, i.e., N=1 would be associated to legacy Type A PUSCH repetitions and N>1 to TBoMS.
* A further selection is performed afterwards, with or without accounting for the value of the product $N\*M$*.* This last aspect will be subject of a question to the group.

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

Companies are invited to confirm/modify/add their preference in the table below

|  |  |
| --- | --- |
|  | Company name |
| **N=1 [15]** | CMCC, QC(for switching to legacy PUSCH) , Intel, vivo, Panasonic, DCM, Spreadtrum, LG,TCL, Apple， Xiaomi, China Telecom, Ericsson, Nokia, NSB (for switching to legacy PUSCH, if N is used for enabling/disabling TBoMS), MediaTek |
| **N=2 [19]** | CMCC, Lenovo, Motorola Mobility, QC, Intel, InterDigital, vivo, Panasonic, DCM, Spreadtrum, CATT, LG,TCL, Apple， Xiaomi, Huawei, Hisilicon, China Telecom, Ericsson, Nokia, NSB, MediaTek |
| **N=3 [6]** | CMCC, DCM,TCL, Apple, Ericsson, Nokia, NSB |
| **N=4 [19]** | CMCC, Lenovo, Motorola Mobility, QC, Intel, InterDigital, vivo, Pansonic, DCM, Spreadtrum, CATT, LG,TCL, Apple， Xiaomi, Huawei, Hisilicon, China Telecom, Ericsson, Nokia, NSB, MediaTek |
| **N=5 [2]** | CMCC, Apple |
| **N=6 [4]** | CMCC,TCL, Apple, Ericsson |
| **N=7 [1]** | Nokia, NSB |
| **N=8 [11]** | Lenovo, Motorola Mobility, QC, Intel, InterDigital, Panasonic, CATT, Apple, Xiaomi, Huawei, Hisilicon, China Telecom, Ericsson |
| **N=12 [1]** | Ericsson |
| **N=16 [2]** | China Telecom, Ericsson |

Companies are also invited to consider the following question and provide an answer in the Table below.

**2.1.1.2-Q1**. *Which of the following constraints, if any, aside from the already agreed* $N\*M\leq 32$*, are to be accounted for while deciding with values of N and M are supported for TBoMS in Rel-17:*

* 1. $N\*M$ *is a valid number of PUSCH Type A repetitions in Rel-17, as per agreements in AI 8.8.1.1.*
	2. *Others (if you choose this option, please specify the constraint)*
	3. *No constraint.*

FL’s recommendation is to have a first round of discussion among companies about **2.1.1.2-Q1**. Please tick the column corresponding to one of more answers and add corresponding additional comments if you choose answer “*B*”.

The goal is to identify the preferred direction RAN1 should pursue for identifying the supported values of *N* (and *M* in the next section). Feel free to elaborate on your answer in the suitable column, if applicable. It is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Company | A | B | C | Additional comments, if any. |
| ZTE | √ |  |  | In addition to the constraint of A, the following should also be satisfied intuitively. 1) For single TBoMS, N should be an integer larger than 1. 2) For repetition of single TBoMS, $N\*M$ should be larger than 4.  |
| CMCC |  |  | √ | The maximum 32 repetitions provide limitations to maximum resources of UE hardware for the data reparations. If the N\*M do not exceed 32, there is no problem for the UE implementation. And the slot number N could be based on the consideration of TDD configurations and the available slots, then constraint A could be too stringent.  |
| Lenovo, Motorola Mobility | √ |  |  |  |
| QC |  |  | √ | Don’t see any benefit to Option A. |
| Intel | √ |  |  | This is to enable similar number of repetitions for single-slot and TBoMS transmission with repetitions.  |
| InterDigital |  |  | √ | Similar view as Qualcomm. We are not sure why N\*M should be aligned with repetition number for Type A repetitions. |
| Vivo | √ |  |  | Since we have already agreed to support repetitions for TBoMS, defining large N value seems less necessary. |
| Panasonic |  |  | √ | We share the similar view with CMCC, Qualcomm and InterDigital. |
| Sharp | √ |  |  |  |
| Spreadtrum |  |  | √ | Agree with CMCC. |
| Samsung  |  |  | √ | We don't think additional constraints will be needed. |
| CATT |  |  | √ | There is no benefit to put additional restriction. |
| LG |  | √ | √ | If *numberOfRepetitions* for PUSCH repetitions is used to indicate the value of *M*, the value of *M*×*N* may exceed 32 since the configured values of *numberOfRepetitions* can be larger than 16. In this case, it is necessary to discuss the handling method when the value of *M*×*N* exceeds 32. For example, if the value of *M*×*N* is larger than 32, the applied number of repetitions for TBoMS can be reduced.On the other hand, if separate parameter is used to indicate the value of *M*, we think Option C should be adopted. |
| TCL |  |  | √ | N\*M align with the number of repetition is not necessary. |
| OPPO | √ |  |  | There should be constraint for UE complexity. |
| Apple |  |  | √ | The additional restriction is not necessary on top of already agreed$N\*M\leq 32$. It is really limits to the gNB scheduling.  |
| Xiaomi |  |  | √ | We share the same view as CMCC, QC, InterDigital, etc. |
| WILUS |  |  | √ | Additional restriction is unnecessary. |
| Huawei, Hisilicon |  |  | √ | The potential combinations of the M and N can be scheduled are restricted in the TDRA table. No further restrictions are needed. |
| China Telecom |  |  | √ | No need for additional restriction. |
| Ericsson |  | X |  | N can be a valid number of PUSCH Type A repetitions, since this allows the same amount of time resource as PUSCH repetition type A, and as good or better coverage than using TBoMS repetition, which we find to have little benefit in [22]. Our original thinking is that at least N={1,2,4,8} is needed at the minimum, but the Rel-16 numbers of slots can allow for better flexibility. Note that we include 6 in our list, since that aligns well with the DDDSUDDSUU pattern.Indication of either PUSCH repetition Type A or TBoMS is done by RRC configuration like PUSCH repetition Type A and Type B, which means it won’t happen that some entries are configured for PUSCH repetition Type A, while others for TBoMS. We don’t see the need to apply the constraint of M\*N as the number of Type A repetitions, with the exception that M\*N is at most the number of PUSCH Type A repetitions according to the agreement. |
| Nokia/NSB | √ |  | √ | Adding the constraint A would simplify the discussion on candidate value for M and also align with the intention of reusing the TDRA of PUSCH repetition type A. However, we are also Ok for not introducing any constraint if it is the majority view. |
| MediaTek | √ |  |  | It is easy for implementation. |

FL’s comments on October 12

Thank you for your comments. I will start by commenting on the answers companies provided to 2.1.1.2-Q1. 15 out of 23 companies do not see any specific benefit with adding further constraints to N\*M other than what has already been agreed in RAN1 #106-e, i.e., N\*M can never exceed 32. FL suggest not to discuss this matter any further, given that a clear majority exists and technical need for introducing additional constraints is unclear.

Having said this, it is worth observing that ZTE proposed to consider that 1) For single TBoMS, N should be an integer larger than 1, and 2) For repetition of single TBoMS, N\*M should be larger than 4. I am highlighting this proposal in particular since it is the only one which focuses on the lower end of the range of values the product N\*M could yield. I suppose that this could become relevant again, depending on which decisions will be taken for M and for the TBoMS activation. It may deserve an FFS in the proposal I will add below.

Switching the focus to the proposed supported values of N, I think that the situation is already very clear:

* 4 Options are favoured by more than 10 companies, with 3 of them attracting more than 15 preferences each. These values are: 1, 2, 4 and 8.
* The number of preferences expressed for other values never exceeds 6.

From FL’s perspective, and regardless of its popularity, it is fair to say that N=1 shall be included in the list of supported values of N only if N=1 is used to indicate that the row of the TDRA table does not provide a configuration for TBoMS or, alternatively if all the values N>1 implicitly serve the purpose of activating TBoMS as well. The rationale of this statement is to be found in the WID, which stipulates that normative work of TBoMS should focus on transmission over multiple slots of a TBS whose size is calculated using the resource of multiple slots. For this reason, all rows carrying N=1 cannot be a valid TBoMS configuration and can only be providing Type A PUSCH repetition configuration.

The following proposal is made, to move to the next step of the discussion.

**FL’s proposal 12**

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

* $N\in \left\{ 2,4,8\right\}$

**FFS: whether N=1 is also supported**

**FFS: further constraints on N\*M**

Companies are invited to express their views in the tables below. Constructive attitude is highly appreciated. Please remember that quick converge on this discussion is very important to advance on RRC parameters discussion.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 12** | QC(prefer to resolve N=1 as well), Sharp, Panasonic, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, Huawei, Hisilicon, ZTE, Samsung [some doubts on “8”], LG, OPPO, Intel |
| **Do not support FL’s Proposal 12** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 12, if any. |
| QC | We prefer to use this proposal to also clarify status of N=1. We think allowing this new column to also take the value N=1 is useful as it brings both TBOMS and legacy PUSCH under one TDRA table. * **N=1 is also allowed with the understanding that legacy R15/R16 PUSCH procedures are followed if a row containing N=1 in the TDRA table is selected.**
 |
| Sharp | We are also OK with QC’s clarification. |
| NTT DOCOMO | We are fine with the proposal at this point. On the other hand, we think introducing N =1 is beneficial to explicitly indicate activation/deactivation of TBoMS. Even the repetition factor in current TDRA table can take value 1. This indication method can be reused for TBoMS. |
| Xiaomi | Whether N=1 is added into the TDRA table should be studied combing with **FL’s proposal 11.** It is no doubt that if **Proposal 11** reaches an agreement, N=1 must be included in the TDRA table.  |
| WILUS | We are fine with the FL’s proposal.@Qualcomm, according to the previous agreement about TBS determination in RAN1#106-e meeting, at least K=N is supported, while further values 1<K<N are FFS.

|  |
| --- |
| **Agreement** To calculate $N\_{info}$ for TBS determination, at least the scaling factor value K=N is supported, where N is the number of allocated slots for a single TBoMS.FFS: whether further values 1<K<N are supported.FFS: details related to the indication of K.Note: No supporting the case K=1 for a single TBoMS. |

Thus, it seems better to leave as a FFS for now.  |
| Lenovo, Motorola Mobility | We are also fine to consider N=1 |
| Samsung  | We want to hear the motivation to support 8, which is relative large number.To our understanding, one TB over 4slots could be quite enough, which one TB is to be smaller number of CB if it is not only one.  |
| LG | We share the similar view with Samsung. |
| Intel | We are also fine to support N = 1 as fallback mode for TBoMS, i.e., fallback to single-slot PUSCH.  |

FL’s comments on October 13

Thank you all your supporting the proposal.

@Samsung and LG: N=8 is a value proposed by a very large number of companies. For this reason, it is captured in the proposal. From FL’s perspective, this is a reasonable number still, since plenty of PUSCH configurations capable of yielding $N\_{info}<3824$ would exist even for N=8. Consider, for simplicity, two long PUSCH configurations, such as 13 os + 1 DMRS and 12 os + 2 DMRS, to consider “the worst case” in terms of large number of allocated resources for PUSCH, for coverage enhancement purpose. Let $N\_{PRB}$be the number of PRB per OFDM symbol (os) allocated to PUSCH.

Table 2‑1 and Table 2‑2 show valid values of $N\_{info}$, for MCS index up to MCS5 (so quite high code rate already) and up to MCS1, respectively, in case of 14 os and 1 DMRS.

Similarly, Table 2‑3 and Table 2‑4 show valid values of $N\_{info}$, in case of 13 os and 2 DMRS.

As you can see, many TBS values of $N\_{info} $can be supported before “hitting” $3824$, and quite a lot of small values as well. From FL’s perspective, this shows that N=8 can provide a good flexibility increase to single TBoMS. I hope you can reconsider your position and support the current version of the proposal.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | $$N\_{PRB}=1$$ | $$N\_{PRB}=2$$ | $$N\_{PRB}=3$$ | $$N\_{PRB}=4$$ | $$N\_{PRB}=5$$ |
| MCS0 | 288 | 608 | 888 | 1192 | 1480 |
| MCS1 | 384 | 768 | 1160 | 1544 | 1928 |
| MCS2 | 480 | 984 | 1416 | 1928 | 2408 |
| MCS3 | 608 | 1224 | 1864 | 2472 | 3104 |
| MCS4 | 768 | 1544 | 2280 | 2976 | 3752 |
| MCS5 | 928 | 1864 | 2792 | 3752 |  |

Table 2‑1. Valid values of $N\_{info}$ for N=8, 13 os and 1 DMRS per slot; MCS0 to MCS5

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | $$N\_{PRB}=1$$ | $$N\_{PRB}=2$$ | $$N\_{PRB}=3$$ | $$N\_{PRB}=4$$ | $$N\_{PRB}=5$$ | $$N\_{PRB}=6$$ | $$N\_{PRB}=7$$ | $$N\_{PRB}=8$$ | $$N\_{PRB}=9$$ | $$N\_{PRB}=10$$ |
| MCS0 | 288 | 608 | 888 | 1192 | 1480 | 1800 | 2088 | 2408 | 2664 | 2976 |
| MCS1 | 384 | 768 | 1160 | 1544 | 1928 | 2280 | 2664 | 3104 | 3496 |  |

Table 2‑2. Valid values of $N\_{info}$s for N=8, 13 os and 1 DMRS per slot; MCS0 and MCS1

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | $$N\_{PRB}=1$$ | $$N\_{PRB}=2$$ | $$N\_{PRB}=3$$ | $$N\_{PRB}=4$$ | $$N\_{PRB}=5$$ |
| MCS0 | 272 | 552 | 808 | 1128 | 1352 |
| MCS1 | 352 | 704 | 1064 | 1416 | 1800 |
| MCS2 | 432 | 888 | 1320 | 1736 | 2152 |
| MCS3 | 576 | 1128 | 1736 | 2280 | 2856 |
| MCS4 | 704 | 1416 | 2088 | 2792 | 3496 |
| MCS5 | 848 | 1736 | 2536 | 3496 |  |

Table 2‑3. Valid values of $N\_{info}$for N=8, 12 os and 2 DMRS per slot; MCS0 to MCS5

|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | $$N\_{PRB}=1$$ | $$N\_{PRB}=2$$ | $$N\_{PRB}=3$$ | $$N\_{PRB}=4$$ | $$N\_{PRB}=5$$ | $$N\_{PRB}=6$$ | $$N\_{PRB}=7$$ | $$N\_{PRB}=8$$ | $$N\_{PRB}=9$$ | $$N\_{PRB}=10$$ |
| MCS0 | 0 | 272 | 552 | 808 | 1128 | 1352 | 1672 | 1928 | 2152 | 2408 |
| MCS1 | 1 | 352 | 704 | 1064 | 1416 | 1800 | 2152 | 2472 | 2856 | 3240 |

Table 2‑4. Valid values of $N\_{info}$for N=8, 12 os and 2 DMRS per slot; MCS0 and MCS1

@Qualcomm and Intel: Whether N=1 is added into the TDRA table should be discussed below **FL’s proposal 11.** If FL’s proposal 11 is agreed, then N=1 must be included in the TDRA table as you (and others) propose. Conversely, there would not be any need. I am adding a part in red in FL’s proposal 13 to make this clearer. I hope you can agree with this.

**FL’s proposal 12-v2**

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

* $N\in \left\{ 2,4,8\right\}$

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

**FFS: further constraints on N\*M**

Companies are invited to add additional comments in the table below, **only if strong concerns exist**. Do not comment if your position has not changed. Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 12-v2, if any. |
| Ericsson | From the discussion, to us it does not seem that companies have thought too much about this issue. Clearly {1,2,4,8} are needed (with 1 being achievable by multiple means), but we fail to see while \*only\* these should be supported. * For example, N=3 or 6 could be appealing for DDDSUDDSUU, or simply to allow more flexible gNB scheduling.
* We have expanded the number of repetitions for Type A in Rel-16 and Rel-17. Why should the number of slots for a TBoMS neglect the enhancements to the number of slots we have already found necessary for Type A?
* Repetition of a TBoMS tends to perform worse than a TBoMS of the same length, so using repetition to fill in the different lengths is not a good solution.
* We hope companies do not think that the list of N values should have a power of two length. Rel-16 TDRA does not require this, and Rel-17 should not for either DCI fields or ASN.1.

While I would guess it is FL’s intention anyway, if we can confirm that values other than {1,2,4,8} will continue to be discussed, i.e by adding the following, we can be OK.**FFS: Additional values.** |
|  |  |
|  |  |

FL’s comments on October 14

Thank you for your comments. I confirm that the intention of the proposal, which starts with “at least” is not to stop further discussions from happening, if needed. The goal is to start having some elements to work on for other discussions which need them. In my view, the addition of an FFS to address Ericsson’s concern does not alter the spirit of the proposal. I will thus reformulate it a bit and add it to the proposal as follows.

**FL’s proposal 12-v2**

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

* $N\in \left\{ 2,4,8\right\}$

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

**FFS: other values, if any.**

**FFS: further constraints on N\*M**

Companies are invited to add additional comments in the table below, **only if strong concerns exist**. Do not comment if your position has not changed. Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 12-v2, if any. |
| OPPO | We are fine for the proposal. Just one clarification: N=1 is FFS. However, if 1 is supported, the M could be 32. We are not sure this could be still called TMoMS repetition or purely Rel-17 TypeA repetition. This is included in the further study, to my understanding. |
|  |  |
|  |  |

#### [OPEN] Candidate values for M

Companies’ preferences concerning the candidate values for the repetition factor for the single TBoMS are as follows.

|  |  |
| --- | --- |
|  | Company name |
| **1 [5]** | Huawei/HiSi [3], vivo [6], CATT [8], Xiaomi [13], Nokia/NSB [21] |
| **2 [5]** | Huawei/HiSi [3], vivo [6], CATT [8], Xiaomi [13], Nokia/NSB [21] |
| **3 [5]** | Huawei/HiSi [3], vivo [6], CATT [8], Xiaomi [13], Apple [16], |
| **4 [6]** | Huawei/HiSi [3], vivo [6], CATT [8], Xiaomi [13], Nokia/NSB [21], Apple [16] |
| **5 [1]** | vivo [6] |
| **6 [1]** | Nokia/NSB [21] |
| **7 [4]** | vivo [6], Huawei/HiSi [3], CATT [8], Xiaomi [13] |
| **8 [6]** | vivo [6], Huawei/HiSi [3], CATT [8], Xiaomi [13], Nokia/NSB [21], Apple [16] |
| **10 [1]** | vivo [6] |
| **12 [4]** | vivo [6], Huawei/HiSi [3], CATT [8], Xiaomi [13] |
| **14 [1]** | vivo [6] |
| **16 [6]** | vivo [6], Huawei/HiSi [3], CATT [8], CMCC [12], Xiaomi [13], Samsung [19] |

FL’s comments on October 11

The discussion in this section will be carried out according to the logic outlined in the previous section:

* First a sub-set of possible candidate values for *N* and *M* are identified separately. Some values in the table above have less than 4 expressed preferences. Those should be considered weaker candidates and discarded due to lack of support as soon as the first check is complete (please see below). For instance, the candidates which satisfy this rule would currently be {1,2,3,4,7,8,12,16}, i.e., the supported values of *numberOfRepetitions* in Rel-15.
* A further selection is performed afterwards, with or without accounting for the value of the product $N\*M$*.* This last aspect will be subject of a question to the group.

It is worth observing that, if we consider the current most popular candidates for both *N* and *M,* we would have the following valid $\{N,M\}$ combinations:

* {2, 1} {2, 2}, {2, 3}, {2, 4}, {2, 7}, {2, 8}, {2, 12}, {2, 16}
* {4, 1} {4, 2}, {4, 3}, {4, 4}, {4, 7}, {4, 8}
* {8, 1} {8, 2}, {8, 3}, {8, 4}

Resulting, values of the product $N\*M$ would finally be {2, 4, 6, 8, 12, 14, 16, 24, 28, 32}, where the numbers in red would not be part of the list of supported repetition factors agreed in AI 8.8.1.1 (as per constraint “*a*” in **2.1.1.2-Q1**).

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

FL’s recommendation is to have a first round of discussion among companies about the candidate values for *M*. Companies are invited to confirm/modify/add their preference concerning this parameter in the table below

|  |  |
| --- | --- |
|  | Company name |
| **M=1 [8]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi, Ericsson, Nokia, NSB |
| **M=2 [8]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi, Ericsson, Nokia, NSB |
| **M=3 [5]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi |
| **M=4 [6]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi, Nokia, NSB |
| **M=5** |  |
| **M=6** |  |
| **M=7 [7]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi |
| **M=8 [7]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi, Nokia, NSB |
| **M=10** |  |
| **M=12 [6]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi |
| **M=14** |  |
| **M=16 [6]** | CMCC, vivo, DCM, Spreadtrum, CATT, Xiaomi |

The goal is to identify the preferred direction RAN1 should pursue for identifying the supported values of *M* (also considering the discussion about *N* in the previous section). Feel free to elaborate on your answer in the table below, if needed. It is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

|  |  |
| --- | --- |
| Company | Comments |
| ZTE | We are fine with any integer values for M that could satisfy 1)  and 2) $N\*M$ is a valid number of PUSCH Type A repetitions in Rel-17, as per agreements in AI 8.8.1.1. |
| CMCC | At least current Rel-16 repetition factors could be reused |
| Lenovo, Motorola Mobility | Any value of “M” corresponding to values of “N” = [2,4,8] such that N\*M <= 32 and N\*M is not equal to any value not supported in Rel-17 repetitions |
| QC | Allow any value of repetitions that satisfies N\*M $\leq $ 32, where M is a valid number of repetitions as per the list determined by 8.8.1.1. (This is primarily to avoid changes in bit width of the repetition field in case we allow a single TDRA table to contain both TBOMS and legacy entries.) |
| Intel | Based on the discussion for N and N\*M, the candidate values of M can be derived accordingly.  |
| Vivo | Limitation on candidate values may be needed. Keeping the same candidate values set as that in rel-16 type-A PUSCH repetition may help to support configuring slot based PUSCH and TBoMS in a single TDRA table, and the repetition number can be provided by a same RRC parameter for these two modes. |
| Panasonic | The values for PUSCH repetition Type A should be reused. |
| Sharp | Agree with Panasonic. |
| Spreadtrum | At least current Rel-16 repetition factors could be reused |
| Samsung  | As long as the N\*M is <32, even it is not in the value set of repetition value, as discussed in previous session, it’s not an issue. |
| CATT | Reusing the current candidates in *numberOfRepetitions* {1,2,3,4,7,8,12,16} should be OK. We already agree N\*M<=32. No need to introduce further spec change. |
| LG | If *numberOfRepetitions* for PUSCH repetitions is used to indicate the value of *M*, the supported values of M should be same with the supported values for *numberOfRepetitions.*On the other hand, if separate parameter is used to indicate the value of *M*, the candidate values of *M* may be selected more flexibly.  |
| TCL | The number of M should be based on N\*M ≤32. |
| OPPO | Reusing the type A values.  |
| Apple | Share the views with QC and Samsung, as long as the M fulfill N\*M<=32. |
| Huawei, Hisilicon | The potential combinations of the M and N can be scheduled are restricted in the TDRA table. No further restrictions are needed. |
| China Telecom | It depends on the value of N and N\*M ≤32. |
| Ericsson | M=1 should be supported at least as a default. The results we have in [22] show that the increased MCS needed for repetition factors > 2 can quickly degrade performance compared to not repeating. From these observations, M=4 seems the largest reasonable repetition factor, and then M=4 with N=8 meets the 32 slot upper bound from the RAN1#1006 agreement. However, the need for M=4 is not so clear if we have N=16, so we only have M=1 and M=2 here. M=3 is also possible, but it is not so obvious to us at this stage that it is needed either if we have a sufficient list of N values. |

FL’s comments on October 12

Thank you for your comments. An extremely large number of companies agree that Rel-16 values for Type A PUSCH repetitions should be used. The preferences expressed in the table above perfectly reflect this situation.

Only one company proposed that . Conversely, one company explicitly proposed M=1 to be included due to performance-related concerns. From FL’s perspective, and given that almost all companies wish to reuse existing values for the number of PUSCH repetitions in Rel-16 for the number of the TBoMS repetitions in Rel-17, the second proposal is accepted, whereas the first one is not. I hope the proposing company can reconsider.

Moving to the impact of companies’ preferences for both *N* and *M* on the range of valid values of the product *N\*M* as per existing agreement (i.e.,$N\*M\leq 32$),it is interesting to observe that we would have exactly the same valid $\{N,M\}$ combinations as what I listed in the comments I made on October 11. This demonstrates that a certain stability already exists in this discussion.

The list would then be:

* *N=2* 🡪$\left\{N,M\right\}\in \left\{\{2, 1\}, \{2, 2\}, \{2, 3\}, \{2, 4\}, \{2, 7\}, \{2, 8\}, \{2, 12\}, \{2, 16\}\right\}$
* *N=4* 🡪$\left\{N,M\right\}\in \left\{\{4, 1\}, \{2, 2\}, \{4, 3\}, \{4, 4\}, \{4, 7\}, \{4, 8\}\right\}$
* *N=8* 🡪$\left\{N,M\right\}\in \left\{\{8, 1\}, \{8, 2\}, \{8, 3\}, \{8, 4\}\right\}$

where the part in red would not be part of the list of supported repetition factors agreed in AI 8.8.1.1. Similarly, the resulting valid range of values of the product $N\*M$ would finally be

* $N\*M\in \left\{2, 4, 6, 8, 12, 14, 16, 24, 28, 32\right\}$.

This seems to cause concerns to at least three companies and may deserve an FFS in the proposal I will add below.

A new FL’s proposal can then be made, to move to the next step of the discussion.

**FL’s proposal 13**

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

* $M\in \left\{1,2,3,4,7,8,12,16\right\}$

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

Companies are invited to express their views in the tables below. Constructive attitude is highly appreciated. Please remember that quick converge on this discussion is very important to advance on RRC parameters discussion.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 13** | QC, Sharp, Panasonic, DCM, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, CATT, Huawei, Hisilicon, CMCC, ZTE, Samsung, LG, OPPO, Intel, Apple |
| **Do not support FL’s Proposal 13** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 13, if any. |
| ZTE | Just to clarify that the condition we proposed was only for repetition of TBoMS. We are ok to the values with N\*M smaller than 4, while it would be either single TBoMS or legacy PUSCH repetition.  |
| Intel | Minor comment: we are fine with the proposal, but would like to add the following note as we already agreed to avoid confusion of the wording “further constraint”. Note: M\*N is no more than the max number of repetitions agreed for repetition Type A enhancement in agenda 8.8.1.1 |
|  |  |

FL’s comments on October 13

Thank you all for the comments so far. The proposal seems agreeable to all companies that have commented.

@Intel: Existing agreements prevent the possibility for N\*M to exceed 32. I understand your point of view, and you are not wrong of course. I just think that maybe we can simply rely on existing agreements (which are binding) instead of adding Notes that some company may then ask to remove “since we already have an agreement on this”. After all, no company proposed to revise that agreement and support N\*M>32. I hope this is acceptable for you. I will keep the proposal in its current form for the time being.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 13, if any. |
| Ericsson | Adding this table for clarity on when our comments are made, hope that’s OK.We now understand that companies prefer to jointly support PUSCH repetition Type A and TBoMS, and so the large list of repetition values is needed from that perspective. Our expectation is that TBoMS can perform as well (or hopefully somewhat better) than repetition Type A, and so this joint configuration seems redundant to us. Nevertheless, any subset of the repetition values can be configured, this simply costs us a few bits of RRC overhead, and we can accept the larger list in principle.However, how this joint configuration of TBoMS and Type A can actually work is not clear to us as we comment in proposal 11. So we can compromise to have this long list of M values, but would ask proposal 11 is revised, as commented there. |

FL’s comments on October 14

Thank you for your comments. I replied to Ericsson’s concerns on proposal 11 in Section 2.2.7. I am not sure I clearly see why that discussion affects the decision would take on the list of supported values of *M* for TBoMS.

Indeed, according to Proposal 1 in Section 2.1.1.1, which is now stable, *M* is going to be indicated to UE using the same column used for indicating the number of repetitions in Type A PUSCH repetitions. UE would then know what this column indicates depending on how TBoMS is enabled/disabled (as per discussion for Proposal 11). Thus, no ambiguity exists, and I am not sure I understand objections in this sense.

Conversely, I think that it could be natural to wonder whether the list of supported values of *M* should coincide with the list of supported values for Type A PUSCH repetitions, given that this may impact the value of the product M\*N (provided that, as per agreement, it will never exceed 32). However, most, if not all, companies believe this is not a problem. Therefore, Proposal 12-v2 has been formulated as is and will be kept in its current form, which follows.

**FL’s proposal 13**

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

* $M\in \left\{1,2,3,4,7,8,12,16\right\}$

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

Companies are invited to add additional comments in the table below, **only if strong concerns exist**. Do not comment if your position has not changed. We should aim at agreeing on all proposals as quick as possible online, to ensure we are able to tie all the loose ends we left behind so far. Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 12-v2, if any. |
|  |  |
|  |  |
|  |  |

### [OPEN] Rate matching

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

#### [OPEN] Time unit of the bit interleaving

Companies’ preferences concerning the indication of the number of allocated slots for the single TBoMS, i.e., *N*, and the repetition factor for the single TBoMS, i.e., *M*, are as follows:

|  |  |
| --- | --- |
| Per slot[15 companies] | Across all allocated slots for TBoMS [15 companies] |
| Panasonic [18] | vivo [6] |
| Huawei/HiSi [3] | Fujitsu [10] |
| Qualcomm [17] | Ericsson [28] |
| Xiaomi [13] | ZTE [5] |
| Samsung [19] | China Telecom [11] |
| MediaTek [20] | Intel [15] |
| Sharp [24] | CATT [8] |
| Nokia/NSB [21] | LGE [29] |
| Interdigital [14] | TCL Communication [4] |
| NTT Docomo [26] | WILUS [7] |
| Lenovo/Motorola [27] | IITH |
| vivo [6] | IITM |
| Spreadtrum [23] | CEWIT |
| OPPO [9] | Tejas Networks |
| CMCC [12] | Reliance Jio |
|  |  |
|  |  |

The following additional remarks have been made:

* Each available slot identified by UE is considered as a transmission occasion for TBoMS transmission, and the transmission occasion based power control, UCI multiplexing, rate matching in the current specification is reused [3].
* RAN1 should make the decision on rate-matching and CB segmentation together by down-selecting the following three options [21]:
	+ Option 1: Rate-matching is performed per slot and CB segmentation is not considered for TBoMS.
	+ Option 2: Rate-matching is performed per TBoMS and CB segmentation is not considered for TBoMS.
	+ Option 3: Rate-matching is performed per TBoMS and CB segmentation per TBoMS is considered.
* RAN1 decision on rate-matching for TBoMS should not account for collision handling nor UCI multiplexing [21].
* Impact of decisions on RM for TBoMS on the per-slot implementation logic followed by all transmission/reception operations in NR should be carefully considered to ensure the relevance of TBoMS use case is preserved [21].
* Rate matching is performed continuously across all the allocated slots for TBoMS, if CB segmentation doesn't occur. Otherwise, rate matching is performed for each CB once [28].
* Rate-matching procedure is performed based on available slots for TBoMS regardless of actual transmission of TBoMS in the available slots [29].

FL’s comments on October 11

Like the situation observed during and at the end of RAN1 #106-e, a majority exists in favor of one option (i.e., rate-matching per slot). Companies’ preferences have not changed significantly since then, and it is rather evident that eventually one of the two solutions will have to be retained and the other discarded. From FL’s perspective, in fact, this is the only reasonable outcome of this discussion to preserve the relevance of the TBoMS feature and ensure that specification impact is reasonable (regardless of which of the two approaches will eventually be selected). Furthermore, it is worth noting that RAN1 had agreed to perform such down-selection already during RAN1 #106-e, and thus did not respect the agreement.

In this context, while the understanding on the specification impact of the two approaches seems to be rather homogeneous across the companies, it is also rather clear that different companies have different technical understanding of the implementation impact of the two approaches. This is unfortunate and ultimately, from FL’s perspective, the corner stone of the problem we are facing as a group, together with the heterogeneous opinions on how much performance gain, if any, one approach would bring over the other.

Having said this, I think that at least the following considerations should be acknowledged and accepted by the whole group:

* The NR system and specification are defined and described according to a per slot logic. Defining a feature which requires a change to this logic is a non-trivial decision to take, given that the relevance of the feature, and corresponding use case, should be considered. In this context, relevance and use case of TBoMS is already narrow by construction.
* This WI is about coverage enhancement. Performance of PUSCH has been studied assuming very low MCS indices and number of allocated PRBs, and so all the studied enhancements have been tested. TBoMS is part of such studied enhancements. Studying performance of TBoMS when MCS index is larger, or TBS is large, does not seem aligned with the scope and spirit of both SID and WID. If lower MCS indices are considered, then the bit interleaving depth does not allow significant time diversity to be harnessed (i.e., as per TS 38.212, if bit interleaving depth is 2 and TBS most of the systematic bits are transmitted the first slot, and smaller number of systematic bits are transmitted in other slots, if any).
* Specification solutions to handle UCI multiplexing and dropping rules for both bit interleaving per slot and across all the allocated slots for TBoMS exist and are not complex. I understand that preferences may exist in this sense, but reality is that all agreements so far are compatible with both approaches, and possible specification solutions for UCI multiplexing and dropping rules, compatible with existing agreements, exist for both approaches.
* A connection has been highlighted by some companies between bit interleaving time unit and CB segmentation, and arguments in favour of either of the two approaches for bit interleaving, based on considerations for CB segmentation, have been proposed. This may not be needed, after all, if we consider that a majority of companies think that only single CB transmissions should be supported for TBoMS in Rel-17 (Please see discussion in Section 2.1.4). Therefore, it is unclear why such aspect should determine the decision on which bit interleaving time unit for TBoMS should be supported in Rel-17.

For all the above reasons, and given the preferences expressed by companies, the following proposal is made.

**FL’s proposal 2**

**For the rate matching of TBoMS, the bit interleaving is performed per slot.**

|  |
| --- |
| I understand that this proposal may not attract the initial preference of a non-negligible number of companies. However, **I warmly invite everyone to be reasonable**. **Our goal is to select one solution for the time unit of the bit interleaving**. In this context, it is unlikely that 15 companies will change their mind by then, especially given the solid arguments many of them bring to justify their position. Of course, we could spend the entire duration of this meeting (again) discussing about this proposal, to then converge on its current form, given that it is very likely that the majority of company will still prefer FL’s proposal 2 as it is. I guess we all agree that this would be a very inefficient use of our time, since it will take time and resource away from all other aspects we still must work out.  |

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

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

Companies are invited to input their position in the first table, while further comments can be added in the second.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 2** | Lenovo, Motorola Mobility, QC, InterDigital, vivo, Panasonic, Sharp, DCM, Spreadtrum, Samsung, Apple, Xiaomi, NEC, Huawei, Hisilicon, Nokia, NSB, MediaTek |
| **Do not support FL’s Proposal 2** | ZTE, Intel, LG,TCL, WILUS, Ericsson (Can accept a modified version) |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 2, if any. |
| ZTE | We are not ok with the proposal, with the following reasons. * The legacy RM is based on per CB logic. RM per slot would cause more complexity and spec impacts.
	+ Current RM is based on all the number of coded bits for each CB, while RM per slot is only based on only the number of coded bits per slot.
	+ RM per slot would require RM first per slot and then per CB, while means each CB has to be RMed on all slots.
* Better performance due to interleaving diversity gain in the time domain.
* RM per slot will complicate the discussion on starting bit in each slot for the single TBoMS as summarized in the next subsection.
 |
| QC | A few additional remarks for proponents of rate matching across slots:As noted by several companies, rate matching across slots would be a major departure from current UE/gNB architectures. Even when Type B repetitions were considered, actual repetitions with independent rate matching were introduced to avoid this issue (among other issues). R17 follows on the foundation laid by R15 and R16, and we think some weightage be placed on following well-established precedent. @ZTE: How does a commercial ZTE base station handle Type A repetitions? Isn’t rate matching per slot already the default behaviour? This should allow both gNB and UE implementations leverage on existing designs. |
| Intel | We have concern on the proposal. We support bit interleaving per TBoMS. The pros/cons of these two alternatives have been discussed extensively. Our view is that1) spec impact for bit interleaving per slot is larger than bit interleaving per TBoMS 2) in term of storage, bit interleaving per slot has similar complexity as bit interleaving per TBoMS. 3) bit interleaving per TBoMS is more robust than bit interleaving per slot especially when considering that some of the systematic bits are not transmitted for TBoMS. In our simulations, this leads to 0.8dB performance gain compared to bit interleaving per slot. |
| Sharp | We have similar question as Qualcomm to ZTE. How to handle PUSCH repetition type-A? How the number of available bits G in TS38.212 is calculated? |
| NTT DOCOMO | The gain of time domain diversity from RM per TBoMS depends on TBS and resource allocation. While it provides better performance in some cases, the performance could be worse than RM per slot as shown in our contribution. As companies have the different views toward the gain of time domain diversity based on different simulation assumption, it is hard to reach the consensus on it. In our views, time domain diversity by RM per TBoMS is mediocre when the modulation order is low.  |
| Samsung  | Strong support FL proposal. This issue has already deeply discussed before.We have strong position that the such bit interleaving operation should be done per slot basis, which is quite essential to the actually make TBoMS to be implemented in UE sides. As well as mentioned by QC, at gNB side, it is also preferred with slot-based operation.  |
| CATT | This is not our first preference; but we can live with it if no other choice to move forward.  |
| TCL | Similar view as ZTE and Intel.1). More spec impact will be caused for bit interleaving per slot than bit interleaving per TBoMS;2). Better performance can be achieved |
| OPPO | It seems over whole TBoMS would bring some complexity but can avoid some problem by per slot. We actually open to the issue and would like to have a full solution on how the rate matching is down, CB segmentation and the UCI multiplexing. This topic does not need RRC parameter. |
| Apple | We support the FL’s proposal. As the coverage enhancement is targeting for UE in cell edge, the MCS and data rate would not be higher. There is no big difference in time domain diversity gain for two options. From UE implementation perspective, per TBoMS slots rate matching is still require dividing the G in 38.212 as per slot rate matching, if ToMB is transmitting over non-consecutive UL slots, as there is no buffer to store the interleaved bits. Per slot interleaving is leverage existing design and is friendly to implementation. |
| Xiaomi | We share the same view as QC and Samsung. Rate-matching per slot is benefit for UE/gNB’s implementation with limited performance loss to the CB without segmentation. Besides, if CB segmentation is supported, more performance gain will be obtained compared with rate matching per TBoMS. |
| WILUS | We share the similar views with ZTE and Intel. Specification impact with per-slot interleaving is larger since rate matching is performed per-CB manner. It’s a new signal generation procedure compared to Rel-15/16. |
| IITH, IITM, CEWIT, Reliance Jio, Tejas Networks | We prefer rate matching across slots as a 1st preference. As explained in our tdoc, the implementation complexities are the same in both cases. However, in the interest of progress, we can compromise and agree to per slot rate matching.  |
| Huawei, Hisilicon | The operation of interleaving based on per slot is exactly the same of what is implemented for repetition type A, where the bit selection and the interleaving is based on one slot. The difference is that the starting bit could be different for each slot between per slot interleaving for TBoMS and repetition type A. And then per slot interleaving reuse the implementation of type A repletion implementation as much as possible without compromise the performance.  |
| China Telecom | Our concern is if bit interleaving is performed per slot, how much performance gain can be achieved compared with PUSCH repetition type A? |
| Ericsson | We think the issues are the following:1. **Performance**: At higher MCS and/or moderate speeds, we observe performance losses [22], e.g. of 0.4 dB.
2. **Robustness**: If a slot of a TBoMS is dropped due to collision, we see performance losses [22] e.g. of 0.7 dB
3. **UCI multiplexing**:
	1. It is not clear to us what the performance will be if UCI is multiplexed in only one slot; as we have seen, some slots can be more sensitive than others. We are not aware of results for UCI multiplexing, and so are hesitant to assume TBoMS will perform adequately if UCI is multiplexed only on one slot.
4. **CB Segmentation**:
	1. *If there is no CB segmentation*, rate matching per slot requires heavier spec impact than rate matching over the entire TBoMS, since a new step of slot segmentation must now be introduced and the slot segments must be rate matched and then concatenated (see the figure below).

* 1. *If there is CB segmentation, we meet the 1 and 10 Mbps data requirements from the SI*. In such a case, it is not clear how to handle multiple CBs with per slot rate matching, since rate matching is done per CB, and per slot rate matched CBs may not fit the resources allocated for the TB. Rate matching over the entire TBoMS uses the Rel-15 principle of rate matching according to the allocated resource, and does not require further changes.

Proposals such as that below have been made to solve CB segmentation with per slot rate matching. These require even more spec impact than the single CB case, and we think are not well studied for TBoMS. The above drawbacks of per slot multiplexing can be mitigated at least to some degree by scheduling lower MCS, avoiding dropped slots, precluding CB segmentation (thereby not meeting the 1 and 10 Mbps SI requirements), and possibly avoiding per slot UCI multiplexing. If such tradeoffs are to be made, they should result in a simpler specification, and most importantly in UEs that are more readily available.In order to ensure the issues above can be addressed, we ask the following:1. Confirm that the coded bits for the N available slots are determined and segmented once from a single RV at the time of scheduling the TBoMS, and that the rate matching per slot (if any) is independent after the per slot segmentation.
	1. That is, we should agree to Proposal 3,
2. Preclude support for CB segmentation, as it is inconsistent with the assumptions of lower MCS and given its substantial specification impact.
3. Ensure that performance with UCI multiplexing is adequate, e.g. with an FFS:

**For the rate matching of TBoMS, the bit interleaving is performed per slot.** * **Performance with UCI multiplexing on single and multiple slots of a TBoMS is FFS**
1. Make this a working assumption, since the specification impacts are larger than per TBoMS rate matching, and since the performance is not so clear at least with respect to UCI multiplexing.
 |

**FL’s comments on October 12**

Thank you all for your comments. I acknowledge a hard effort made by many companies to bridge the gap and progress. I truly appreciate this and think several good points were made. This also applies to comments made by companies during the GTW. My high-level summary of the inputs that were shared is the following:

* A non-negligible number of companies think that the discussion on several aspects is mature enough to sketch a “small jumbo proposal” which could ensure consistency and coherence of all the aspects related to, or impacted by, decisions on RM.
* Performance of UCI multiplexing can be source of concerns.
* It is acknowledged that per-slot logic would allow to support TBoMS with a smaller implementation impact, given current NR implementation logic at both UE and gNB, but can result in larger specification impact, depending on what is agreed for aspects other than RM.
* All companies understand the importance of deciding on this aspect as soon as possible.
* A working assumption may be a good starting point to take some steps forward.

Now, given the above, I would like to try sketching a “small jumbo working assumption” we could work on, to further progress on several discussions at the same time, while respecting the spirit of current proposals (which are supported by most companies already) at the most. I am aware that this is a perilous exercise, but I trust all companies will work together to identify the best middle ground for everyone.

In this context, I would also:

* Pause, at least for the time being, all discussions related to aspects which will be captured in the proposal, for the sake of efficiency, i.e., discussions in 2.1.4.
* **Invite all companies not to copy-paste what has been already said/written/discussed in this and previous meetings concerning complexity and specification impact.** This is not helpful and makes us all losing a lot of time. New elements can be shared of course, and new observations can be added.
* Invite companies, if possible, to **answer when a question is asked** to them **by other companies**. This is the only way we can progress reasonably, while attempting to have a proper discussion and not just a sequence of opinions.

The following proposal for a working assumption is then made.

**Working Assumption 1**

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

* **Bit interleaving is performed per slot.**
* **The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.**
* **UCI multiplexing bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot.**
* **Transmission is limited to one CB only.**

**Performance with UCI multiplexing on single and multiple slots of a TBoMS is FFS**

Companies can input their views on the Working Assumption in the suitable tables below.

|  |
| --- |
| **Please, avoid commenting “we prefer bit interleaving across all the slots”, since this would not be compatible with what I am proposing to do here. Conversely, please try working on the “per slot” approach together with others, to make it more suitable for you, if the current formulation is not acceptable**. Thank you. |

|  |  |
| --- | --- |
|  | Company name |
| **Support Working Assumption 1** | QC(requires some clarification), Sharp, Panasonic, Xiaomi, Lenovo, Motorola Mobility, Samsung, LG(for the whole package), OPPO, Apple |
| **Do not support Working Assumption 1** | DCM, CATT(on UCI), Huawei, Hisilicon |

|  |  |
| --- | --- |
| Company | Additional comments related to Working Assumption 1, if any. |
| QC | Question to the FL: What is the intention behind adding the third bullet and what is the expected impact? I wasn’t able to trace it back to Ericsson’s comment. Ericsson’s first request seemed to bring more clarity --- we could try to repurpose that as is.“Confirm that the coded bits for the N available slots are determined and segmented once from a single RV at the time of scheduling the TBoMS, and that the rate matching per slot (if any) is independent after the per slot segmentation.” |
| NTT DOCOMO | We think the third bullet imposes constraints on scheduling UCI scheduling. If the UCI has to be prior to be known, stricter timeline is necessary for TBoMS. It is against the idea not to reuse UCI multiplexing for legacy PUSCH repetition type A. We think it is better to keep FFS regarding the third bullet. |
| vivo | Generally Fine with the WA.Does the 3rd bullet means the same UCI multiplexing timeline as that in Rel-15/16? Or any other implications? |
| CATT | We have a question on the UCI multiplexing part. It is a little ambiguity on whether it means the timeline of UCI multiplexing of each slot is different, and allows mapping different UCIs in different slots. This will be a big difference with PUSCH repetition type A. Better to discuss this in Section 2.2.2. |
| Huawei, Hisilicon | From our understanding, the third bullet will change the timeline of the uplink UCI feedback or it will put additional limits on the UCI feedback occasions. Something needs to be clarified regarding to the UCI feedback timing and any restrictions on the UCI feedback flexibility. |
| ZTE | @QC@ Sharp Regarding the question in the first round about the difference between RM of PUSCH repetition type A and per slot RM for TBoMS. Our understanding is, the latter requires a new rule to determine the start bit for each CB, and coded bits are from one single RV. This may cause other problems, e.g., error propagation for UCI multiplexing. In addition, as far as we know, PUSCH repetition is not typically implemented in practice. Our intention to reuse as much as possible the following existing implementing procedure, and we think RM per TBoMS is simpler for implementation and has smaller spec impacts.* RM per TBoMS follows the legacy logic for single PUSCH transmission, i.e., per CB with a single RV. This ensures the whole signal generation procedure (including TBS determination, RV determination, RM, mapping etc.) are all based on all slots of TBoMS, and actual transmission can still be per slot. RM per slot would break the signal generation procedure into different handling logic.

For sake of progress, we can live with a WA with adding some conditions, among which limiting the start bit and one CB are important. In addition, we suggest to merge the following proposal 14 into the WA, to make the scheme more complete.  |
| Samsung  | UCI bits will impact the number of total bits in one slot, but whether it has to prior to be known before all the transmitted slot, we think it could be upto the timeline implementation at UE side, e.g., a UE could retrieve the number of bits for one slot ahead of it as long as it just need to retrieve from the buffer.We prefer to remove the 3rd bullet. |
| LG | We appreciate for your effort to combine diverge views. We need to make a solution that take into account various concerns from companies, and it is almost impossible to reach to a solution that satisfies everyone.In our view, in order to support slot level bit interleaving for TBoMS, problems and complexity caused by applying slot level interleaving instead of bit interleaving across all allocated slots for TBoMS should be avoided as much as possible. For this, it is necessary to support the techniques that help the problem of slot level bit interleaving with a small specification impact.For one thing, in order to use slot level bit interleaving, it is necessary to apply a restriction that supports only single CB for TBoMS. In addition, it should be assumed that the rate-matched bits for each transmitted slot and UCI multiplexing bits are determined before the start of TBoMS transmission. In this case, it is possible to prevent “on the fly” determination of transmitted bits in each slot while continuously mapping and transmitting all coded bits to multiple slots without omission. Therefore, by applying this simple restriction, it is possible to avoid the problem of omission of some important systematic coded bits due to UCI multiplexing without increasing the UE transmission complexity.In that sense, we support the proposed working assumption with as a whole package. If some of sub-bullet is deleted, it is hard to accept in our perspective. |
| Intel | We still have concern on the performance of bit-interleaving per slot, especially when some of the systematic bits cannot be transmitted in case of UCI multiplexing or dropping. This is also for the case when Option C for the starting position of coded bits is applied.For “Performance with UCI multiplexing on single and multiple slots of a TBoMS is FFS”, it would be good to clarify what the exact meaning of this? Do we plan to run some simulation to check the performance for UCI multiplexing on TBoMS or other purpose? We can be okay to support this as working assumption and share similar view as LG that it is important to consider UCI multiplexing as part of WA. Otherwise the performance would be degraded due to the fact that certain systematic bits would be dropped in case of UCI multiplexing.  |
| Apple | The third bullet is changing the multiplexing timeline, or defines new dropping rule. We prefer it is FFS. |

FL’s comments on October 13

Thank you all for your comments. As far as I can see **the part related to the UCI multiplexing** is particularly problematic.

The purpose of this bullet was to expresses that a UE must have all the necessary information to select bits from the circular buffer, i.e., to segment the RV, prior to the TBoMS transmission. In this sense, having such information prior to the determination of the index of the starting coded bit for each transmitted slot would allow UE to know everything since the “start”.

On the one hand, we have companies who argue in favour of not adding the third bullet, since this may change the UCI timeline rules, given that a certain amount of time will pass between the scheduling of the TBoMS transmission and the TBoMS transmission itself. This is a fair argument and should be considered.

On the other hand, we have companies that would like to ensure that the least number of systematic bits are lost in case of UCI multiplexing. These companies, who often prefer Option B in **FL’s proposal 14**, are concerned by the possible performance loss in this case. While being fair, this argument is from FL’s perspective a flaw since it does not prevent error propagation to happen in case of missing DCI. It is also worth observing that the support of TBoMS repetitions has been agreed also to reduce/mitigate the impact of a large loss of systematic bits due to puncturing (in case of UCI multiplexing). In other words, the fact that TBoMS can be repeated with RV cycling provides an effective way to get those systematic bits back with the repetitions using a different RV.

For all these reasons, I think that while it is unfair to ask to remove the third bullet, we should probably have it as an FFS for the time being (at least until we take a decision on the starting bit in each slot in Section 2.1.2.2).

Finally, moving to the comment made by Intel on the Note. The purpose of the Note is to give company the possibility to simulate the impact of different approaches to UCI multiplexing on the performance. This does not mandate nor ask companies to study such performance but allows such studies to be performed. Of course, this also implies that the final decision on UCI multiplexing rule will be taken in RAN #107-e.

I hope this can address all your concerns. Working assumption 1 is modified as follows.

**Working Assumption 1-v2**

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

* **Bit interleaving is performed per slot.**
* **The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.**
* **Transmission is limited to one CB only.**
* **FFS: whether UCI multiplexing bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not**

**Performance with UCI multiplexing on single and multiple slots of a TBoMS is FFS**

If any concerns on the proposal still exist, companies are invited to express them below.

|  |  |
| --- | --- |
| Company | Concerns on proposal WA1-v2 |
| LG | Unfortunately, we cannot accept the proposed working assumption 1-v2. When Option C is applied, some coded bits cannot be transmitted during UCI multiplexing, resulting in the same result as puncturing TBoMS transmission. This means that TBoMS transmission can fail during UCI multiplexing with high probability.On the other hand, in Option B, the case of mismatch in UCI multiplexing by missing the DL grant is much rarer than the case that a problem occurs in Option C.If we say that the problem of Option C can be handled by retransmission, this can be true of Option B as well.In that sense, we cannot agree to make the sub-bullet related to UCI multiplexing as FFS. |
|  |  |
|  |  |

FL’s comments on October 14

Thank you for your comments.

@LG: keeping that bullet as FFS does not imply that changes to the UCI multiplexing timeline are precluded. Conversely, removing that FFS point would imply that UCI multiplexing timeline changes are to be designed. I think there is a big change between the two perspectives, and what you are asking does not respect the fact that most companies do not agree with you. I invite you to consider that we are working together as a group, and the current formulation still gives you the possibility to make your point and convince other companies if you so wish. What you propose does not give proponents of Option C the same possibility and it is thus not fair. Finally, I should note that this WA is of fundamental importance for us to be able to discuss other aspects and complete the feature. We have all worked hard to get here, since many meetings, and as FL I do not think we can afford scrapping this effort to start from scratch again. I hope you can reconsider your position in view of my considerations.

Given the above consideration, I would keep the WA as is, and will copy it below for completeness.

**Working Assumption 1-v2**

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

* **Bit interleaving is performed per slot.**
* **The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.**
* **Transmission is limited to one CB only.**
* **FFS: whether UCI multiplexing bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not**

**Performance with UCI multiplexing on single and multiple slots of a TBoMS is FFS**

This proposal will certainly be discussed tomorrow during the GTW, where I hope we could finally achieve an agreement. I invite everyone to be reasonable and I’d like to offer another opportunity for further discussion among companies who still wish to discuss about **strong concerns**. **Please remember the importance of this WA for being able to complete this feature**. Thank you.

|  |  |
| --- | --- |
| Company | Concerns on WA1-v2 |
|  |  |
| ZTE | The proposal is not our preference, but we can like with this direction with a clear understanding on the proposed scheme. One point not clear to us is about the FFS on UCI multiplexing. Below is the scheduling restriction in Rel-16 for multiplexing HARQ-ACK on PUSCH. With such restriction, our understanding is the UCI bits would be always known prior to PUSCH transmission in the first slot, in case of DG PUSCH and CG type 2 PUSCH. Please correct me if I am wrong.

|  |
| --- |
| *A UE does not expect to detect a DCI format scheduling a PDSCH reception or a SPS PDSCH release, a DCI format 1\_1 indicating SCell dormancy, or a DCI format including a One-shot HARQ-ACK request field with value 1, and indicating a resource for a PUCCH transmission with corresponding HARQ-ACK information in a slot if the UE previously detects a DCI format scheduling a PUSCH transmission in the slot and if the UE multiplexes HARQ-ACK information in the PUSCH transmission.* |

If above understanding is correct, we need to revise the FFS as: * **Note: UCI multiplexing bits, if any, is known prior to the determination of the index of the starting coded bit for each transmitted slot, for DG/CG type 2 TBoMS, according to Rel-15/16 scheduling restriction/processing timeline.**
	+ **FFS for CG type 1 TBoMS**
 |
| FL | Thank you for this observation. Other companies are invited to check the above and provide further views |
| QC | Some knowledge of UCI may be available/known beforehand. **But its hard to conclude that all UCI information on all slots of a single TBOMS will be known beforehand**. Imposing this constraint might prove too difficult for gNB scheduler to abide by.For example, for legacy CG repetitions, the above timeline constraint does not apply, so new HARQ bits may be multiplexed in later slots and may not be known beforehand.A-CSI on PUSCH overlapping with CG-PUSCH can occur. This is another case where all details on UCI mux. may not be known beforehand. There are detailed prioritization rules involved here.Even for DG PUSCH with repetitions, there are proposals in R17 TEI to alter the above rule.One thing is clear --- we are debating how UCI multiplexing influences transmission in each slot of a single TBOMS. And as things stand, we don’t have a clear solution.Can we add the following bullet/note to clarify the current status?How UCI multiplexing influences the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further. I am not sure if this addresses ZTE’s concern. I would be okay with any note/bullet that gives the group some clarity on issues that we need to resolve.Minor note: I think Type 1 CG is ruled out for TBOMS unless we decide to revamp the associated TDRA table.  |
| Sharp | We share the view with ZTE. At least for HARQ-ACK multiplexing to a dynamically scheduled PUSCH, the number of bits can be known to the UE prior to the first transmission of the PUSCH. On the other hand, we also think that it’s hard to conclude in this meeting that all the UCI to be multiplexed can be known to the UE prior to the first transmission according to the current specification. An example is first SP-CSI on PUCCH after activation. In that sense, we are OK with keeping it as FFS and discussing details in the next meeting. |
| Spreadtrum | We share a similar view that for some UCI multiplexing on PUSCH repetitions cannot be known before the first slot of PUSCH. Such as dynamic HARQ-ACK on PUCCH overlapping with CG-PUSCH repetitions, dynamic HARQ-ACK can be mapping to the other CG-PUSCH repetitions. This case is also valid that dynamic HARQ-ACK on PUCCH overlapping with TBoMS CG-PUSCH. So we are fine to leave it as FFS point. |
| OPPO | We agree the UCI bits determination is somehow more stringent. But put this FFS is important for Per slot interleaving. Otherwise, seem per TBoMS interleaving will be simpler. We don’t want performance loss in case multiplexing UCI will puncture some coded bits. |
|  |  |

#### [OPEN] Starting bit in each slot for the single TBoMS

Companies’ preferences concerning the starting bit in each for the single TBoMS are as follows.

The starting bit position for first slot in one TBoMS PUSCH is determined like legacy by RV index. The position in the circular buffer of the starting bit for each further allocated slot is defined as:

* A multiple of the LDPC lifting size $Z\_{c}$. **[2]**:
	+ - Huawei/HiSi [3], NTT DOCOMO [2]
* The position continuous from the end of the bits from previous allocated slot. **[1]**:
	+ - Samsung [19]
* The position determined by the position of last coded bits read from the circular buffer for the previous allocated slot assuming no UCI multiplexing occurred**[2]**:
	+ - NEC [25], Sharp [24].
* The position depends on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated **[1]**:
	+ - Panasonic [18]

Furthermore, one company (Qualcomm [19]) proposes that, to avoid error propagation issues, the index of the starting coded bit for each slot is predetermined prior to the start of the TBoMS transmission.

FL’s comments on October 11

From FL’s perspective, the views expressed by companies so far, already highlight the two most important aspects of this discussion:

1. Which reference is to be used to identify the starting point for the bit selection in the circular buffer in each slot?
2. When should the UE determine the starting point for the bit selection in the circular buffer for each transmitted slot?

Concerning the first aspect, the input company proposed so far may not be sufficient to form any possible FL’s proposal. More views are needed and will be asked below.

Concerning the second aspect, from FL’s perspective, the current agreement on application of dropping rules for TBoMS already implies that the UE knows how many bits will be eventually transmitted prior to the start of the TBoMS transmission.

|  |
| --- |
| **Agreement**The UE determines whether or not to drop a slot determined as available for TBoMS transmission according to Rel-15/16 PUSCH dropping rules, where the dropped slot is still counted in the N allocated slots for the single TBoMS transmission.FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s) |

In this context, it seems natural to propose that the starting point for the bit selection in the circular buffer for each transmitted slot is determined prior to the start of the TBoMS transmission as well.

**FL’s proposal 3**

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

A question is also added to start the discussion on how to identify the starting coded bit for each transmitted slot for the TBoMS transmission.

**2.1.2.2-Q1**. *How should* *the position of the starting point for the bit selection in the circular buffer be determined for the i-th allocated slot?*

* 1. *As a multiple of the LDPC lifting size* $Z\_{c}$*.*
	2. *As the position continuous from the end of the bits selected and transmitted in the previous allocated slot*
	3. *As the position continuous from the end of the bits selected and transmitted in the previous allocated slot, assuming no UCI multiplexing occurred*
	4. *As the position given by* $k\_{i}=\left\{\begin{matrix}l\_{RV\_{x}}&i=0\\l\_{RV\_{x}}+i∙N\_{ref}+1&i>0\end{matrix}\right.$*, where* $l\_{RV\_{x}}$ *is the starting bit of the first slot, as function of the RV id, and* $N\_{ref}$ *is the reference number of bits based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated.*
	5. *Others*

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

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 3.** The content of the proposal reflects the proposals of a very large majority of companies; hence a fast convergence is desirable. If you do not support the content of the proposal, it is very much appreciated if you can provide alternative formulations which can address your concern while respecting the core of the proposal. A suitable table is added to this end before the first one.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 3** | Lenovo, Motorola Mobility, QC(critical for resuming after cancellation), vivo, Panasonic, Sharp, DCM, Spreadtrum, CATT, LG, Apple, Xiaomi, WILUS, NEC, Huawei, Hisilicon, Ericsson, Nokia, NSB, MediaTek |
| **Do not support FL’s Proposal 3** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 3, if any. |
| ZTE | We would like to clarify that, does this proposal mean that the UCI multiplexing bits if any has to be known prior to the start of TBoMS transmission? If so, we are fine with the proposal.  |
| Intel | It may be good to clarify whether UCI multiplexing is included in the predetermined starting position of coded bits in each slot of TBoMS transmission.  |
| Samsung  | The proposal itself has bit confusion if I combined with Q1.Proposal seems to say, the bits for each slots should be determined before actual transmission. But the Q1, e.g., B, C, it seems related to “*transmitted in the previous allocated slot*”, which I don't this is the case if it is aligned with the proposals. Could FL clarify a little bit.FL: I apologize for the ambiguity. My understanding is that all options above are compatible with FL’s proposal 3. If available slot determination if performed prior to the first transmission, as per agreement, then for each available slot the UE would be able to identify what is the “previous allocated slot”. Please note that this logic applies regardless of whether any dropping rule applies or not. |
| LG | It is desirable that the composition of rate-matched bits should not be changed due to UCI multiplexing or TBoMS dropping. Whether to multiplex UCI on TBoMS should be determined before starting TBoMS transmission, and TBoMS should be punctured in case of collision. |
| OPPO | We agree the clarification needed as comment by ZTE and intel. |
| Huawei, Hisilicon | *Option A could be combined with B, C and D. because per slot processing can be applied to all the options.* *From UE and BS implementation perspective, to reuse the repetition type A as much as possible for TBoMS processing, per slot is preferred. And option A together with option B, C and D can make this processing easier with fewer stating bit positions**Otherwise the starting bit position index could be from 0 to* 25344. With granularity of Zc, there are only up to 66 values for the potential starting bit positions. |

Additionally, companies are invited to provide an answer to **2.1.1.2-Q1** in the table below. Please tick the column corresponding to one answer and add corresponding additional comments if you choose answer “*E*”.

The goal is to identify the preferred direction RAN1 should pursue for determining the position of the starting point for the bit selection in the circular buffer, for the i-th allocated slot. Feel free to elaborate on your answer in the suitable column, if applicable. It is very much appreciated if discussion is kept at technical level, for the sake of an efficient use of the limited time RAN1 has. Constructive attitude is warmly recommended.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Company | A | B | C | D | E | Additional comments, if any. |
| ZTE |  | √ |  |  |  | We suggest to further discuss this issue after more progress made for Proposal 2 (RM per slot or per TBoMS). Because many of the proposed methods seem only applicable to RM per slot.  |
| Lenovo, Motorola Mobility |  | √ |  |  |  |  |
| QC |  |  |  | √ |  | Option D seems like a good starting point --- also seems to subsume C. Open to accommodating A. |
| Intel |  | √ |  |  |  | Firstly, Option A can be selected only together with B/C/other. So, our view is to discuss down selection from: B, C, A&B, A&C while B is preferred to be included in the decision.Additionally, it would be reasonable to clarify that Option B assumes to account UCI multiplexing for bit selection starting position determination. |
| Vivo |  |  | √ |  |  | Option-C is straightforward, resolving ambiguity in UCI MUX, and seems less spec impact. |
| Panasonic |  |  | √ | √ |  | For high level, we support Option C. We think the intention of C and D is same. |
| Sharp |  | √ | √ | √ |  | How to handle UCI bits can be discussed further. To us, C is almost equal to D. |
| NTT DOCOMO | √ |  |  |  | √ | We also prefer the starting point shifted by a certain constant value from the end of bit selection in the previous slot, as a margin for UCI multiplexing. This approach also can satisfy the FL’s proposal 3. |
| Spreadtrum |  |  | √ | √ |  | We support Option C or D. |
| CATT |  |  |  |  |  | Intuitively there seems no much inner difference between Option A~D (considering the repetition type A like TDRA pattern). It is more like a wording issue on how the spec captures ‘per slot’ rate matching. If so, we are fine with any one of A~D. |
| TCL |  | √ |  |  |  | Option B is preferred. |
| OPPO |  | √ |  |  |  |  |
| Xiaomi |  |  | √ |  |  | Option C is more suitable for TBoMS with one single RV. |
| WILUS |  | √ |  |  |  |  |
| NEC |  |  | √ | √ |  | Both option C and D are OK if N\_ref in option D is considered assuming no UCI is multiplexed on the first L symbols. |
| Huawei, Hisilicon | √ |  |  |  |  | Option A could be combined with B, C and D. because per slot processing can be applied to all the options. From UE and BS implementation perspective, to reuse the repetition type A as much as possible for TBoMS processing, per slot is preferred. And option A together with option B, C and D can make this processing easier with fewer stating bit positionsOtherwise the starting bit position index could be from 0 to 25344. With granularity of Zc, there are only up to 66 values for the potential starting bit positions. |
| Ericsson |  | X | X |  |  | At least if UCI presence meets timeline requirements prior to the first TBoMS transmission, we think it can be taken into account. On the other hand, we are not aware of simulation results for this, so we can consider both B and C.  |
| Nokia, NSB |  | √ | √ | √ |  | Option B, C or D are more aligned with the agreement that only a single RV is supported for a single TBoMS. Option A can be considered as multiple RVs within a single TBoMS since there could be overlapping between the bits mapped to each slot determined by Zc, and therefore contradicts the previous agreement.  |

**FL’s comments on October 12**

Thank you all for your comments. As you have seen when reading the previous session, I have decided to incorporate FL’s proposal 3 in the Jumbo Working assumption of section 2.1.2.1, given that:

* it received unanimous support.
* it was mentioned by some company as an important aspect to agree on together with the others.

For this reason, discussions on FL’s proposal 3 as such are paused for the time being.

Switching the focus to 2.1.2.2-Q1, a high-level summary of the inputs that were shared is the following:

* Option A is preferred by 2 companies.
* Option B is preferred by 9 companies.
* Option C is preferred by 8 companies.
* Option D is preferred by 6 companies.

It has also been argued that:

* Options B, C and D are extremely close to each other, where Option D may subsume C.
* Option A can be compatible with Options B, C and D.
* Option A could be suitable for TBoMS repetitions but less compatible with existing agreements on single RV for the single TBoMS transmission.
* Decision on this aspect should be taken after an agreement on the bit interleaving time-unit has been reached.

Now, from FL’s perspective the following observations are made:

* Option A’s merits are not questioned by any company. However, only 2 companies think the advantage this Option A is significant. In this sense, I am not sure it makes sense continuing including this option in the list and I’d like to ask proponents to reconsider their position.
* Option B is different from Option C as in the way UCI multiplexing is considered when performing the bit selection from the circular buffer. This solution could be described differently as “bit selection from the circular buffer is continuous; when UCI multiplexing occurs in a slot, coded bits selected from the circular buffer are rate-matched around the UCI; the starting bit index in each slot may not be expressed as an integer multiple of E (max number of coded bits that can be transmitted in a slot, i.e., $N\_{ref}$ in Option D)”
* Similarly, Option C could be described differently as “bit selection from the circular buffer is continuous; when UCI multiplexing occurs in a slot, the coded bits selected from the circular buffer which would be transmitted over the REs used for the UCI are not transmitted; the starting bit index in each slot can be expressed as an integer multiple of E (max number of coded bits that can be transmitted in a slot, i.e., $N\_{ref}$)”
* I agree with the assessment that Option D subsumes Option C, given that:
	+ *The starting bit of the first slot would be the same in the two Options, and function of the RV id.*
	+ *The same number of coded bits can be transmitted at the most in each slot allocated for TBoMS. This number is called* $N\_{ref}$ *in Option D but is the same number of coded bits that would be considered in Option C to identify the starting bit in each slot. Indeed, the number of coded bits in the first L symbols over which the TBoMS transmission is allocated is the number of REs present in each allocated slot for TBoMS (assuming that, if UCI multiplexing occurs, the bits that would have been transmitted over the REs occupied by the UCI are simply not transmitted).*

Having said this, Option D may sound more obscure (where it is not) and probably too close to spec language (hence, unnecessarily precise🡪this is a task for the Editor). For this reason, I suggest using Options C instead.

For all the above reason, I think that the following proposal can be formulated.

**FL’s proposal 14**

**For each allocated slot for TBoMS, one of the following options for the position of the starting point for the bit selection in the circular buffer is down selected:**

* **Option B: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and transmitted in the previous allocated slot.**
* **Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and transmitted in the previous allocated slot, assuming no UCI multiplexing occurred**

**Note: this applies irrespective of the bit interleaving time unit.**

I realize that agreeing on FL’s proposal 14 before agreeing on the Jumbo Working Assumption may not be possible. For this reason, I prefer avoiding asking companies to input views at this stage and defer this step to when a decision on the WA is taken. At the same time, I’d like to progress in terms of understanding of the different options. Hence, for the time being, I’d like to check whether companies agree on my analysis above and, if yes, what their preference would be for FL’s proposal 14.

|  |  |
| --- | --- |
|  | Preferred Option (this is just an exploratory question) |
| **Option B** | Sharp, CATT, ZTE, LG, OPPO, Intel,TCL |
| **Option C** | QC, Sharp, Panasonic, DCM, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, CATT, CMCC, Apple |

|  |  |
| --- | --- |
| Company | Comments on FL’s understanding and analysis |
| QC | We have tried hard to avoid error propagation in 8.8.1.1 and are also trying to do the same in 8.8.1.3. We would like to strive for the same principle to also be applied here and would therefore like to go with Option C.Any solution that decouples the dynamics of UCI mux/cancellations/prioritizations from the dynamics of TBOMS transmission across multiple slots would be acceptable to us. |
| Sharp | Option C is slightly preferred. On the other hand, we are also OK with Option B, as commented in the 1st round.  |
| Panasonic | We support FL’s understanding and analysis. We are fine to merge Option D to Option C. On Option C, in order to clarify that it achieves “the index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission”, we propose to add “to be” before transmitted in the previous allocated slot like following. Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and **to be** transmitted in the previous allocated slot, assuming no UCI multiplexing occurredWe are not sure how to achieve “the index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission” in Option B. |
| NTT DOCOMO | We support Option2 among these two options. When DCI scheduling UCI is not detected, Option B causes misalignment of the starting position between UE and gNB.  |
| WILUS | We mis-commented our preference in the last round. We prefer Option C, which is robust to DTX. |
| CATT | We are fine with both options. Option B is natural while Option C is more robust to the case if UCI response to a DCI is missed. The performance between these two options is not expected to be large eventually. |
| Huawei, Hisilicon | From the feature lead summary, and feedback from companies, there seems no technique concerns on option A, and some companies are open to discuss it. We think that option A together with other options could be discussed further to see if there is any technique concerns. And combination of the A&B, A&C, A&D could be discussed. From our implementation, the starting bit of each slot needs to be as a multiple of the LDPC lifting size $Z\_{c}$. the merits includes:* This is also because the QC-LDPC decoder is operated in unit of Zc
* For per slot processing, the starting bit index range only within 0 to 65. It is because the maximum length of the coded bits in the circular buffer is $66×Z\_{c}$. this apparently simplify the index counting.
* This can reuse the typeA repetition implementation as much as possible. (note: the index of the starting bit of each slot is multiple of the LDPC lifting size $Z\_{c} $in type A repletion is ). Otherwise, the index of the starting bit of each slot will be within 0 to 25344, which complicated the implementation.
* If a starting bit location is multiple of Z, it would be beneficial to decoder complexity and latency aspect. And many contributions described this during R15 LDPC rate matching including R1-1714590, R1-1713231, R1-1713210, R1-1714168 in RAN1#90.

Overall, if the TBoMS is interleaved by a slot based unit, then the starting position should be multiple of Zc for each slot to facilitate the LDPC decoding and encoding on a per slot based style. We need to take care of the technique concern during the discussion.Our preference is option C combined with option A, i.e.**Option C’ : The position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and transmitted in the previous allocated slot, assuming no UCI multiplexing occurred, and the stating bit index of each slot is a multiple integer of Zc** |
| ZTE | If UCI multiplexing bits, if any, can be known prior to the determination of start index of coded bits, Option B is sufficient.  |
| Samsung  | Follow-up by preivous comments from us and FL’s reply.“My understanding is that all options above are compatible with FL’s proposal 3. If available slot determination if performed prior to the first transmission, as per agreement, then for each available slot the UE would be able to identify what is the “previous allocated slot”. Please note that this logic applies regardless of whether any dropping rule applies or not.”My concern is not on the allocated, my concern in on the “transmitted”, as we know that a determined available PUSCH slot, the transmission on it could be cancelled, this is then not fit the “transmitted”. This in turn, will ask UE to recalculate the bit starting position. One example, 3 available slots, normally, slot 1 transmits bit 0~99; slot 2 transmits bit 100~199; slot 3 transmits bit 200~299; if slot 2 gets cancelled, then by this proposal, slot did not counted as “transmitted”, then slot 3 will switch to 100~199 instead of 200~299; is this the intention of the group? I thought the group wanted to determine the bits to be transmitted in each slot before any of them is actually transmitted, then cancellation wont impact the slot 3. Thus, suggested change:* **Option B: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected ~~and transmitted~~ in the previous allocated slot.**
* **Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected ~~and transmitted~~ in the previous allocated slot, assuming no UCI multiplexing occurred**
 |
| LG | Under the assumption that the UCI multiplexing is determined prior to the start of the TBoMS transmission as in the proposed working assumption 1, we support Option B and don’t see the necessity of Option C.As we mentioned in 2.1.2.1, it should be assumed that the rate-matched bits for each transmitted slot and UCI multiplexing bits are determined before the start of TBoMS transmission. If Option C is applied, it causes a problem that transmission of some coded bits is omitted when UCI multiplexing is performed. If the omitted bits include systematic bits, it will be a problem for reliable TBoMS transmission.  |
| OPPO | The Option B can select bits with best bits without loss performance. The UCI multiplexing bits should be know before the bit selection to avoid “Puncturing” data bits. |
| Intel | If we do not consider the continuous mapping of the coded bits for TBoMS transmission, in case of UCI multiplexing or dropping, certain systematic bits would be dropped, which would lead to performance degradation.  |
| Apple | For option B, the benefit/limitation is multiplexing on the first slot without picturing, but it multiplexing is on the other slot, missing the UCI could be problematic. |
| Qualcomm2 | We acknowledge that Option B and Option C each have their own merits. For clear recovery from cancellations, we would need something along the lines of Option C.Will be good to understand what proponents of Option B have in mind for how the UE is to select bits for a slot immediately after a slot in which a cancellation occurs.Currently, as per R15/R16 rules, UE does not resume transmission in a slot after a cancellation. The bits in the pipeline are discarded and a new set of bits are chosen for the next slot. It will be good to identify a clear starting point for each slot especially to address such cases.We would strongly urge against any changes to UCI multiplexing timeline. That topic gets complicated rather quickly and we will not be able to converge in the remaining time we have. |

FL’s comments on October 13

I understand that different opinions exist. However, a clear majority exists for Option B. In this context, I invite companies in favour of this option to try convincing other companies that this is the best solution for this problem.

**Please use the table above to continue this discussion**.

To facilitate this process, I will try summarizing what in my view are the most critical aspects of Option B, according to companies’ comments and what I also said in the previous section. From my perspective, the questions that proponents of Option B should answer is the following:

* How can mismatch/misalignment between NW and UE be avoided in case a DCI is missed at the UE and UCI is not multiplexed as expected?
* How can the index of the starting coded bit for each transmitted slot be predetermined prior to the start of the TBoMS transmission according to Option B?
* Is UCI multiplexing timeline to be changed (to make it more constrained) to ensure that neither of the two above problems occur?

I warmly invite proponents of Option B to address these questions in the table below.

Conversely, proponents of Option B observe that Option C may suffer from non-negligible performance loss for the single TBoMS in case, UCI is multiplexed, given that a large number of systematic bits may be lost in this case. In this case, at least one answer has already be provided many times and is, from FL’s perspective, quite convincing:

The TBoMS repetition framework provides an effective way of getting back to systematic bits in another repetition rather quickly, even if a large part of them was lost due to a UCI multiplexing in a previous TBoMS repetitions. In this regard, it should be noted that that the RV cycling would also provide a certain level of diversity to be able to accommodate for the UCI multiplexing to occur in any slot of the single TBoMS transmission, if repetitions are enabled.

Further comments follow:

@Huawei – I retain your point; however, it is fair to say that your proposal did not get a very large support. Your logic is sound though, hence I think an FFS point can be added to given other companies more time to think about this aspect. I hope this can be acceptable for you.

@Samsung: I think your comment applies to Option C and not to Option B. I modify Option C to account for this. Conversely, I will keep Option B as is, unless proponents ask the change. Indeed, proponents assume that all information about UCI multiplexing will be available prior to per slot starting bit determination. Accordingly, all the information is there to ensure that the UE would be able to identify for any allocated and transmitted slot the position of the starting point, for the bit selection in the circular buffer, as the position continuous from the end of the bits selected and to be transmitted in the previous allocated slot. This is also the reason why I think my three questions above are quite relevant for proponents of Option B to convince all the other companies to change opinion. Indeed, this Option seems to rely on a much stronger set of assumption as compared to Option C.

@Panasonic: your suggestion is retained.

FL’s proposal 14-v2 is thus modified as follows.

**FL’s proposal 14-v2**

**For each allocated slot for TBoMS, one of the following options for the position of the starting point for the bit selection in the circular buffer is down selected:**

* **Option B: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and to be transmitted in the previous allocated slot.**
* **Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected ~~and transmitted~~ in the previous allocated slot, assuming no UCI multiplexing occurred**

**FFS: whether the stating bit index of each slot is expressed as a multiple integer of the lifting size Zc**

**Note: this applies irrespective of the bit interleaving time unit.**

Companies are invited to state if they support or not **FL’s proposal 14-v2** in the first table below. Further comments can be added in the Second table. Please ensure that you consider the guidelines I suggested above to continue the discussion on the two Options. It would be cleaner if the table above was used to this end. Thank you.

|  |  |
| --- | --- |
|  | Company |
| **Support FL’s proposal 14-v2** | QC, Panasonic, Ericsson, TCL |
| **Do not support FL’s proposal 14-v2** | LG |

|  |  |
| --- | --- |
| Company | Further views on FL’s Proposal 14-v2 |
| QC | What to do after cancellation is not very clear with Option B. Will be good to clarify in future. Okay with the proposal as it currently stands. |
| Samsung  | Though we see the intention with current proposal some far. But few clarification is needed for us to decide to support or not.1. as we commented, as QC also mentioned. We want to clarify the operation for option B with mentioned example, 3 available slots, normally, slot 1 transmits bit 0~99; slot 2 transmits bit 100~199; slot 3 transmits bit 200~299; if slot 2 gets cancelled, then by option, UE will still transmit slot 3 transmits bit 200~299. The bit 100~199 will be dropped when slot 2 is dropped. Is it the correct understanding? Because even with “to be transmitted”, it may still be actually transmitted or not transmitted. Do you mean these bits should be transmitted? Then the slot 2 is prohibited to be cancelled?2. by comparing option B and C, it seems the major difference is option B should consider the UCI multiplexing bits, and make me feel option B is more adaptive to timely change (i.e., UCI, tx cancellation), is this also correct understanding?3. For the FFS added by HW, we can live it for FFS now. but we don’t see the need to still ask it for round operation to align integer Zc matrix. First, as we checked, the impacted performance is negligible. More importantly, for a TBoMS, even with the alignment with Zc matrix, UE will to calculate based on the bits selected/transmitted from previous, the round operation is an additional operation, which is even not an optimization. And such starting position is not be signaled, it is only used at Tx side and Rx side, by implementation, it is not difficult to do.  |
| Panasonic | Thank you for considering our suggestion in the updated proposal. Our intention was to add “to be” to Option C (not to Option B), However, we are fine with the current version of Option C. “to be” in Option B may not be necessary. |
| LG | We cannot support the proposal.In Option B, mismatch between gNB and UE may occur in UCI multiplexing by missing the DL grant. However, we think that the probability of omitting some important coded bits in Option C is higher than the probability that such a problem occurs in Option B. If we say that the problem of Option C can be handled by retransmission, this can be true of Option B as well.To determine the index of the starting coded bit for each transmitted slot prior to the start of the TBoMS transmission in Option B, the timeline requirement for UCI multiplexing on TBoMS needs to be properly defined. For the UCI multiplexing on PUSCH, the timeline is determined based on the first symbol of PUSCH transmission. In case of TBoMS, very simply, the timeline can be determined based on the first symbol of the first slot allocated for the TBoMS. |
| Ericsson | Option c seems to lend itself to more flexible and backward compatible UCI multiplexing, if per slot rate matching is used for TBoMS. Presuming that this kind of rate matching works well, we prefer that. If on the other hand it does not, option B could perform better, but perhaps at the cost of less flexible UCI multiplexing. |
| TCL | The main difference between option B and Option C is whether the UCI multiplexing bits are consideration or not. In our view, if the UCI multiplexing is determined prior to the start of the TBoMS transmission, Option B is preferred.  |

FL’s comments on October 14

Thank you for your comments. I will answer to each company individually, hoping to help everyone. I invite all companies to read what is written below. Thank you.

@Samsung: My clarifications follow:

* + - 1. With reference to this sentence “The bit 100~199 will be dropped when slot 2 is dropped”, the answer is IT DEPENDS. If the slot is canceled due to dropping rules, after available slot determination (which yields the N “starting” slots), then **yes**, the bits 100-199 would not be transmitted and slot 3 would carry bits 200-299. Conversely, if UCI is to be multiplexed over the slot 2, then according to Option B, all remaining available REs after the UCI is multiplexed, are used to transmit some bits from 100 from 100 to B, with $100\leq B<199$. The first bit transmitted in slot 3 would then be bit B+1 and so on. According to proponents, this is not a problem if UCI multiplexing timeline is adjusted to ensure that all the information about UCI multiplexing is available at the UE, prior to the determination of the first bit to be transmitted in each available slot (this implies specification and implementation change). **Conversely**, while in case dropping the behavior of Option B and C is the same, the UCI multiplexing case is handled differently in Option C. According to this option, when UCI multiplexing occurs in slot 2, the bits, if any, transmitted in the remaining REs are not the ones from 100 to B, with $100\leq B<199, $but rather the ones from B to 199. This has the effect of ensuring that the starting bit for slot 3 will always be 200 (in your examples), regardless of the occurrence of UCI multiplexing or not.
			2. If all information about UCI multiplexing can be made available at UE prior to the determination of the first bit to be transmitted in each available slot (this implies specification and implementation change), then Option B ensures that no puncturing of selected bits ever occurs at the UE side. However, this also implies that NW can never be sure about what is going on in case a DCI is missed, since there would not be any fixed reference point (integer multiple of E) for the first bit transmitted in each slot (but this could change depending, at least, on UCI multiplexing).
			3. Personally, I agree with your assessment. On the other hand, I see no harm in leaving the FFS there, and I am glad you can accept its presence,

@Panasonic: Thank you.

@Ericsson: I agree with your assessment and this is why I think the safest choice is to go for Option C, which does not require specification and implementation change to accommodate for UCI multiplexing timeline modifications. Phrased it differently, Option C seems more aligned with the spirit of current WA.

@LG: I do not think your proposal is fair w.r.t. what most companies support. I am also not sure that your argument can be accepted as is. Indeed, you start by referring to “retransmissions” of TBoMS to solve possible issues with NW/UE bit-selection mismatch for Option B in case of missing DCI, or for systematic bits loss for Option C in case of UCI multiplexing. However, what other companies refer to is “repetitions”, not “retransmissions”. Indeed, what justified the introduction of the support of TBoMS repetitions for most companies is the fact that when you cycle RVs through repetitions, **you get multiple opportunities to transmit/receive systematic bits**. Therefore, even if several of them were lost, e.g., during the first repetition, NW can still get them back when further repetitions are received, thanks to the RV cycling.

Now, the question could be: “Doesn’t this benefit of TBoMS repetitions apply to Option B and Option C identically?”

Unfortunately, I am afraid the answer is “**NO**”:

* In Option B, when mismatch occurs, gNB fails at decoding and cannot identify which received bit segments are wrong. Of course, hypotheses, could be made by gNB (e.g., is this the result of a missing DCI? Is this the result of a deep fade? Etc.), but no certainty would be achievable at gNB, only guesses would. Furthermore, if such hypotheses must be tested to mitigate the problem, then implementation impact at gNB increases. Therefore, when a new repetition is received, these bit segments must be received **correctly**. On top of this, if the RV id of the new repetitions is 2 or 1, then even this may not be sufficient, because gNB cannot do soft combining. Finally, we would need both specification and additional implementation impact for implementing new UCI multiplexing timeline.
* In Option C, gNB would know when the UCI is expected to be received, deterministically. Even if the DCI is missed. Hence, the portion of the resource where UCI is supposed to be multiplexed can never be considered as part of the TBoMS by gNB. Now, this can cause large losses of systematic bits in some cases. However, gNB would always know exactly which bits have not been transmitted (according to the RV id), hence soft combining approaches could still be used with no implementation impact. When a new repetition is received, a better decoding can be achieved. No change would be needed for the UCI multiplexing timeline, hence implementation and specification impact would be low, if not zero.

I think is just **fair to acknowledge this**. On the one hand, we have a solution that uses a conservative approach that cannot fail, even if specification and implementation is not changed (Option C). On the other hand, we have a solution that can arguably deliver better performance in the best case, but that can also fail in a more complex way to solve, unless specification and implementation impact is accepted.

While I understand that LG’s preference is different from what the majority prefers, I would really appreciate if you could think about the above and possibly reconsider your position. All companies are trying to work together to finally converge on this fundamental aspect of TBoMS. I am sure many companies are unhappy, but our priority should be to ensure we can complete a basic feature that can work.

Given the above observations, I would keep the Proposal unchanged as follows, especially because a down selection is proposed at this stage, and not the final selection.

**FL’s proposal 14-v2**

**For each allocated slot for TBoMS, one of the following options for the position of the starting point for the bit selection in the circular buffer is down selected:**

* **Option B: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and to be transmitted in the previous allocated slot.**
* **Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected ~~and transmitted~~ in the previous allocated slot, assuming no UCI multiplexing occurred**

**FFS: whether the stating bit index of each slot is expressed as a multiple integer of the lifting size Zc**

**Note: this applies irrespective of the bit interleaving time unit.**

This proposal will certainly be discussed tomorrow during the GTW, where I hope we could finally achieve an agreement. I invite everyone to be **reasonable and fair**. I’d like to offer another opportunity for further discussion among companies who still wish to discuss about **strong concerns**. **Please remember the importance of this Proposal for being able to complete this feature**. Thank you.

|  |  |
| --- | --- |
| Company | Concerns on Proposal 14-v2 |
| ZTE | We were OK with the proposal as commented before. But, as we realized the UCI multiplexing timeline for DG/CG type 2 may not an issue as commented above. We may also need to clarify whether Option C is still valid for DG/CG type 2.  |
| Huawei, Hisilicon | To Samsung, thanks for the comment, and, although the index is not indicated through signalling, similar with the redundancy version, the actual bit index is not signalled, but it is multiple integer of the lifting size. Furthermore, it is making the reuse of repetition type A processing modules as much as possible, and it avoids any risks of incompatibility from the implementation perspective, since most of the functions of rate matching and decoding is on chip which is not easy to change and is operation in the unit of lifting size Zc.As commented before, it seems there is no strong concerns on “**the stating bit index of each slot is expressed as a multiple integer of the lifting size Zc**”. We would like to propose it as a agreement. As follows to try to make an agreemet:**For each allocated slot for TBoMS, one of the following options for the position of the starting point for the bit selection in the circular buffer is down selected:*** **Option B: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected and to be transmitted in the previous allocated slot.**
* **Option C: the position of the starting point for the bit selection in the circular buffer is the position continuous from the end of the bits selected ~~and transmitted~~ in the previous allocated slot, assuming no UCI multiplexing occurred**
* **The stating bit index of each slot is expressed as a multiple integer of the lifting size Zc**

**Note: this applies irrespective of the bit interleaving time unit.** |
|  |  |

### [PAUSED] TBoMS repetitions

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail. In this context, one high-level sub-aspect is isolated as high priority, as illustrated above. The summary of companies’ preferences and opinions based on the contributions is organized accordingly.

#### [PAUSED] Whether and how RVs are cycled across M repetitions of a single TBoMS

A high-level summary of companies’ preferences based on the contributions is as follows.

* Twelve companies (Huawei/HiSi [3], Spreadtrum [23], vivo [6], OPPO [9], CATT [8], China Telecom [11], CMCC [12], Samsung [19], Intel [15], Nokia/NSB [21], Sharp [24], Ericsson [22]) proposed that RVs are cycled across M repetitions of a single TBoMS transmission, i.e., across M groups of N slots allocated for each TBoMS repetition.

FL’s comments on October 11

From the summary above, there is a clear majority view of supporting RV cycling across TBoMS repetitions. Therefore, the following proposal is formulated.

**FL’s proposal 4**

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

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 4**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 4** | CMCC, Lenovo, Motorola Mobility, QC, Intel, vivo, Panasonic, Sharp, DCM, Spreadtrum, Samsung, CATT, LG,TCL, Apple, Xiaomi, WILUS, NEC, Huawei, Hisilicon, China Telecom, Ericsson, Nokia, NSB, MediaTek |
| **Do not support FL’s Proposal 4** | ZTE |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 4, if any. |
| ZTE | We have agreed that TBoMS is based on available slot, and we have defined new RV cycling method (based on available slot regardless of further omission or not). So, shouldn’t we reuse the Rel-17 RV cycling rules defined in AI 8.8.1.1 here? |
| Sharp | We have agreed “the number of slots allocated for TBoMS” is counted based on the available slots. RV is open.  |
| Samsung  | To ZTE, in our understanding, in the multiple slots of one TBoMS, there is only one RV, for another TBoMS, the RV will be cycled. So I am not sure if the issue is conflicted or not. |
| OPPO | It seems agree implicitly in the last meeting of M repetition.  |
| Xiaomi | Since TBoMS is adopted for Configured grant, TBoMS with repetition can also applied for CG scheduling. Under this circumstance, the RV sequences can be {0,0,0,0},{0,3,0,3},{0,2,3,1}. |

FL’s comments on October 12

Thank you all for the comments. All companies but one support FL’s Proposal 4. My understanding is that the proposal does not say anything about the rules, but about the sequences, e.g., {0,0,0,0, {0,3,0,3}, {0,2,3,1}, which I referred to as “patterns” (synonyms from my perspective, in this case) and on the indication of which RV sequence is to be used by UE. I suppose this created some confusion about what FL’s Proposal 4 is trying to say. On the other hand, it should be noted that, differently from what is stated by ZTE, we agreed that TBoMS is based on available slot, but haven’t defined new RV cycling method yet. In particular, an adaptation off Rel-17 RV cycling rules in AI 8.8.1.1 may or may not be used here. As commented by some companies, RV cycling mechanism has not been agreed yet (though, I assume may companies have the same understanding in this sense).

At this stage, maybe a clarification and a decision on the cycling rule is needed before taking any further decision in this direction. From FL’s understanding, there are two possible ways to respect current agreements and working assumptions, while also allowing different RVs to be used in different TBoMS repetitions. Let us assume that RV sequence {0,2,3,1} is configured and, as per agreement, that TBoMS is transmitted over available slots. For simplicity, we assume that no dropping rules apply in this example.

We set N = 2 and M = 3. This gives 6 U slots in total for completing the TBoMS transmission with repetitions. This gives us the following situation, where the 6 slots have been grouped by groups of N slots to represent the allocation of a single TBoMS:

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | U | U | U | U | U | U |

According to agreements, a single TBoMS is transmitted using only one RV, where using one RV does not imply that the same set of coded bits is transmitted in each slot, but rather that the coded bits are selected continuously from the circular buffer. If we then allow RVs to be cycled, then we have the following two possibilities to choose from:

**Alt 1**: The configured RV sequence is used as is over the TBoMS repetitions, and RVs are not cycled over available slots. This gives the following scenario (RV id used in each slot are in the second row of the plot)

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | U | U | U | U | U | U | Slot |
| 0 | 0 | 3 | 3 | 2 | 2 | 1 | 1 | Actual RV id  |

**Alt 2**: RVs are “nominally” cycled through available slots, as in AI 8.8.1.1, but the RV id of the first slot of a group of N slots determines the RV id used for all the slots in that group

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | U | U | U | U | U | U | Slot |
| 0 | 2 | 3 | 1 | 0 | 2 | 3 | 1 | Nominal |
| 0 | 0 | 3 | 3 | 0 | 0 | 3 | 3 | Actual |

As you can see, the two alternatives can result in two different results. From FL’s perspective, both would have specification and implementation impact. Companies are invited to express their views on which Alternative should be used for TBoMS repetitions, and add the rationale of this choice, if they so wish.

*2.1.3.1-Q1: Which alternative should be used to cycle RVs through TBoMS repetitions, as per above description of the alternatives?*

|  |  |
| --- | --- |
|  | Company name |
| **Alt. 1** | QC, Sharp, Panasonic, DCM, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, Huawei, Hisilicon, CMCC, ZTE, Samsung, LG, OPPO, Intel, Apple |
| **Alt. 2** |  |

|  |  |
| --- | --- |
| Company | Additional views on 2.1.3.1-Q1 |
| QC | Alt 1 is the most straightforward choice. We may have to alter the RV selection table to indicate that a new RV is selected per TBOMS repetition and not per transmission occasion as it is done for Type A repetition --- but then there is a clear precedence to doing this given that a similar change already exists to accommodate Type B repetitions: |
| Panasonic | As described in the examples described by FL, Alt.2 does not utilize 4 RVs depending on the value of N. The example uses only RV 0 and 3. Alt.1 ensures different RVs are used. Therefore, we propose to use Alt.1. |
| NTT DOCOMO | Support Alt.1. In our understanding, this RV cycling is performed over available slots, which are before applying to dropping rules. It implies that there is no chance that gNB and UE have different RV indexes. In that case, we could not find any benefits from Alt2.  |
| Xiaomi | Alt 1 is the most straightforward way. For Alt.2, we don’t see the need to introduce the concept of “nominally” cycle, since it is two different functions between PUSCH repetitions and TBoMS with repetitions. |
| WILUS | We share the similar view with above companies. Additional step for RV mapping is unnecessary. |
| Lenovo, Motorola Mobility | We don’t support Alt 2 as it brings unnecessary complexity to RV mapping and should be avoided. Alt1 moreover is able to utilize all RV indices |
| CATT | Alt.1 is straightforward and aligns with our understanding. Alt.2 is weird -- also it may lead to ta case when all single TBoMSs have the same RV, for example, when N=4 and {0,2,3,1} is used:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | U | U | U | U | U | U | Slot |
| 0 | 2 | 3 | 1 | 0 | 2 | 3 | 1 | Nominal |
| 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | Actual |

 |
| CMCC | For each TBOMS, single RV is used. And for the repetition of TBOMS, the RV should be cycled per TBOMS, not per slot. |
| ZTE | Indeed, the confusion comes from the wording ‘patterns’, which we were thinking it is equal to ‘rules’.Alt 1 is preferred. What in our mind was the following case, where N = 2 and M = 3, and the second repetition of TBoMS was postponed due to collision with semi-static DL symbols (not available slots), and the actual transmission of the third repetition is dropped (assuming the two slots for this repetition are all dropped for simplicity). In such case, our understanding is Option 2 should be chosen to align with the Rel-17 rules defined in AI 8.8.1.1 (i.e., RV is cycled across transmission occasions, irrespective of whether PUSCH transmission in the transmission occasion is further omitted or not.)Option 1:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | D | D | U | U | U | U | Slot |
| 0 | 0 | 2 | 2 | 3 | 3 | 1 | 1 | Actual RV id  |
|  |  | Not available | Dropped due to cancellation |  |  |  |

Option 2:

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| U | U | D | D | U | U | U | U | Slot |
| 0 | 0 |  |  | 2 | 2 | 3 | 3 | Actual RV id  |
|  |  | Not available | Dropped due to cancellation |  |  |  |

 |
| LG | For the Rel-16 PUSCH repetition type A, when PUSCH transmission is repeated K times, the applied RV is determined by the index of transmission occasion n. Applying the same principle, the applied RV for n-th repetition of TBoMS can be determined by n.  |
| Intel | Alt. 1 is straightforward solution as single RV is applied for one TBoMS repetition.  |
| Apple | We don’t see the benefits of option 2 comparing with the option 1 but introducing additional complexity. |

FL’s comments on October 13

Thank you all for your comments. I guess this settles the problem and everyone has the same understanding. FL’s proposal 4 could then be rephrased as follows:

**FL’s proposal 4-v2**

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

If any concerns on the proposal exist, companies are invited to express them below. If no concern is expressed before the end of the GTW scheduled on October 14, this proposal will be copied in the reflector for email approval. Thank you.

|  |  |
| --- | --- |
| Company | Concerns on proposal 4-v2 |
|  |  |
|  |  |
|  |  |

FL’s comments on October 14

Thank you for refraining from commenting further. The proposal will be copied in the reflector for email approval. This discussion is paused.

###  [PAUSED] CB segmentation

Several contributions acknowledged the fundamental nature of this aspect and discussed it in detail. A summary of companies’ preferences and opinions based on the contributions follows:

* Limit TBoMS transmission to one CB only [4]
	+ Panasonic [18], NTT DOCOMO [26], Nokia/NSB [21], Qualcomm [17]
* All the CBs corresponding to the TB as part of single TBoMS are to be transmitted on each slot partially/completely. Bits selected from each CB for the given slot are interleaved in per-slot basis to maintain consistency with existing specs and current hardware design [1].
	+ MediaTek [20]
* CB segmentation is supported. Rate matching is performed continuously across all the allocated slots for TBoMS, if CB segmentation doesn't occur. Otherwise, rate matching is performed for each CB once [1].
	+ Ericsson [22]

Two companies listed above mentioned the possibility of supporting CB segmentation, upon conditions, as second preference (Panasonic, Nokia/NSB).

FL’s comments on October 11

As discussed earlier, this aspect has an evident interplay with the bit interleaving time unit. At the same time, it could be discussed separately, given that CB segmentation is directly related to the TBS. A majority of company expressed the opinion that TBoMS transmission could be limited to one CB in Rel-17, and thus CB segmentation should not be supported/needed.

As we know, in fact, CB segmentation in Rel-15 occurs only when TBS is large than 3824 bits which could correspond to a bitrate ranging between few hundreds of kbit/s to more than 1.5 Mbit/s in FR1, depending on how many slots are used to transmit the TBoMS. As argued by several companies, these values would seem largely superior to the typical values one can expect to support over a PUSCH experiencing coverage shortage. Considering larger TBS values for TBoMS in Rel-17, and thus deciding on other aspects of the system such as the bit interleaving time unit depending on this, does not seem intuitive in this context.

Of course, this does not mean that considering larger TBS values for TBoMS does not make sense in absolute terms. However, the relevance of this approach in the context of the CovEnh WID of Rel-17, is highly debatable. From FL’s perspective, priority should be given to the design of a basic and meaningful TBoMS feature, aligned with scope of the WID, in Rel-17. Further enhancements would not be precluded and could be introduced in further releases, if any need in this sense arises.

It is worth reminding that available time before the end of the release is very limited, hence we should really strive to converge rapidly on more intuitive aspects, such as CB segmentation, using intuitions directly stemming from the content, scope and spirit of the WID.

For all the above reasons, the following proposal is made.

**FL’s proposal 5**

**TBoMS transmission is limited to one CB only.**

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

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 5.** The content of the proposal reflects the proposals of a majority of companies, which outline a reasonable and sensible direction. If you do not support the content of the proposal, it is very much appreciated if you can provide alternative formulations which can address your concern while respecting the core of the proposal. A suitable table is added to this end before the first one.

Given the observations provided so far, I would ask companies to focus on the technical aspects of the matter and provide technical comments in these regards. The goal is to converge rapidly for an aspect which does not seem to present criticalities, given the content, scope and spirit of WID.

Constructive attitude in this regard is greatly appreciated.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 5** | ZTE, Lenovo, Motorola Mobility, QC, Intel, vivo, Panasonic, DCM, Spreadtrum, Samsung,TCL, Apple, WILUS, IITH, IITM, CEWIT, Reliance Jio, Tejas Networks, Ericsson (only if per TBoMS interleaving is precluded) , Nokia, NSB, MediaTek |
| **Do not support FL’s Proposal 5** | LG, Huawei, Hisilicon, Ericsson (first preference) |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 5, if any. |
| ZTE | We are fine with the proposal. |
| QC | Don’t see any strong motivation to support multi-CB TBOMS. |
| NTT DOCOMO | One of the biggest motivations to support TBoMS is to enlarge the channel coding output length. If the CB segmentation is applied, the gain by TBoMS is unclear. Also, limiting only one CB accelerates TBoMS discussion. Given that only two meetings are left, it is not a good idea to spend discussing about TBoMS with multiple CB cases, which are not likely to be used for cell-edge UE. |
| LG | Even though network may assign narrower subband for operating TBoMS, we didn’t make a conclusion to limit a bandwith for TBoMS. Similarly, if we assume that network may configure small size of TBS for operating TBoMS, this operation can be possible by network scheduler and indication.In addition, in order to fully obtain the advantage of TBoMS capable of reducing MAC header overhead, it is necessary to increase the TB size even if the TB is segmented into multi-CBs. In this sense, we don’t see any strong motivation to permit a limitation of using single CB only in the specification. |
| OPPO | We also agree the proposal, that is another way to simplify the TBoMS |
| Huawei, Hisilicon | Don’t see any necessity to have the restriction. And propose to postpone the discussion. |
| Ericsson | As explained above, some of the data rates studied in Cov Enh do require CB segmentation, and so it is clearly in scope of the WID. However, if per TBoMS interleaving is precluded, then per CB interleaving becomes rather more complex and the performance losses from per slot interleaving for larger MCSs tend to make the use case for CB segmentation less interesting. So if we go for only per slot interleaving (and so preclude per TBoMS interleaving), we think CB segmentation should not be supported, and agree with the FL proposal in this case. |

FL’s comments on October 12

Thank you all for your comments. A majority of companies expressed preference for supporting only one CB for TBoMS in Rel-17. Given what I am proposing in Section 2.1.2.1, this discussion is now paused.

## Mid priority aspects

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

1. TBS determination
	* 1. Whether 1<K<N is supported
		2. Whether maximum TBS should be limited
2. UCI multiplexing rules
3. Dropping rules
4. Transmission power determination
5. Frequency hopping
6. Rank of TBoMS transmission
7. Additional indicators and configuration options

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 FL’s comments/proposals on these aspects are provided in the following different sub-sections, whose numbers are given in the list above.

### [PAUSED] TBS determination

#### [PAUSED] Whether 1<K<N is supported

Most contributions acknowledged the fundamental nature of this aspect and proposed that 1<K<N is not supported for Ninfo calculation for TBoMS. A high-level summary of companies’ preferences based on the contributions, is as follows:

* The scaling factor 1<K<N to calculate N\_info for TBS determination is **not** supported **[9]**:
	+ Huawei/HiSi [3], ZTE [5], IITH [29], CATT [8], Panasonic [18], Samsung [19], Nokia/NSB [21], WILUS [7], Ericsson [22],
* The scaling factor 1<K<N to calculate N\_info for TBS determination is supported [**3**]:
	+ Vivo [6], OPPO [9], LGE [28],

In addition, the following were also proposed:

* One company (CATT [8]) proposed the following:
	+ For initial transmission, TBS of TBoMS is calculated by the following steps:
		- Step 1: A UE first determines the number of REs allocated for TBoMS within a PRB ($N\_{RE}^{'}$) by $N\_{RE}^{'}=N∙(N\_{sc}^{RB}∙N\_{symb}^{sh}-N\_{DMRS}^{PRB}-N\_{oh}^{PRB})$.
		- Step 2: A UE determines the total number of REs allocated for TBoMS ($N\_{RE}$) by $N\_{RE}=min(N\_{RE}^{'}∙n\_{PRB} , 156∙N\_{PRB})$.
		- Step 3: Obtain unquantized intermediate variable ($N\_{Info}$) by $N\_{Info}=N\_{RE}∙R∙Q\_{m}∙v$.
		- Where *N* is the total number of the allocated available slots for TBoMS, and $N\_{PRB}$ is the maximum bandwidth of the active UL BWP.
	+ For retransmission, TBS of TBoMS follows the TBS of initial transmission.
* One company (NTT Docomo [26]) proposed that if scaling factor 1<K<N is supported, the scaling factor should be dynamically indicated.
* One company (Qualcomm [17]) proposed that, for retransmissions of TBOMS, support shorter duration transmissions by also allowing values of N≤ K. This ensures the same TB size can be determined for a retransmission even if the number of slots for a single TBOMS is reduced.

FL’s comments on October 11

It can be observed from the summary above that a large number of companies considers that supporting 1<K<N for TBS determination is not necessary. However, there are also 3 companies proposing to support 1<K<N. From FL’s perspective, a proposal that captures the majority view should be formulated, especially considering that the support of TBoMS repetitions, already agreed, provides a lot of flexibility in terms of effective code rate reduction. In addition, it is worth noting that, if there is no further consensus on supporting 1<K<N, then only K=N is supported for TBoMS, as agreed in RAN1 #106-e.

**FL’s proposal 6**

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

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 6**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 6** | ZTE, CMCC, Lenovo, Motorola Mobility, Intel, Panasonic, Sharp, DCM, Spreadtrum, Samsung, CATT, Apple, Xiaomi, WILUS, IITH , IITM, CEWIT, Reliance Jio, Tejas Networks, Huawei, Hisilicon, Ericsson, Nokia, NSB |
| **Do not support FL’s Proposal 6** | LG,TCL,OPPO |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 6, if any. |
| TCL | In our views, K<N could be supported for calculating N\_info. In one hand, high code rates could be avoided if K<N is supported, in another hand, the TBS could be adjusted by the configured value of K, which is align with the agreement of the TBS of TBoMS could not be larger than legacy TBS in Rel-15/16. |
| OPPO | The K can be a smaller number which can be additionally indicated in the table. |
| Ericsson | K<N is not needed; we already have repetition, and gains from K<N are not clear to us. |

FL’s comments on October 12

From the first-round discussion, 17 companies support FL’s proposal 6 for not considering values 1<K<N, while 3 companies do not support it. From FL’s perspective, given that the pros and cons of considering 1<K<N or not have been extensively discussed, a binary decision on this aspect should be taken in this meeting. Given that there is a clear majority view on supporting FL’s proposal 6 and that TBoMS repetition is already supported, I would like to invite the objecting companies to be flexible and reconsider their position. This seem a rather reasonable approach given, as I said, the already agreed support of TBoMS repetitions.

My replies to some comments in the first round are as follows.

@TCL: Thank you for your comment. From my understanding, avoiding high coding rate can be done by selecting low MCS, as it is by the way expected in the context of coverage shortage. In addition, given that TBoMS repetition is also supported then the lower effective coding rate brought by TBoMS repetition would be comparable with (if not higher than) supporting 1<K<N. My understanding on the agreement that TBS of TBoMS should not be larger than legacy max TBS in Rel-15/16 is to avoid any modification on the channel coding procedure, whereas it does not imply that TBS of TBoMS should be smaller than the legacy PUSCH case. Indeed, if the intention of introducing TBoMS is to reduce resource in frequency domain (to obtain higher EPRE) and extending it in time domain, the TBS in case of TBoMS may or may not be the same as the legacy PUSCH and can be adjusted via suitable MCS configuration.

@OPPO: Thank you for your comment. As mentioned by several companies, additional configuration of K in the TDRA table may add the unnecessary RRC overhead given that TBoMS repetitions can offer comparable (if not better) alternative.

**FL’s proposal 6**

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

Companies are invited to input their views on FL’s proposal 6 in the corresponding table below **if there is strong concern only**.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 6, if any. |
|  |  |
|  |  |
|  |  |

FL’s comments on October 13

No concerns have been expressed so far. If any concerns on the proposal exist, companies are invited to express them below. If no concern is expressed before the end of the GTW scheduled on October 14, this proposal will be copied in the reflector for email approval. Thank you.

FL’s comments on October 14

The proposal has been stable for the last 40 hours. No comment was received. The proposal will be copied in the reflector for email approval and this discussion is paused. Thank you.

#### [CLOSED] Whether maximum TBS should be limited

Details of whether maximum TBS should be limited or not were discussed in several contributions and can be summarized as follows.

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

$$\frac{\sum\_{m=0}^{M-1}V\_{j,m}}{L×T\_{s}^{μ}}\leq DataRateCC$$

where V\_(j,m) still represents the scheduled bits for the m-th TB over multi-slot and L represents the number of symbols assigned to the PUSCH within a slot.

* One company (ZTE [5]) proposed that maximum TBS can be limited by the conditions of date rate limitations DataRate and DataRateCC.
* One company (CATT [8]) proposed that, for a single TBoMS, no restriction is specified except for the maximum TBS.
* One company (Qualcomm [17]) proposed that, for TBoMS, no new TB sizes are introduced.

FL’s comments on October 11

From FL’s perspective, this topic is closely related to the discussion on CB segmentation in Section 2.1.4, FL suggests postponing discussions on this topic until further progress is made (or, whenever applicable, jointly discussing it) in Section 2.1.4.

### [PAUSED] UCI multiplexing rules

Most contributions acknowledged the fundamental nature of this aspect and discussed it in detail. The discussions and can be summarized as follows.

* Five companies (China Telecom [11], MediaTek [20], NTT Docomo [26], Nokia/NSB [21], Qualcomm [17]) proposed that Legacy R15/R16 framework for UCI multiplexing with PUSCH should be reused (as much as possible).
* Four companies (Intel [15], Samsung [19], NEC [25], InterDigital [14]) explicitly proposed that UCI multiplexing on TBoMS is supported.
* One company (Huawei/HiSi [3]) proposed the following:
	+ Each available slot identified by UE is considered as a transmission occasion for TBoMS transmission, and the transmission occasion based power control, UCI multiplexing, rate matching in the current specification is reused.
	+ The parameter $β\_{offset}^{PUSCH}$ should be scaled by K for TBoMS transmission.
* One company (vivo [6]) proposed that the number of modulated symbols in the TBoMS for UCI should be same/close to that multiplexed in a single slot PUSCH, following options can be considered:
	+ Opt-1: Re-define the parameter N\_"symb,all" ^"PUSCH" as number of symbols per slot allocated for TBoMS;
	+ Opt-2: BetaOffset and scaling (α) is scaled by 1/N, where N is the number of slots for a TBoMS.
* Two companies (Fujitsu [10], Sharp [24]) proposed that UCI multiplexing should be performed per slot.
* One company (OPPO [9]) proposed that UCI is equally multiplexed into all slots of TBoMS transmission.
* One company (NEC [25]) proposed that legacy UCI multiplexing behaviour for PUSCH repetition can be considered as baseline. When PUCCH transmission without PUCCH repetition overlaps with PUSCH TBoMS transmission, UCI is multiplexed with TBoMS within a slot. When to calculate ratio of resources for UCI in PUSCH in a slot, additional scaling factor based on scaling factor K used for TBoMS TB size determination should be considered.
* One company (CATT [8]) proposed that to determine the number of REs for UCI multiplexing on TBoMS, the following are supported:
	+ The number of available slots for TBS determination can be used to determine the data rate for UCI resource computation.
	+ The number of available overlapping slots between PUCCH and TBoMS can be used to determine the upper bound of UCI resource on TBoMS.
* One company (CATT [8]) proposed that the current UCI mapping rules can be reused for UCI multiplexing in one slot of TBoMS. For UCI multiplexing in multiple slots of TBoMS, the REs occupied by UCI are evenly divided and mapped in each of the overlapped slots.
* One company (TCL [4]) proposed the following:
	+ UCI multiplexing is performed by puncturing or rate-matching depending on whether the determination time is before or after the starting time of PUSCH preparation.
	+ If rate matching is performed per-TOT or cross all allocated slots of TBoMS, S\_0 should be redefined.
	+ If UCI multiplexing is performed by puncturing, S\_0 may differ from rate-matching for UCI multiplexing.
	+ For per-TBoMS rate-matching, the calculation formula of Q\_ACK^' should be scaled by k/N, or β\_offset^PUSCH | α scaled by k/N to keep the UCI resources close to the current specification.
	+ If UCI multiplexing in TBoMS is supported, UCI repetition should be considered.
* One company (Samsung [19]) proposed the following:
	+ Parallel transmission of PUCCH and TBoMS PUSCH is not preferred due to power splitting during CE situation.
	+ The timeline requirement is applied for the actual overlapped slot in the TBoMS.
* One company (LGE [28]) proposed the following:
	+ In case of collision between TBoMS and PUCCH without repetition, UCI is multiplexed on the TBoMS in the overlapped slot.
	+ Aperiodic CSI can be multiplexed on the TBoMS in the first actual slot of the TBoMS transmission.
	+ $N\_{symb,all}^{PUSCH}$ is the number of symbols for TBoMS in a corresponding slot in which UCI is multiplexed for determination of the values of $Q\_{ACK}^{'}$, $Q\_{CSI-part 1}^{'}$, $Q\_{CSI-part 2}^{'}$, and $Q\_{CG-UCI}^{'}$.
	+ To determine the values of $Q\_{ACK}^{'}$, $Q\_{CSI-part 1}^{'}$, $Q\_{CSI-part 2}^{'}$, and $Q\_{CG-UCI}^{'}$, ${\sum\_{l=0}^{N\_{symb,all}^{PUSCH}-1}M\_{sc}^{UCI}\left(l\right)}/{\sum\_{r=0}^{C\_{UL-SCH}-1}K\_{r}}$ is multiplexed by N, where N is the number of slots allocated for TBoMS.
* One company (Ericsson [22]) proposed that if UCI multiplexing in TBoMS is supported, HARQ-ACK can be included in any overlapping slot by puncturing, and CSI or HARQ-ACK can be repeated in all slots of a TBoMS.
* One company (WILUS [7]) proposed further discussing how to determine the number of REs for UCI multiplexing and UL transmission power in case of TBoMS.

FL’s comments on October 11

It can be observed from the summary above that many companies explicitly or implicitly propose that UCI multiplexing should be possible for TBoMS transmission. In addition, several companies also propose that the legacy Rel-15/16 framework for UCI multiplexing should be reused as much as possible. Therefore, from FL’s perspective, RAN1 can agree on supporting UCI multiplexing for TBoMS following the legacy Rel-15/16 framework of UCI multiplexing on PUSCH as a baseline. Any other enhancements to support UCI multiplexing for TBoMS can be further discussed when the rate-matching approach is clarified. Thus, the following proposal is formulated.

**FL’s proposal 7**

**UCI multiplexing is supported for TBoMS transmission in Rel-17. The legacy Rel-15/16 framework of UCI multiplexing on PUSCH is reused as a baseline.**

* **FFS: other enhancements to support UCI multiplexing for TBoMS, if applicable.**

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 7**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 7** | Lenovo, Motorola Mobility, vivo, Panasonic, Sharp, DCM, Spreadtrum, LG,TCL, Xiaomi, WILUS, NEC, Huawei, Hisilicon, Ericsson (with the clarification below) , Nokia, NSB |
| **Do not support FL’s Proposal 7** | Intel, CATT |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 7, if any. |
| Intel | Suggest to defer the discussion on the UCI multiplexing rule before we can conclude on bit-interleaving.  |
| CATT | May be a good direction, but clarification is still needed: what is the exact baseline? Is it ‘The legacy Rel-15/16 framework of UCI multiplexing on PUSCH repetition type A’? Or something else? |
| LG | We support the FL’s proposal. In our view, enhancement on the UCI RE number determination should be specified regardless of rate-matching discussion. |
| WILUS | Support. The legacy Rel-15/16 framework of UCI multiplexing means ‘UCI multiplexing per slot’. It’s nothing to do with bit-interleaving options. |
| Ericsson | Just to clarify (similar to CATT): Since TBoMS is multislot transmission, the intention is the following, right? UCI multiplexing is supported for TBoMS transmission in Rel-17. The legacy Rel-15/16 framework of UCI multiplexing on PUSCH Repetition Type A is reused as a baseline. |

FL’s comments on October 12

From the first-round discussion, 14 companies support FL’s proposal 7, while 2 companies do not support it. This is already quite a good step in the direction of a possible agreement, however given what is being discussed in Section 2.1.2.1, i.e., the jumbo WA, I prefer pausing this discussion for the time being, to resume it later.

### [CLOSED] Dropping rules

Details of dropping rules for TBoMS are discussed in several contributions and can be summarized as follows.

* Three companies (MediaTek [20], Nokia/NSB [20], Qualcomm [17]) proposed that the legacy approach of collision handling in Rel-15/16 for PUSCH repetition Type A should be reused for TBoMS.
* One company (Fujitsu [10]) proposed that collision handling should be performed per slot.
* One company (Ericsson [22]) proposed that PUCCH repetition can override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s)
* One company (Ericsson [22]) proposed that Rel-17 PUSCH dropping rules include the case that one particular slot is determined as an available slot for multiple time-overlapping UL channels or signals (including TBoMS, Type A PUSCH repetition enhancement option 2, A-SRS, or SPS HARQ-ACK). RAN1 is to define the priority of the multiple time-overlapping UL transmissions. The UE only transmits the channel or signal with the highest priority in overlapping symbols in the slot.

FL’s comments on October 11

From FL’s perspective, it is worth noting that the following agreement was made in RAN1#106-e, wherein a basic framework of PUSCH dropping rules for TBoMS was agreed which follows Rel-15/16 PUSCH dropping rules. Therefore, discussions on this topic can be considered as further enhancements and may not be as paramount as discussions on the higher priority aspects in Section 2.1, or other mid priority aspects in Section 2.2. FL suggests postponing discussions on this topic until need arises (during #106-bis-e or later).

|  |
| --- |
| AgreementThe UE determines whether or not to drop a slot determined as available for TBoMS transmission according to Rel-15/16 PUSCH dropping rules, where the dropped slot is still counted in the N allocated slots for the single TBoMS transmission.FFS: Rel-17 PUSCH dropping rules are also applied if introduced in other WI(s) |

### [OPEN] Transmission power determination

Details of transmission power determination for TBoMS are discussed in several contributions. Two options are identified for the transmission power determination in TBoMS, which can be summarized as follows.

* Option 1: The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals.
	+ Huawei/HiSi [3], Ericsson [22],
* Option 2: The transmission power determination of TBoMS should be based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.
	+ ZTE [5], TCL [4],

In addition, the following were also proposed:

* One company (Huawei/HiSi [3]) proposed that, for power control of TBoMS, BPRE should be divided by the scaling factor K to compensate the power control error caused by the large TB scaled by K.
* One company (CATT [8]) proposed that the transmitted power of a single TBoMS remains unchanged during the transmission.
* One company (WILUS [7]) proposed to further discuss on how to determine the number of REs for UL transmission power in case of TBoMS.

FL’s comments on October 11

From FL’s perspective, the discussion on this topic is relevant both to complete the feature and to be able to provide input for the first version of the CRs expected to be ready shortly after the end of RAN1 #106-bis-e. With the above two identified options for the transmission power determination for TBoMS, the following proposal and question are formulated. Details on whether BPRE should be scaled by K or not should be discussed after the approach for transmission power determination for TBoMS is clarified.

**FL’s proposal 8**

**For transmission power determination of TBoMS transmission in Rel-17, RAN1 to down-select in RAN1 #106-bis-e meeting one of the following two options:**

* **Option 1: The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals**
* **Option 2: The transmission power determination of TBoMS should be based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.**

**FFS: details on BPRE**

A question is also added to start the discussion on down-selection in the next step, if FL’s proposal 8 is agreed.

**2.2.4-Q1**

*What is your preference on the two options listed in FL’s proposal 8 above? Please indicate 1st and 2nd preference, if applicable.*

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 8** and **2.2.4-Q1**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which considers the current spirit of the proposal in the suitable table (the second from the top).

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 8** | ZTE, CMCC, Lenovo, Motorola Mobility, Intel, Panasonic, Sharp, DCM, Spreadtrum, CATT, LG,TCL,OPPO, Apple, WILUS, IITH , IITM, CEWIT, Reliance Jio, Tejas Networks, Ericsson, Nokia, NSB |
| **Do not support FL’s Proposal 8** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 8, if any. |
|  |  |
|  |  |
|  |  |

**Views on 2.2.4-Q1**

|  |  |
| --- | --- |
|  | Company name |
| **Option 1**(The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals) | Lenovo, Motorola Mobility, Panasonic, CATT, LG, WILUS, IITH , IITM, CEWIT, Reliance Jio, Tejas Networks, Ericsson, Nokia, NSB |
| **Option 2**(The transmission power determination of TBoMS should be based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.) | ZTE, Intel, CATT,TCL |

**Further comments on 2.2.4-Q1, if any**

|  |  |
| --- | --- |
| Company | Views |
| ZTE | The support of TBoMS impacts . Per our understanding, Kr is the TBS which depends on all slots, and therefore NRE should be also based on REs in all slots.  |
| Vivo | In our understanding, this proposal is related to how BPRE is calculated in Tx power determination, considering RE number within a slot or RE number in N slots. $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{N\_{RE}}$, considering $\sum\_{r=0}^{C-1}K\_{r}$ has been scaled by number of slots, it is nature that $N\_{RE}$ should also be scale by *N*. The BPRE calculation should be revised to $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{(N\_{RE}\*N)}$. That is our understanding on Opt-2.While we reading contributions for opt-1, $BPRE$ is scaled by 1/N, i.e., $BPRE=(\sum\_{r=0}^{C-1}{K\_{r}}/{N\_{RE})/N}$. These two equations are actually the same? If our understanding is correct, we can avoid discussion on selection of opt-1 and opt-2, but focus on how to revise the equation for BPRE calculation for TBoMS? |
| Sharp | We can discuss the detail once the basic functionality (i.e., rate-matching) was confirmed. |
| CATT | Either is fine with us. |
| TCL | We agree with ZTE. |

FL’s comments on October 12

The following agreement was made in the online GTW session today:

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

Concerning question 2.2.4-Q1, 8 companies supported Option 1 whereas 3 companies supported Option 2 and one company supported both options. What vivo commented is indeed another reasonable way of discussing about transmission power determination. However, it may be more convenient to first define the principle, and then straightforwardly identify with BPRE calculation corresponds to the principle. I hope this approach can be agreeable.

Now, given that most companies support Option 1 and that Option 1 is more aligned with the legacy way of handling transmit power determination, FL’s proposal 15 (which takes Option 1) is formulated as follows.

**FL’s proposal 15**

**The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals.**

**FFS: details on BPRE**

Companies are invited to input their views on **FL’s proposal 15** in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 15** | Sharp, Panasonic, DCM, WILUS, Lenovo, Motorola Mobility, CATT, OPPO |
| **Do not support FL’s Proposal 15** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 15, if any. |
| QC | We wonder if we can go a step further. We are discussing how to compute BPRE. Can we draft a proposal to say that BPRE is to be computed using a certain formula?Vivo points out that both approaches arrive at the exact same BPRE calculation. So can we go with:Proposal:BPRE for TBOMS is calculated as $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{(N\_{RE}\*N)}, $ where N is the number of slots allocated for a single TBOMS and $N\_{RE}$ is the number of allocated REs in one allocated slot of a single TBOMS. |
| Sharp | QC’s proposal is also OK for us. |
| Xiaomi | We are fine with QC proposal. |
| WILUS | Support and also fine with QC’s proposal. |
| Vivo | Prefer with QC’s proposal, and it is what the spec looks like in our mind, no matter which option is agreed. |
| CATT | Also fine with QC’s version or leave it to the editor. |
| Huawei, Hisilicon | When 1<K<N is supported, the BPRE equation should be $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{(N\_{RE}\*K)}$.Then it is better to be decided after the conclusion of 1<K<N. |
| CMCC | QC’s proposal is fine to us. And also no problem for FL’s proposal. |
| ZTE | We have similar understanding as above companies. We are fine with the proposal from QC.  |
| LG | Same view with QC. |
| Intel | This may have some misunderstanding on the detailed proposal. If this is related to BPRE determination, we suggest to go with the solution directly. As proposed by QC, in our view, this is similar to take all the REs allocated for TBoMS to calculate BPRE.  |
| Apple | Agree with QC’s proposal. |

FL’s comments on October 13

Thank you all for your comments. All companies agree we can move straight the agreeing on the BPRE. This is fine with me. The proposal will be updated below.

Concerning Huawei’s comment. I checked Section 2.2.1 and no company expressed further concerns on **FL’s proposal 6**. I think it is safe to assume that no further values of K will be supported, and the formulation proposed by Qualcomm is sufficient.

**FL’s proposal 15-v2**

**BPRE for TBOMS is calculated as** $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{(N\_{RE}\*N)}, $ **where N is the number of slots allocated for a single TBOMS and** $N\_{RE}$ **is the number of allocated REs in one allocated slot of a single TBOMS.**

Companies are invited to input their views on **FL’s proposal 15-v2** in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit. Comment in the second table below **only if you have strong concerns**. Thank you.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 15-v2** | Panasonic, LG |
| **Do not support FL’s Proposal 15-v2** | Ericsson (Should be simplified for single CB) |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 15-v2, if any. |
| Ericsson | This decision depends on the number of codeblocks for TBoMS. Presuming that only one CB is supported, then the equation should be $BPRE={K}/{(N\_{RE}\*N)}$ |
|  |  |
|  |  |

FL’s comments on October 14

Concerning Ericsson’s comment, I think the current equation still works and is formally correct. Indeed, if only one CB is supported (as more likely, at this stage), we would have C=1 and $BPRE=\sum\_{r=0}^{C-1}{K\_{r}}/{(N\_{RE}\*N)=K/(N\_{RE}\*N)}$,hence no ambiguity would exist. Furthermore, it may be argued that such equation could already be suitable to accommodate further enhancement down the road, if applicable. I propose to keep it like this for the time being, without modifying the original formulation.

@Ericsson: is my explanation acceptable to you?

I add another table here for capturing further comments, if any. If no comment is received by the next GTW, scheduled on October 15, I hope we can agree on the proposal quickly online (or have an email approval if the subject is not treated online). Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 15-v2, if any. |
| Ericsson | I think we agree the sum is unneeded, and I don’t think we normally write equations in case they could be forward compatible. I would be OK with adding a note: “How this equation or its equivalent is captured in the specification is left to the editor”. |
|  |  |
|  |  |

### [OPEN] Frequency hopping

Many contributions acknowledged the importance of this aspect and discussed details in their contributions, which can be summarized in the following table.

|  |  |  |
| --- | --- | --- |
|  | Support | Not support |
| Inter-slot FH (same as the legacy PUSCH repetition Type A) | Spreadtrum [23], CATT [8], China Telecom [11], TCL [4], Panasonic [18], vivo [6], Intel [15], Nokia/NSB [21], Sharp [24], Qualcomm [17] |  |
| Intra-slot FH (same as the legacy PUSCH repetition Type A) | Spreadtrum [23], CATT [8], TCL [4], Nokia/NSB [21], Sharp [24], Qualcomm [17] | Vivo [6] |
| Inter-slot frequency hopping with inter-slot bundling for a single TBoMS (with or without JCE) | China Telecom [11], TCL [4], Xiaomi [13], Panasonic [18] (for JCE and follow AI 8.8.1.3), Intel [15], CATT (with JCE) [8] | Spreadtrum [23], CATT (w/o JCE) [8], Nokia/NSB [21], Qualcomm [17] |
| Inter-repetition FH for TBoMS repetitions | Intel [15] | Spreadtrum [23], CATT [8], Nokia/NSB [21], Qualcomm [17] |

Additionally:

* One company (CATT [8]) proposed that for TBoMS without joint channel estimation, no new inter-slot FH mechanism is introduced.
* One company (TCL Communications [4]) proposed that the inter-slot bundling with inter-slot frequency hopping should be supported for TBoMS.

FL’s comments on October 11

From FL’s perspective, the discussion on this topic is relevant to complete the feature and to be able to provide input for the first version of the CRs expected to be ready shortly after the end of RAN1 #106-bis-e. As summarized in the table above, there is no objection on supporting at least the inter-slot FH for TBoMS, as done for PUSCH repetition Type A. Therefore, the following proposal is formulated.

**FL’s proposal 9**

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

* **FFS: other frequency hopping schemes.**

In contrast, further discussion is needed to decide whether to support intra-slot FH, inter-slot FH with inter-slot bundling without JCE and inter-repetition FH for TBoMS repetitions. From FL’s perspective, two observations are in order in these regards:

* Only one company objected to support of inter-slot FH (same as in legacy PUSCH repetitions Type A) for a single TBoMS transmission. The position described in the corresponding paper [6] is justified by the small channel estimation accuracy that such scheme would yield as compared to inter-slot FH, which would always be possible for TBoMS, given its multi-slot nature.
* A discussion on the design of inter-slot FH with inter-slot bundling with JCE for TBoMS is not aligned with the scope of this AI, but rather with the scope of AI 8.8.1.3. It is thus recommended to discuss this matter therein, not to introduce inconsistencies and ambiguities between the two AIs. The discussion in this AI should be related only to the application or not to TBoMS of the framework for inter-slot FH with inter-slot bundling with JCE, as discussed in AI 8.8.1.3.

The following question is formulated to collect companies’ views on other FH schemes.

**2.2.5-Q1**

*Should the following frequency hopping schemes be supported for TBoMS?*

* *Intra-slot FH (same as the legacy PUSCH repetition Type A),*
* *Inter-slot frequency hopping with inter-slot bundling for a single TBoMS without JCE,*
* *Inter-repetition FH for TBoMS repetitions.*

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 9** and **2.2.5-Q1**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 9** | ZTE, Lenovo, Motorola Mobility, vivo, Panasonic, DCM, Spreadtrum, CATT, LG,TCL,OPPO, Xiaomi, WILUS, Ericsson, Nokia, NSB, Sharp, Samsung  |
| **Do not support FL’s Proposal 9** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 9, if any. |
| Intel | We already agree as working assumption to support joint channel estimation for TBoMS. It would be reasonable to also consider inter-slot frequency hopping with inter-slot bundling for a single TBoMS when joint channel estimation is supported. Our view is that we should discuss this issue here rather than in joint channel estimation AI.  |
| Sharp | We don’t see the motivation to have Inter-repetition FH. If necessary, enhanced FH developed in AI8.8.1.3 can be reused. |
| CATT | We support inter-bundling hopping when JCE is applied. When not applied, not new hopping pattern is introduced.Agree that inter-bundling hopping depends on the outcome of 8.8.1.3. |

**Views on 2.2.5-Q1, if any**

|  |  |  |
| --- | --- | --- |
|  | Support | Not support |
| Intra-slot FH (same as the legacy PUSCH repetition Type A) | ZTE, Lenovo, Motorola Mobility, Intel, Panasonic, Sharp, Spreadtrum, CATT,TCL, Xiaomi, WILUS, Ericsson, Nokia, NSB | vivo |
| Inter-slot frequency hopping with inter-slot bundling for a single TBoMS without JCE | Lenovo, Motorola Mobility, Panasonic, Sharp,TCL, Xiaomi, WILUS, Ericsson (Given clarification below) | ZTE, vivo, Spreadtrum, CATT, LG, Nokia, NSB |
| Inter-repetition FH for TBoMS repetitions. | Lenovo, Motorola Mobility, Intel, Spreadtrum,TCL, Xiaomi | ZTE, vivo, Sharp, CATT, LG, Nokia, NSB |

**Further comments on 2.2.5-Q1**

|  |  |
| --- | --- |
| Company | Views |
| Vivo | Do not understand why Inter-slot frequency hopping with inter-slot bundling for a single TBoMS **without** **JCE.** Besides, if we agree that the per slot implementation logic is followed by TBoMS, and treat it like PUSCH repetition, there is no need to have new frequency hopping pattern for Inter-slot frequency hopping with inter-slot bundling for a single TBoMS **with** **JCE,** in addition to that defined for type-A PUSCH repetition. same mechanism can be reused from AI 8.8.1.3. |
| Ericsson | **Intra-slot FH** is not likely to perform as well as inter-slot in general, but may be beneficial in a few specific cases like 3 repetitions. So we are OK to have it as long as the spec impact is low.**Inter-slot hopping for TBoMS without JCE** makes sense to us, but the wording “with inter-slot bundling” without JCE seems self contradictory. We understand that this wording is taken from the WID, but think the intent is that the UE is configured with a new hopping pattern that allows bundling, but that the UE is not configured for bundling when using this hopping pattern. We see two benefits to such a configuration (please find more details in R1-2110127):* A UE not capable of, or not in a configuration suitable for, DMRS bundling can hop with other UEs in the cell that are configured for DMRS bundling with the new hopping pattern. This is needed to maintain spectral efficiency in such a scenario.
* The hopping pattern developed for DMRS bundling can be beneficial more generally, i.e. it provides gains even without being configured for DMRS bundling.

**Inter-repetition FH** is not so clear to us. Does it mean that the UE is one one set of PRBs for all slots of a repetition and another set for all slots of the next repetition? Or does it mean that the hopping is inter-slot, but resets with each TBoMS repetition, or? |
| Sharp | We don’t see the motivation to have Inter-repetition FH. If necessary, enhanced FH developed in AI8.8.1.3 can be reused. |

FL’s comments on October 12

From the first-round discussion, no company objected the FL’s proposal 9. Therefore, **email approval will be requested for FL’s proposal 9**.

Concerning question 2.2.5-Q1, the outcome of first round discussion is the following:

* Intra-slot FH (same as the legacy PUSCH repetition Type A): supported by 12 companies not supported by 1 company.
* Inter-slot frequency hopping with inter-slot bundling for a single TBoMS without JCE: supported by 7 companies and not supported by 6 companies.
* Inter-repetition FH for TBoMS repetitions: supported by 5 companies and not supported by 6 companies.

It can be observed from the above outcome that there is no consensus on supporting inter-slot frequency hopping with inter-slot bundling for a single TBoMS without JCE and inter-repetition FH for TBoMS repetitions. In contrast, there is a clear majority view on further supporting intra-slot FH for TBoMS (same as the legacy PUSCH repetition Type A). Therefore, the following FL’s proposal 16 is formulated.

**FL’s proposal 16**

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

* **FFS: other frequency hopping schemes.**

Companies are invited to input their views on **FL’s proposal 16** in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 16** | QC, Sharp, Panasonic, DCM, Xiaomi, WILUS, Lenovo, Motorola Mobility, CATT, ZTE, LG, OPPO, Intel |
| **Do not support FL’s Proposal 16** | Ericsson |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 16, if any. |
| Ericsson | Intra-slot frequency hopping should generally perform worse than inter-slot, since TBoMS is a multi-slot transmission. We are open to discussing this further, but would like more study of frequency hopping designs in general before agreeing to this proposal now.  |
|  |  |
|  |  |

FL’s comments on October 13

Thank you all for your comments so far. The proposal seems agreeable to all companies who commented so far. If any concerns on the proposal exist, companies are invited to express them below. If no concern is expressed before the end of the GTW scheduled on October 14, this proposal will be copied in the reflector for email approval. Thank you.

FL’s comments on October 14

Thank you for your comments.

@Ericsson: your comment puzzles me a bit. When I asked **2.2.5-Q1**, you added your name in row the table corresponding to **Intra-slot FH (same as the legacy PUSCH repetition Type A)**. There seems to be an incompatibility between the two. Can you please double check? In the meantime, I will leave the proposal as is, since you are the only company who objects it, and further clarification may actually solve the issue.

I add another table here for capturing further comments, if any. If no comment is received by the next GTW, scheduled on October 15, I hope we can agree on the proposal quickly online (or have an email approval if the subject is not treated online). Thank you.

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 16, if any. |
| Ericsson | @FL: My apologies: you’re right, I was a bit inconsistent about intra-slot. As you can see from our first response, we doubt the benefit of intra-slot in the general case for multi-slot transmission, but can identify some possibilities. My intention with the second response is to stimulate some quantitative analysis of FH for TBoMS, and to see how the new patterns we develop for JCE can benefit TBoMS, since we have found that such schemes can provide substantial gains for TBoMS, as we show in R1-2110127.I will not object proposal 16, but hope that we can address the FFS point at this or the next meeting. |
|  |  |
|  |  |

### [CLOSED] Rank of TBoMS transmission

Details of the number of MIMO layers (rank) that should be considered for TBoMS transmission are discussed in several contributions and can be summarized as follows.

* Three companies (vivo [6], Ericsson [22], Qualcomm [18]) propose that TBoMS transmission should be limited to single transmission layer.

FL’s comments on October 11

From FL’s perspective, the discussion on this topic is relevant to complete the feature and to be able to provide input for the first version of the CRs expected to be ready shortly after the end of RAN1 #106-bis-e. In this context, it is worth observing that the use case for TBoMS transmission is coverage enhancement, and not high throughput. In addition, restriction on the rank is also applied in the legacy PUSCH repetition, which again aims at enhancing the reliability and not the throughput as such. Therefore, the following proposal is formulated.

**FL’s proposal 10**

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

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 10**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 10** | ZTE, CMCC, Lenovo, Motorola Mobility, Intel, InterDigital, vivo, Panasonic, Sharp, DCM, Spreadtrum, CATT, LG,TCL, Apple, Xiaomi, WILUS, IITH , IITM, CEWIT, Reliance Jio, Tejas Networks, Ericsson, Nokia, NSB |
| **Does not support FL’s Proposal 10** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 10, if any. |
| CATT | Though we do not see a strong need to have such restriction, we can leave with it. But we should avoid spend precious time on minor optimizations due to single layer restriction, e.g. reducing field bits from DCI. |
| OPPO | Wondering how this 1 MIMO layer (rank) for TBoMS will cause. If we have TDRA table freely configured with 1 to 4 for N. Then for entry N=1, does that means the transmission can be multiple layers? |
|  |  |

FL’s comments on October 12

Given that the following agreement was made in the online GTW session today, this section is closed.

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

### [OPEN] Additional indicators and configuration options

Details of indication/configuration for enabling/disabling TBoMS transmission were discussed in several contributions and can be summarized as follows.

* Option 1: Dynamic enabling/disabling of TBoMS transmission [5 companies]
	+ N = 1 can be configured in TDRA table to indicate single-slot PUSCH transmission. The TBoMS transmission is enabled if N>1: Huawei/HiSi [3], Intel [15], Qualcomm [17],
	+ Using explicit or implicit indication using the value of N or K: LGE [28]
	+ Semi-static and/or dynamic configuration of TBoMS feature for PUSCH should be supported and independent from PUSCH repetition: Lenovo/Motorola [27]
* Option 2: the transmission type between TBoMS and PUSCH repetition can be indicated by higher layers [2 companies]: Ericsson [22], Lenovo/Motorola [27]

In addition, one company (Nokia/NSB [21]) proposed that an indication method for enabling TBoMS transmission per PUSCH scheduling/configuration should be specified. FFS: details.

FL’s comments on October 11

From FL’s perspective, the discussion on this topic is relevant given that RAN1 should decide on one approach to enable/disable the Rel-17 TBoMS transmission feature to complete it. This is particularly relevant for being able to provide input for the first version of the CRs expected to be ready shortly after the end of RAN1 #106-bis-e. Therefore, the following proposal and question are then formulated.

**FL’s proposal 11**

**For enabling/disabling the TBoMS transmission in Rel-17, RAN1 to down-select one of the following two options in RAN1#106-bis-e:**

* **Option 1: TBoMS transmission is enabled/disabled dynamically by using a row in the TDRA table.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**
* **Option 2: TBoMS transmission is enabled/disabled by higher layer signaling.**
	+ **FFS: details.**

A question is also added to start the discussion on down-selection in the next step, if FL’s proposal 11 is be agreed.

**2.2.7-Q1**

*What is your preference on the two options listed in FL’s proposal 10 above? Please indicate 1st and 2nd preference, if applicable.*

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 11** and **2.2.7-Q1**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 11** | ZTE, Lenovo, Motorola Mobility, Intel, InterDigital, vivo, Panasonic, Sharp, DCM, Spreadtrum CATT,TCL,OPPO, WILUS, Nokia, NSB, Apple |
| **Do not support FL’s Proposal 11** | LG, Ericsson (need clarification) |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 11, if any. |
| LG | In our view, if the TDRA table including N is configured, TBoMS is enabled by itself. Therefore, semi-static TBoMS enabling/disabling by TDRA table configuration should be supported. In addition, it is desirable to discuss whether to support dynamic switching between PUSCH repetition and TBoMS transmission according to the indicated value of N here. |
| Ericsson | The terminology of enabling/disabling TBoMS is unclear for me. If the UE behavior changes according to if it is transmitting TBoMS or not, we need to ensure that such behavior can change dynamically if it is indicated dynamically. For example, if power control is over all slots of the TBoMS, or CB segmentation is precluded, or repetition vs. TBoMS repetition is used, could all vary according to if it is enable/disabled for TBoMS. On the other hand, if we say that TBoMS is enabled/disabled according to the length of the TBoMS, but this does not preclude behaving a certain way according to a configuration, then I think I understand… In short, we think a UE should be configured for TBoMS, but can be indicated to transmit a PUSCH with one slot according to TDRA. That is, something like:* Option 2: TBoMS transmission is enabled/disabled by higher layer signaling.
	+ N=1 can be indicated by a row (or rows) in the TDRA table
 |
|  |  |

**Views on 2.2.7-Q1**

|  |  |
| --- | --- |
|  | Company name |
| Option 1(TBoMS transmission is enabled/disabled dynamically by using a row in TDRA table) | ZTE, Lenovo, Motorola Mobility, Intel, InterDigital, vivo, Panasonic, Sharp, DCM, Spreadtrum, TCL, Nokia, NSB,  |
| Option 2(TBoMS transmission is enabled/disabled by higher layer signaling) |  |

**Further comments on 2.2.7-Q1, if any**

|  |  |
| --- | --- |
| Company | Views |
| CATT | One important thing is whether dynamic switching between legacy transmission and TBoMS brings additional complexity to a UE. If no additional complexity is brought, Option 1 is slightly preferred for flexibility. |
| WILUS | Option 1 means that Rel-17 UE who has TBoMS feature is always configured with enhanced/dedicated TDRA table? |
| Ericsson | Please see our comments to proposal 11. We put them there since the terminology of enabling/disabling is unclear to us. |

FL’s comments on October 12

From the first-round discussion, 14 companies support the FL’s proposal 9 while 2 companies do not support it. In addition, concerning question 2.2.7-Q1, 11 companies support Option 1. Following the explanations from the proponents of Option 2, there is some confusion on the wording “enabling/disabling the TBoMS transmission”, which may have two meanings: (i) enabling/disabling of the TBoMS feature or (ii) dynamically indicating a TBoMS transmission for PUSCH (or not) when the feature is already enabled. Therefore, FL’s proposal 11 has been modified to: address this confusion, capture the majority view on question 2.2.7-Q1 and address some comments on question 2.2.7-Q1.

**FL’s proposal 11-v2**

**For TBoMS transmission in Rel-17:**

* **TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in the TDRA table.**
* **Dynamic switching between TBoMS transmission and the legacy PUSCH transmission by using a row in the TDRA table is supported.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**

Companies are invited to input their views on **FL’s proposal 11-v2** in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which takes into account the current spirit.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 11-v2** | QC, Sharp (w/ minor modification), Panasonic, DCM, Xiaomi, WILUS, vivo, Lenovo, Motorola Mobility, CATT, CMCC, LG, OPPO, Intel, Apple |
| **Do not support FL’s Proposal 11-v2** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 11-v2, if any. |
| Sharp | To be clearer, the following update to the first bullet is preferred.**TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row in the TDRA table.** |
| Xiaomi | If there are only limited number of rows (e.g. 3) with N=1 in the combined table, the scheduling flexibility of the legacy PUSCH transmission will be affected. Otherwise, the TDRA table should be configured properly and may need to be enlarged. Another way is just using a 1-bit dynamic indication field to enable or disable TBoMS transmission. Anyway, both are ok for us. |
| ZTE | We wonder why TBoMS feature can be enabled by configuring N=1 in the TDRA table.  |

FL’s comments on October 13

Thank you all for your comments so far.

@ZTE: TBoMS is not enabled by configuring N=1, but rather by indicating a row of the TDRA table for which N>1 is configured. If a row with N=1 is indicated, then TBoMS is not enabled.

Sharp’s comment is retained, and the proposal is modified as follows.

FL’s proposal 11 is thus modified as follows.

**FL’s proposal 11-v3**

**For TBoMS transmission in Rel-17:**

* **TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.**
* **Dynamic switching between TBoMS transmission and the legacy PUSCH transmission by using a row in the TDRA table is supported.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**

If any concerns on the proposal exist, companies are invited to express them below. If no concern is expressed before the end of the GTW scheduled on October 14, this proposal will be copied in the reflector for email approval. Thank you.

|  |  |
| --- | --- |
| Company | Concerns on proposal 11-v3 |
| Ericsson | **If we agree to this proposal, the UE will dynamically switch between behaviors that are different between TBoMS and Repetition Type A when M>1 (where M is the number of repetitions for Type A as well as for TBoMS in the table). If the differences are limited, this is probably OK. However, we already have differences in bit selection, which makes me wonder how retransmission of TBoMS by Type A or vice-versa will work. Power control should be equivalent for this to work, and this constrains UCI multiplexing pretty heavily. Overall, this is a very big step, and while it could make fast progress on the TBoMS design, we would rather first check that the underlying mechanisms work. In our understanding, dynamic switching between Type A with M>1 and TBoMS is a nice to have feature rather than a crucial one for TBoMS. Therefore, we would propose to update the agreement to the following:*** **TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.**
* **Dynamic switching between TBoMS transmission and the legacy PUSCH transmission by using a row in the TDRA table is supported at least for the legacy PUSCH, i.e. the {N=1, M=1} case.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**

**FFS: Dynamic switching between transmissions with** $\{N>1,M\geq 1\}$ **and** $\{N=1,M>1\}$ |
|  |  |
|  |  |

FL’s comments on October 14

Thank you for your comments. I understand that this decision steers the design in a very precise direction and, as such, it should be carefully taken. From FL’s understanding, the possible combinations offered by the proposed signaling are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Single slot PUSCH | Type A PUSCH repetitions | TBoMS | TBoMS repetitions |
| N=1, M =1 |  |  |  |  |
| N=1, M>1 |  |  |  |  |
| N>1, M=1 |  |  |  |  |
| N>1, M>1 |  |  |  |  |

The dynamic switching between each of these configurations would be possible via DCI in the case of DG or CG-PUSCH Type-2. In this sense, the signaling does not seem less powerful than the existing for switching between single slot PUSCH and Type A PUSCH repetitions.

In this context, I am not sure I see the implications that Ericsson hints as concerning UCI multiplexing and power control which, in my view, are related only to UCI multiplexing and power control, and not to the signaling for enabling/disabling TBoMS.

Conversely, I see the implications previously highlighted by Xiaomi concerning the flexibility of this signaling. Indeed, the fact that four types of parameter combinations can exist in the table, then only few rows may be available for each of the combinations, assuming NW wants to configure all of them via RRC. However, this does not seem to be a huge issue for a first basic definition of the TBoMS feature, in my view. Indeed, NW would always have the possibility to decide what to configure, and in which direction skewing the number of rows associated to each of the four possible combinations when configuring the UE-specific TDRA table.

Only one alternative to this approach exists, and this is the addition of an external 1-bit semi-static configuration, or dynamic indication, to enable or disable TBoMS transmission. In this case, such 1-bit configuration/indication would tell the UE whether the column of the TDRA table indicating N is to be considered (TBoMS) or not (legacy PUSCH) for the scheduled PUSCH transmission. Thus, there would be no need to support N=1.

Now, the reason why FL’s proposal 11-v3 has been formulated like this is that it is supported by at least 14 companies (and for now objected only by 1). I think that, given that both Options have pros and cons, and are technically feasible, it does not see unreasonable from FL’s perspective to propose agreeing on the current version of FL’s proposal 11-v3, without overcomplicating it.

After all, and aside the above considerations related to the full control NW would have on each configuration, I guess it is not to be excluded that future extensions to the max number of rows the UE-specific TDRA table can have may be considered by RAN1. Therefore, if any flexibility problem were to be seen on the field, further relatively straightforward enhancements could still be performed.

I would then keep the proposal in its current form and ask companies to add any further comment they may have on this on the table below. I would appreciate if you commented **only in case of strong concerns**.

**FL’s proposal 11-v3**

**For TBoMS transmission in Rel-17:**

* **TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.**
* **Dynamic switching between TBoMS transmission and the legacy PUSCH transmission by using a row in the TDRA table is supported.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**

|  |  |
| --- | --- |
| Company | Concerns on proposal 11-v3 |
| Ericsson | To dynamic switching between Type A PUSCH repetition (i.e. with M>1) and TBoMS (with N>1 and M>=1) is not motivated by performance as far as we can see. The performance of TBoMS is generally as good or slightly better than Type A (if there are no gains, why are we specifying TBoMS?). So we don’t see a need to switch to Type A repetition, although we do see the need to adapt to changing channel conditions and to allow for N=1, M=1. Then the question is if this dynamic switching can have drawbacks, since Type A and TBoMS may be quite similar, but of course will not be identical, ways of transmission, and switching between them may not be seamless. To the extent that they are separate ‘modes’ of transmission that need to be maintained over time, there can be impacts from dynamic switching between them.One example is retransmission. A first TBoMS transmission will have a certain TBS, and a Type A with the same number of slots will have a different TBS. So switching retransmission between Type A and TBoMS is not obvious to me. There could be other problems, such as differences in UCI multiplexing, which then may make timelines messy. But this may not be an issue given the direction we are going, though.In general, I think we’re supporting functionality that is not really motivated by performance gains, and that could (but may not) have significant unforeseen complications. I am certainly open to considering it further, but think RAN1 should look into the details before taking this big step of dynamically switching between repetition Type A and TBoMS.So I continue to propose the modification:**For TBoMS transmission in Rel-17:*** **TBoMS transmission feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.**
* **Dynamic switching between TBoMS transmission and the legacy PUSCH transmission by using a row in the TDRA table is supported at least for the legacy PUSCH, i.e. the {N=1, M=1} case.**
	+ **FFS: details, e.g., TBoMS is enabled when N>1, where N is the number of allocated slots for a single TBoMS.**

**FFS: Dynamic switching between transmissions with** $\{N>1,M\geq 1\}$ **and** $\{N=1,M>1\}$ |
|  |  |
|  |  |

## 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 #106-bis-e. Priority has been given to the aspects and topics discussed in sections 2.1 and 2.2. All other aspects are listed in this section, i.e, 2.3, where proposals made by companies in their contributions are reported and described in detail.

These aspects may not be handled during RAN1 #106-bis-e, unless technical need arises during the discussion on other aspects. For this reason, no specific FL’s proposal or recommendation is formulated at this stage. Should discussions for 2.1 and 2.2 progress fast and converge to agreements, sections for specific aspects, currently in 2.3, may be open for discussions and corresponding FL’s proposals and recommendations may be made.

### [CLOSED] Time domain resource determination

#### For CG-PUSCH TBoMS

One company (Xiaomi [13]) proposed that each slot associated with RV#0 can be deemed as an initial transmission position/slot.

One company (Panasonic [18]) proposed that the domain resource determination including limitation of overall duration for PUSCH repetition Type A is reused and TBoMS for CG-PUSCH does not start in the middle of the single TBoMS.

One company (WILUS [7]) proposed that for TBoMS repetition with configured grant, the initial TO determination should not be confined at TO with RV=0 and only RV sequence {0, 0, 0, 0} can be configured to reduce complexity at the gNB.

#### For a single TBoMS in TBoMS repetitions

One company (Sharp [24]) proposed that time domain resource for m-th (m=0,…M-1) single TBoMS in TBoMS repetition is comprised of ((m-1)\*N)-th available slot to (m\*N-1)-th available slot where the available slots are identified by counting based on available slots.

#### Use of non-consecutive physical slots for paired spectrum

One company (Ericsson [22]) proposed that non-consecutive physical slots can be supported for TBoMS for paired spectrum.

FL’s comments on October 11

From FL’s perspective, discussions on these aspects may not be as paramount as discussions on the higher priority aspects in Sections 2.1.1 for the time domain resource determination. Therefore, FL suggests postponing discussions on these aspect until need arises (during #106-bis-e or later).

### [CLOSED] Rate-matching

#### Definition of the parameter G

One company (Huawei/HiSi [3]) proposed that the parameter G used in the bit selection should be redefined as the total number of coded bits available for transmission of a TB and UCI in one slot.

#### Bit interleaving in case of multiple CBs

One company (Panasonic [18]) proposed that either TBoMS is limited to one CB (1st preference) or multiple CBs are interleaved and concatenated per slot.

One company (MediaTek [20]) proposed that all the CBs corresponding to the TB as part of single TBoMS is expected to be transmitted on each slot partially (or completely) and bits which are selected from each CB for the given slot are interleaved in per-slot basis to maintain consistency with existing specs and current hardware design.

FL’s comments on October 11

From FL’s perspective, albeit very relevant in general, the discussions on these topics may directly depend on the outcome of the discussions in Section 2.1.2 and Section 2.1.4 Therefore, FL suggests postponing discussions on this topic until need arises (during #106-bis-e or later).

### [CLOSED] Slot mapping for TBoMS repetitions

One company (InterDigital [14]) proposed supporting both non-interleaved and interleaved mapping for TBoMS repetitions.

### [CLOSED] FDRA

Four companies (ZTE [5], Xiaomi [13], and Samsung [19], TCL [4]) proposed that the maximum number of PRBs allocated for TBoMS should be limited.

FL’s comments on October 11

From FL’s perspective, albeit relevant in general, discussions on this aspect for TBoMS may not be as paramount as discussions on the higher priority aspects in Sections 2.1-2.2. In addition, relevant discussions on this topic may be carried out under Section 2.1.4. Therefore, FL suggests postponing discussions on this topic until need arises (during #106-bis-e or later).

### [CLOSED] Retransmissions

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

* Four companies (CMCC [12], Samsung [19], Ericsson [22], CATT [8]) proposed that TB-based retransmission of TBoMS should be considered.
* One company (InterDigital [14]) proposed supporting enhanced retransmission mechanisms to avoid the retransmission of the entire TBoMS.
* One company (CATT [8]) proposed that TBS of TBoMS retransmission follows the TBS of initial transmission.
* One company (Apple [16]) proposed that it is up to gNB scheduling to determine the TBoMS re-transmission is by TBoMS, or by repetition, or by single slot transmission.
* One company (Qualcomm [17]) proposed that for retransmissions of TBOMS, support shorter duration transmissions by also allowing values of N≤ K. This ensures the same TB size can be determined for a retransmission even if the number of slots for a single TBOMS is reduced.
* One company (Nokia/NSB [21]) proposed that discussion on partial retransmission should be deprioritized, given the limited available time before the end of the discussions for Rel-17.
* One company (Lenovo/Motorola [27]) proposed that if retransmission for duration shorter than the overall duration of TBoMS is supported, then implicit/explicit configuration of the portion (duration) should be supported with portion indication in the retransmission DCI.

FL’s comments on October 11

From FL’s perspective, discussions on this aspect for TBoMS may not be as paramount as discussions on the higher priority aspects in Sections 2.1-2.2. Indeed, if there is no consensus on supporting partial retransmission of TBoMS, then the TB-based retransmission of the TBoMS is applied. The resource allocation for the retransmission follows the retransmission scheduling. Given that there is only one company which explicitly proposed to discuss the partial retransmission, while several companies proposed not to consider it, FL suggests postponing discussions on this topic until need arises (during #106-bis-e or later).

### [CLOSED] Timeline requirements for UCI multiplexing

One company (LGE [28]) proposed to discuss timeline requirement for UCI multiplexing on TBoMS in slot #n based on: a) the first symbol of the first slot allocated for the TBoMS or b) the first symbol of the slot #n allocated for the TBoMS.

### [CLOSED] Interleaved TBoMS transmission

One company (Qualcomm [17]) proposed that interleaved TBoMS transmissions (carrying different TBs) are not permitted. A UE does not expect a TBoMS transmission in a component carrier to begin before the completion of an ongoing TBoMS transmission in the same component carrier.

# 3 [CLOSED] Proposals for GTW

# 4 [CLOSED] Agreements during RAN1 #106-bis-e

# References

1. RP-202928 New WID on NR coverage enhancements, China Telecom, RAN#90e, Dec. 2020
2. TR 38.830 Study on NR coverage enhancements, 3GPP RAN1 Technical Report, Dec. 2020
3. R1-2108739 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2109329 Discussion on TBoMS, TCL Communication Ltd.
5. R1-2108846 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2108990 Discussion on PUSCH TB processing over multiple slots, vivo
7. R1-2110328 Discussion on TB processing over multi-slot PUSCH, WILUS Inc.
8. R1-2109241 Discussion on TB processing over multi-slot PUSCH, CATT
9. R1-2109089 Issues for TB over multi-slot PUSCH, OPPO
10. R1-2109035 Views on TB processing over multi-slot PUSCH, Fujitsu
11. R1-2109248 Discussion on TB processing over multi-slot PUSCH, China Telecom
12. R1-2109296 Discussion on TB processing over multi-slot PUSCH, CMCC
13. R1-2109425 TB processing over multi-slot PUSCH, Xiaomi
14. R1-2110153 TB processing over multi-slot PUSCH, InterDigital, Inc.
15. R1-2109625 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
16. R1-2110047 Discussion on TB processing over multi-slot PUSCH, Apple
17. R1-2110202 TB processing over multi-slot PUSCH, Qualcomm Incorporated
18. R1-2109456 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
19. R1-2109595 TB processing over multi-slot PUSCH, Samsung
20. R1-2109571 Discussion on TB Processing over multi-slot PUSCH, MediaTek Inc.
21. R1-2109887 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
22. R1-2110123 TB Processing over Multi-Slot PUSCH, Ericsson
23. R1-2108920 Discussion on TB processing over multi-slot PUSCH, Spreadtrum Communications
24. R1-2110001 TB processing over multi-slot PUSCH, Sharp
25. R1-2109133 Discussion on TB processing over multi-slot PUSCH, NEC
26. R1-2109693 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.
27. R1-2110238 Enhancements for TB processing over multi-slot PUSCH, Lenovo, Motorola Mobility
28. R1-2110097 Discussions on TB processing over multi-slot PUSCH, LG Electronics
29. R1-2109141 On TB processing over multiple slots for PUSCH, IITH, IITM, CEWIT, Tejas Networks, Reliance Jio

# Appendix A: Proposals from contributions aggregated by topic

## A.1 Time domain resource determination

**TDRA Table**

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| **R1-2108739 Huawei/Hisi*****Proposal 3:*** *An enhanced TDRA table is preferred.** *A new field should be introduced in PUSCH-Allocation to denote the number of allocated slots* $N$ *for a single TBoMS transmission, and the existing field numberOfRepetitions denotes the repetition number* $M$*;*
* *The candidate values of* $N$ *are [2, 4, 8] as a starting point;*
* *The candidate values of* $M$ *reuses the existing values in Rel-15/16;*
* *The TBoMS transmission is enabled if* $N$ *is configured in PUSCH-Allocation while* $N>1$*; otherwise, it is disabled.*

**R1-2108846 ZTE*****Proposal 1:*** *For TBoMS, add a column in a dedicated TDRA table to indicate the number of slots.** *Support {1, 2, 3, 4, 7, 8, 12, 16} as the candidate values.*

**R1-2108920 Spreadtrum*****Proposal 2:*** *N and M can be informed by a row index of a TDRA table for DG-PUSCH, Type 1 and Type 2 CG-PUSCH.* *A new column is configured for N.* **R1-2108990 vivo****Proposal 3:** Both repetition number (M) and number of slots (N) are configured by RRC and indicated by a row index in TDRA table.* Value range for N can be {2,4}.
* Value range for M can be {1,2,3,4,5,7,8,10,12,14,16}.

**R1-2109241 CATT****Proposal 6:** For time domain resource allocation of a single TBoMS, a new RRC IE is introduced in the TDRA entry to indicate the number of allocated slots for a single TBoMS.**Proposal 8:** For repetition of TBoMS, reuse *numberOfRepetitions* in the TDRA entry to indicate the number of repetition of a single TBoMS.**R1-2109248 China Telecom****Proposal 3:** The time domain resource allocation is indicated by enhanced existing TDRA table. One column can be added to indicate N or two columns can be added to indicate M and N respectively, depending whether *numberOfRepetitions* can be reused to indicate M.**R1-2109296 CMCC****Proposal 2:*** The resource allocation mechanism of PUSCH repetition Type A should be used as most.
* The repetition factor in PUSCH TDRA could be reused to indicate the repetition factor of TBOMS.
* A field in DCI could be used to indicate the slot number of TBOMS.

**R1-2109329 TCL Communication*****Proposal 1:*** *Adding a new column into TDRA table to indicate the number of slots for TBoMS.** *Support {2, 3, 4, 6} as the candidate values.*

**R1-2109425 Xiaomi****Proposal 2:** Indicate the number of repetitions of TBoMS by TDRA field.**R1-2109456 Panasonic****Proposal 6:** The number N of allocated slots for TBoMS is indicated by TDRA table configured via *PUSCH-TimeDomainAllocationList*. A new column is configured in TDRA table.**Proposal 7:** Total number of slots (M×N) is indicated by reusing the existing column for configuring the number of repetitions in the TDRA for PUSCH repetition Type A, i.e., *numberOfRepetitions*. The number of TBoMS repetitions is determined as M = *numerOfRepetitions* / N. For TBoMS, *numerOfRepetitions* should be an integer multiple of N.**R1-2109505 Samsung*****Proposal 1:*** *for TBoMS PUSCH repetition:** *Two columns in TDRA table to indicate the number of slots for one TBoMS and the number of repetition of TBoMS, respectively;*
* *Largest number of repetition could be 16;*
* *Support re-cycling the RV over the M groups;*
* *Adopt TB based re-transmission only for TBoMS.*

**R1-2109625 Intel****Proposal 2*** *A dedicated TDRA table is configured for TBoMS, where number of slots for a single TBoMS transmission (N), number of repetitions (M), k2, SLIV and mapping type are configured in each row of the TDRA table.*

**R1-2109693 NTT DOCOMO****Proposal 7:** Support enhanced TDRA table where an additional IE is added to the legacy table to represent the number of allocated slots (*N*) for TBoMS.**R1-2109887 Nokia/NSB****Proposal 10.** For the indication of repetition factor for the repetition of a single TBoMS, the repetition factor (M) can be obtained from the number of repetitions for PUSCH repetition Type A configured in TDRA table, according to one these two alternatives:* M is directly indicated via one additional column of the TDRA table.
* M\*N is indicated via one additional column of the TDRA table.

**R1-2110001 Sharp*****Proposal 5:*** *M and N are configured by separate parameters.****Proposal 8:*** *TBoMS-specific configuration (e.g., numberOfSlotsTBoMS-r17) can be inserted into Rel-17 TDRA table (i.e., PUSCH-TimeDomainResourceAllocation-r17).***R1-2110047 Apple****Proposal 3:** A dedicated RRC parameter is used to indicate TBoMS repetition.**R1-2110097 LGE*****Proposal 8:*** *An independent field to indicate the number of allocated slots for TBoMS is included to the TDRA table.****Proposal 11:*** *If enhanced TDRA table is applied for TBoMS transmission, numberOfRepetitions is reused to indicate the repetition number M for TBoMS, and the handling method when the value of M×N exceeds 32 is specified.****Proposal 12:*** *If dedicated TDRA table is applied for TBoMS transmission, a parameter to indicate the value of M is included to the table, and the UE expects that the values of M and N are configured so that M×N does not exceed 32.***R1-2110123 Ericsson****Proposal 8**. Only one Rel-17 TDRA list is defined for Rel-17 repetition and TBoMS.**Proposal 9**. Resource allocation of a single-slot TB without repetition can be configured in the TDRA list of TBoMS.**R1-2110153 Interdigital****Proposal 3:** New dedicated TDRA table is used for TBoMS time domain resource allocation.**Proposal 4:** The UE determines the number of TBoMS repetitions using the indicated TDRA.**R1-2110328 WILUS** * ***Proposal 3:*** *Enhanced TDRA table can be configured for TBoMS with an additional column that denotes the number of allocated slots N.*
	+ *For the number of repetitions for a single TBoMS M, a column that denotes numberOfRepetitions-17 in the TDRA table can be reused.*

**R1-2110202 Qualcomm****Proposal 7:** Introduce a new R17 TDRA table that supports both legacy PUSCH transmission and TBOMS. A new column is introduced to the existing R16 TDRA table to specify the number of slots, N, of a single TBOMS. When N=1, legacy PUSCH transmission is assumed.**R1-2110138 Lenovo Motorola Mobility*****Proposal 8:*** *For PUSCH coverage enhancements in NR Rel-17 with repetition of TBoMS, following two methods can be considered to indicate the number of slots for TBoMS and repetition factor for TBoMS repetition:** *Introduce indication for number of slots for TBoMS in addition to repetition factor via TDRA row index*
* *Only support dynamic indication for number of slots for TBoMS via TDRA, but the repetition factor for TBoMS repetition is indicated only via RRC configuration*
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**Candidate values for N**

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| **R1-2108739 Huawei/Hisi*** *The candidate values of* $N$ *are [2, 4, 8] as a starting point;*

**R1-2108846 ZTE*****Proposal 1:*** *For TBoMS, add a column in a dedicated TDRA table to indicate the number of slots.** *Support {1, 2, 3, 4, 7, 8, 12, 16} as the candidate values.*

**R1-2108990 vivo****Proposal 3:** Both repetition number (M) and number of slots (N) are configured by RRC and indicated by a row index in TDRA table.* Value range for N can be {2,4}.
* Value range for M can be {1,2,3,4,5,7,8,10,12,14,16}.

**R1-2109241 CATT****Proposal 7:** {2, 4, 8} can be considered as the configurable number of slots for a single TBoMS.**R1-2109248 China Telecom****Proposal 5:** The maximum value of allocated slots for the single TBoMS is at least 16.**R1-2109329 TCL Communication*****Proposal 1:*** *Adding a new column into TDRA table to indicate the number of slots for TBoMS.** *Support {2, 3, 4, 6} as the candidate values.*

**R1-2109887 Nokia/NSB****Proposal 8.** RAN 1 to consider the following candidate values of the number of slots allocated for TBoMS as a starting point:* [1], 2, 3, 4, or 7 slots

Note: value 1 may or may not be introduced depending on how TBoMS is enabled/disabled.**R1-2110047 Apple****Proposal 1:** The candidate value set of allocated slots for single TBoMS is {2, 3, 4, 5, 6, 7, 8}.**R1-2110123 Ericsson****Proposal 5**. {2, 4, 8} can be considered for the candidate numbers of slots for a single TBoMS. |

**Candidate values for M**

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| **R1-2108739 Huawei/Hisi*****Proposal 3:*** *An enhanced TDRA table is preferred.** *The candidate values of* $M$ *reuses the existing values in Rel-15/16;*

**R1-2108990 vivo****Proposal 3:** Both repetition number (M) and number of slots (N) are configured by RRC and indicated by a row index in TDRA table.* Value range for N can be {2,4}.
* Value range for M can be {1,2,3,4,5,7,8,10,12,14,16}.

**R1-2109241 CATT****Proposal 9:** Reusing {1, 2, 3, 4, 7, 8, 12, 16} of *numberOfRepetitions* as the configurable set of repetition factors for TBoMS.* A UE is not expected to be scheduled/configured with M\*N > 32, where M is the number of repetition and N is the number of slot for a single TBoMS.

**R1-2109425 Xiaomi****Proposal 4:** Reuse the candidate values of number of repetitions in rel-17 for the repetition of TBoMS.**R1-2109296 CMCC****Proposal 3:** The maximum repetition number of TBOMS should be 16.**R1-2109505 Samsung*****Proposal 1:*** *for TBoMS PUSCH repetition:** *Two columns in TDRA table to indicate the number of slots for one TBoMS and the number of repetition of TBoMS, respectively;*
* *Largest number of repetition could be 16;*
* *Support re-cycling the RV over the M groups;*
* *Adopt TB based re-transmission only for TBoMS*

**R1-2109887 Nokia/NSB****Proposal 9.** RAN1 to consider the following candidate values for the number of repetitions of a single TBoMS (M):* M∈{1,2,4,6,8}

**R1-2110047 Apple****Proposal 2:** The candidate value set of TBoMS repetition number is {1, 2, 3, 4}. |

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

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| **R1-2109425 Xiaomi****Proposal 7:** Each slot associated with RV#0 can be deemed as an initial transmission position/slot.**R1-2109456 Panasonic****Proposal 9:** For TBoMS for CG-PUSCH, the domain resource determination including limitation of overall duration for PUSCH repetition Type A is reused.**Proposal 10:** TBoMS for CG-PUSCH does not start in the middle of the single TBoMS.**R1-2110328 WILUS** * ***Proposal 4:*** *For TBoMS repetition with configured grant, the initial TO determination should not be confined at TO with RV=0.*
	+ *In terms of gNB complexity, only RV sequence {0, 0, 0, 0} can be configured.*
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**Time domain resource determination for single TBoMS in TBoMS repetition**

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| **R1-2110001 Sharp*****Proposal 4:*** *Time domain resource for mth (m=0,…M-1) single TBoMS in TBoMS repetition is comprised of ((m-1)\*N)th available slot to (m\*N-1)th available slot where the available slots are identified by counting based on available slots.* |

**Use of non-consecutive physical slots for paired spectrum**

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| **R1-2110123 Ericsson****Proposal 13**. Non-consecutive physical slots can be supported for TBoMS for paired spectrum. |

**Others**

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| **R1-2109089 OPPO*****Proposal 1:*** *In TBoMS, TB size determination over multiple slots 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.***R1-2109693 NTT DOCOMO****Proposal 1:** Performance gain of TBoMS compared to PUSCH repetition Type A should be taken into consideration, when designing TBoMS.**R1-2110123 Ericsson****Proposal 1**. Reuse resource determination and signaling of Rel-15/16 PUSCH repetition as much as possible to avoid specifying duplicate functionality.**R1-2110202 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. |

## A.2 Single TBoMS structure

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| **R1-2108846 ZTE*****Proposal 3****: Confirming the WA on single TBoMS structure of Option 3, i.e., a single RV is used.***R1-2109241 CATT****Proposal 1:** Confirm the working assumption with the modification: For a single TBoMS, the TB is transmitted on the allocated slots using a single RV.**R1-2109296 CMCC****Proposal 1:** Replace the TOT with multiple slots and confirm the working assumption without FFS.* Single TBoMS structure of Option 3 is selected
	+ Multiple slots are determined for a TBoMS. The TB is transmitted on the multiple slots using a single RV.

**R1-2109329 TCL Communication*****Proposal 3:*** *Confirming the working assumption of multiple TOTs are determined for a TBoMS and TB is transmitted on the multiple TOTs using a single RV.** *Rate matching is performed based on all slots/TOTs allocated for TBoMS.*

**R1-2109456 Panasonic****Proposal 1:*** Following on the single TBoMS should be clarified.
	+ A single TBoMS contains multiple consecutive or non-consecutive slots.

**R1-2109571 MediaTek** ***Proposal 1:*** *Single RV based working assumption should be adopted with continuous bit selection across slots in single TBoMS.***R1-2109887 Nokia/NSB****Proposal 1.** RAN1 to confirm the working assumption on adopting Option 3 for a single TBoMS structure, i.e., the TB is transmitted using a single RV.**R1-2110047 Apple****Proposal 5:** Working assumption on Option 3 can be confirmed with the updates* Option 3: A single RV is applied to the all the slots for single TBoMS transmission.

**R1-2110123 Ericsson****Proposal 17**. The working assumption of a single RV for a single TBoMS is confirmed.**R1-2110153 Interdigital****Proposal 1:** Confirm the Working Assumption on TBoMS structure (Option 3)**R1-2110138 Lenovo Motorola Mobility*****Proposal 1****: For PUSCH coverage enhancements in NR Rel-17 with TBoMS, working assumption for supporting option 3 should be confirmed.****Proposal 2:*** *For PUSCH coverage enhancements in NR Rel-17 with TBoMS, for option 3, different starting points (to apply coded bits) from a single RV should be considered for different slots or contiguous set of slots.* |

## A.3 Rate-matching

**Bit interleaving time unit**

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| **R1-2108739 Huawei/Hisi*****Proposal 4:*** *Each available slot identified by UE is considered as a transmission occasion for TBoMS transmission, and the transmission occasion based power control, UCI multiplexing, rate matching in the current specification is reused.****Proposal 5:*** *Option a (bit interleaving performed per slot) is supported for TBoMS transmission.***R1-2108846 ZTE*****Proposal 4:*** *Bit interleaving is performed over all the allocated slots for a single TBoMS.***R1-2108920 Spreadtrum*****Proposal 1:*** *Bit interleaving performed per slot is supported.***R1-2108990 vivo****Proposal 1:**SupportBoth interleaving per slot and interleaving across all slots for TBoMS* UE reports capabilities indicating which interleaving method is supported.

**R1-2109035 Fujitsu****Proposal 1**: Bit interleaving is performed over all the allocated slots for a single TBoMS**R1-2109089 OPPO*****Proposal 4:*** *Bit interleaving performed per slot is slightly preferred.***R1-2109241 CATT****Proposal 3:** Support bit interleaving over all the allocated slots for a single TBoMS.* FFS whether additionally support bit interleaving per slot.

**R1-2109248 China Telecom****Proposal 1:** Bit interleaving is performed over all the allocated slots for a single TBoMS.**R1-2109296 CMCC****Proposal 6:** Single slot level bit interleaving is preferred. **R1-2109329 TCL Communication*****Proposal 3:*** *Confirming the working assumption of multiple TOTs are determined for a TBoMS and TB is transmitted on the multiple TOTs using a single RV.** *Rate matching is performed based on all slots/TOTs allocated for TBoMS.*

**R1-2109425 Xiaomi****Proposal 1:** Support rate-matching per slot for TBoMS.**R1-2109456 Panasonic****Proposal 2:** For single TBoMS, interleaving is performed per slot.**R1-2109505 Samsung*****Proposal 5:*** *option a (*Rate-matching is performed per slot*) shall be supported for TBoMS.***R1-2109571 MediaTek** ***Proposal 4:*** *Rate matching per slot is supported for TBoMS.***R1-2109625 Intel****Proposal 1*** *For a single TBoMS transmission, bit interleaving is performed over all the allocated slots.*

**R1-2109693 NTT DOCOMO****Proposal 2:** Support rate matching per slot for single TBoMS.**R1-2109887 Nokia/NSB****Proposal 2.** RAN1 should make the decision on rate-matching and CB segmentation together by down-selecting the following three options:* Option 1: Rate-matching is performed per slot and CB segmentation is not considered for TBoMS.
* Option 2: Rate-matching is performed per TBoMS and CB segmentation is not considered for TBoMS.
* Option 3: Rate-matching is performed per TBoMS and CB segmentation per TBoMS is considered.

**Proposal 3.** RAN1 decision on rate-matching for TBoMS should not account for collision handling.**Proposal 5.** RAN1 decision on rate-matching for TBoMS should not account for UCI multiplexing.**Proposal 6.** Impact of decisions on RM for TBoMS on the per-slot implementation logic followed by all transmission/reception operations in NR should be carefully considered to ensure the relevance of TBoMS use case is preserved.**R1-2110001 Sharp*****Proposal 2:*** *Rate-matching is performed per slot.***R1-2110047 Apple****Proposal 6:** Per single slot bit interleaving is adopted for TBoMS.**R1-2110097 LGE*****Proposal 1:*** *Rate-matching procedure is performed based on available slots for TBoMS regardless of actual transmission of TBoMS in the available slots.****Proposal 7:*** *For TBoMS transmission, adopt bit interleaving over all of the allocated slots for TBoMS.***R1-2110123 Ericsson****Proposal 4**. Rate matching is performed continuously across all the allocated slots for TBoMS, if CB segmentation doesn't occur. Otherwise, rate matching is performed for each CB once.**R1-2110153 Interdigital****Proposal 2:** Rate matching is performed per slot.**R1-2110202 Qualcomm****Proposal 2:** Adopt per-slot rate matching for TBoMS transmission.**R1-2110328 WILUS** * ***Proposal 1:*** *For TBoMS, the rate-matching is performed across all the allocated slots for TBoMS (Option-c).*
	+ *FFS: Handling for issues on rate-matching, such as UCI multiplexing.*

**R1-2110138 Lenovo Motorola Mobility*****Proposal 3****: For PUSCH coverage enhancements in NR Rel-17 with TBoMS, option a should be adopted for rate-matching i.e., the rate-matching is performed per slot basis.* |

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

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| **R1-2108739 Huawei/Hisi*****Proposal 6:*** *Within a single TBoMS transmission, the index of starting bit in bit selection for each allocated slot is defined as the integer times of LDPC lifting size* $Z\_{c}$*.***R1-2109133 NEC*****Proposal 4:*** *The starting position of circular buffer for rate matching of TBoMS in slot n should be RV + n\*E, where n = 0,1,…, is the logical slot index within TBoMS, RV is starting position provided by RV indication, and E is number of bits for a code block assuming no UCI is multiplexing with data.***R1-2109456 Panasonic****Proposal 4:*** Starting point (bit position in circular buffer) for rate matching in the subsequent slots in a single TBoMS is based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated.
	+ For example, the start position of rate matching in the circular buffer on $i$-th slot can be given by $k\_{i}=\left\{\begin{matrix}l\_{RV\_{x}}&i=0\\l\_{RV\_{x}}+i∙N\_{ref}+1&i>0\end{matrix}\right.$, where $N\_{ref}$ is the reference number of bits based on the number of REs determined in the first L symbols over which the TBoMS transmission is allocated.

**R1-2109505 Samsung*****Proposal 4:*** *The bit starting position for first slot in one TBoMS PUSCH is determined like legacy by RV index; and the bit starting position for continuous slots in the TBoMS PUSCH is continuous from the end of the bits from previous slot.***R1-2109693 NTT DOCOMO****Proposal 3:** Starting points of bit selections other than the first bit selection should be selected so that encoded bits are taken continuously from circular buffer over slots (Opt.3-2). **Proposal 4:** The starting point of each bit selection should be floored with a LDPC lifting size.**R1-2110001 Sharp*****Proposal 3:*** *Starting position k for reading the circular buffer for nth slot should be determined by the position of last coded bits read from the circular buffer for (n-1)th slot assuming no UCI multiplexed****.*****R1-2110202 Qualcomm****Proposal 3:** For a single TBOMS, to avoid error propagation issues, the index of the starting coded bit for each slot is predetermined prior to the start of the TBoMS transmission. |

**The definition of the parameter G**

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| **R1-2108739 Huawei/Hisi*****Proposal 8:*** *For TBoMS transmission, the parameter* $G$ *used in the bit selection should be redefined as the total number of coded bits available for transmission of a TB and UCI in one slot.* |

**Bit interleaving in case of multiple CBs**

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| **R1-2109456 Panasonic****Proposal 3:** For CB segmentation if TBoMS, either of following should be supported. Our first preference is Alt.1.* Alt.1: To limit only one CB case for TBoMS
* Alt.2: Multiple CBs are interleaved per-slot manner and interleaved multiple CBs are concatenated per slot.

**R1-2109571 MediaTek** ***Proposal 2:*** *All the CBs corresponding to the TB as part of single TBoMS is expected to be transmitted on each slot partially (or completely).****Proposal 3:*** *Bits which are selected from each CB for the given slot are interleaved in per-slot basis to maintain consistency with existing specs and current hardware design* |

## A.4 TBS determination

***N*Info calculation**

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| **R1-2108739 Huawei/Hisi*****Proposal 1:*** *The scaling factor* $1<K<N$ *to calculate* $N\_{info}$ *for TBS determination is not supported to construct the TBoMS repetition, where* $N$ *is the number of allocated slots for a single TBoMS transmission.****Proposal 2:*** *The scaling factor* $K$ *to calculate* $N\_{info}$ *for TBS determination should be implicit indicated by the number of allocated slots* $N$ *for a single TBoMS transmission, i.e.,* $K=N$*.****Proposal 11****: Apply the following data rate constraint in Clause 6.1.4 of TS 38.214 for the initial transmission of TBoMS PUSCH,*$$\frac{\sum\_{m=0}^{M-1}V\_{j,m}}{L×T\_{s}^{μ}}\leq DataRateCC$$*where* $V\_{j,m}$ *still represents the scheduled bits for the m-th TB over multi-slot and* $L$ *represents the number of symbols assigned to the PUSCH within a slot.***R1-2108846 ZTE*****Proposal 5:*** *Only K=N is supported for N*Info *calculation, and no need additional explicit indication.* **R1-2108990 vivo****Proposal 2:** For TBoMS TBS determination, Scaling factor K<N can be supported for $N\_{info}$ calculation.* The scaling factor is configured in TDRA table, and can be indicated along with the row index in TDRA table.

 **R1-2109089 OPPO*****Proposal 2:*** *For coverage enhancement, TB size of PUSCH can be derived by a K factor（1<K<N） in case when PUSCH repetition of N and TBoMS is configured together.**The factor K can be 2, 4, 8 for determining TBS.***R1-2109141 IITH, IITM, CEWIT, Tejas Networks, Reliance Jio*****Proposal***: *For Ninfo calculation only K=N is supported.* **R1-2109241 CATT****Proposal 2:** No need to support the cases with 1<K<N for the TBS calculation for a single TBoMS.* No need to indicate K to the UE.

**Proposal 4:** For initial transmission, TBS of TBoMS is calculated by the following steps:* + Step 1: A UE first determines the number of REs allocated for TBoMS within a PRB ($N\_{RE}^{'}$) by $N\_{RE}^{'}=N∙(N\_{sc}^{RB}∙N\_{symb}^{sh}-N\_{DMRS}^{PRB}-N\_{oh}^{PRB})$.
	+ Step 2: A UE determines the total number of REs allocated for TBoMS ($N\_{RE}$) by $N\_{RE}=min(N\_{RE}^{'}∙n\_{PRB} , 156∙N\_{PRB})$.
	+ Step 3: Obtain unquantized intermediate variable ($N\_{Info}$) by $N\_{Info}=N\_{RE}∙R∙Q\_{m}∙v$.

Where *N* is the total number of the allocated available slots for TBoMS, and $N\_{PRB}$ is the maximum bandwidth of the active UL BWP.**Proposal 5:** For retransmission, TBS of TBoMS follows the TBS of initial transmission.**R1-2109456 Panasonic****Proposal 5:** For TBS determination of TBoMS, 1 < K < N is not necessary.**R1-2109505 Samsung*****Proposal 3:*** *further values 1<K<N is not needed.***R1-2109693 NTT DOCOMO****Proposal 5:** If scaling factor 1<*K<N* is supported, the scaling factor should be dynamically indicated.**R1-2109887 Nokia/NSB****Proposal 7.** For TBS determination of a single TBoMS, the values 1<K<N are not supported.**R1-2110097 LGE*****Proposal 10:*** *To calculate* $N\_{info}$ *for TBS determination, the scaling factor values of 1 <* $K$ *< N are supported and the value of K is dynamically indicated by DCI.***R1-2110328 WILUS** * ***Proposal 2:*** *For the value of scaling factor K, only K=N is supported.*
	+ *Both K and N can be jointly indicated by using a row index of a TDRA list, configured via RRC.*

**R1-2110123 Ericsson****Proposal 2**. To calculate Ninfo for TBS determination, further values 1<K<N are not supported.**R1-2110202 Qualcomm****Proposal 4:** For retransmissions of TBOMS, support shorter duration transmissions by also allowing values of $\leq K$ . This ensures the same TB size can be determined for a retransmission even if the number of slots for a single TBOMS is reduced.**Proposal 5:** The scale factor $K$ used to determine the TBS of TBoMS may take at least the following values: 2, 4, 8, 16. |

**Specific TBS values for TBoMS**

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| **R1-2108739 Huawei/Hisi*****Proposal 11****: Apply the following data rate constraint in Clause 6.1.4 of TS 38.214 for the initial transmission of TBoMS PUSCH,*$$\frac{\sum\_{m=0}^{M-1}V\_{j,m}}{L×T\_{s}^{μ}}\leq DataRateCC$$*where* $V\_{j,m}$ *still represents the scheduled bits for the m-th TB over multi-slot and* $L$ *represents the number of symbols assigned to the PUSCH within a slot.***R1-2108846 ZTE*****Proposal 6:*** *The maximum TBS can be limited by the conditions of date rate limitations DataRate and DataRateCC.***R1-2109241 CATT****Proposal 13:** For a single TBoMS, no restriction is specified except for the maximum TBS.**R1-2110202 Qualcomm****Proposal 6:** For TBoMS, no new TB sizes are introduced. |

## A.5 FDRA

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| **R1-2108846 ZTE*****Proposal 2:*** *The maximum number of PRBs can be limited when TBoMS is enabled.* * *FFS how to determine the maximum number of PRBs.*

**R1-2109329 TCL Communication*****Proposal 2:*** *The maximum number of PRBs can be limited when TBoMS is enabled.***R1-2109425 Xiaomi****Proposal 5:** Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling.**R1-2109505 Samsung*****Proposal 2:*** *The maximal number of PRB allocated in time domain is reduced for TB over multi-slot.* |

## A.6 TBoMS repetitions

**Whether and how RVs are cycled across M repetitions of a single TBoMS**

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| **R1-2108739 Huawei/Hisi*****Proposal 7:*** *RVs are cycled across* $M$ *repetitions of a single TBoMS transmission, i.e.,* $M$ *groups of* $N$ *allocated slots for each single TBoMS transmission.** *Only the first allocated slot in a repetition is associated with a RV.*

**R1-2108920 Spreadtrum*****Proposal 4:*** *Support RV indices are cycled across the M groups of N alloated slots for each single TBoMS repetition.***R1-2108990 vivo****Proposal 5:** RV is cycled per TBoMS repetition.**R1-2109089 OPPO*****Proposal 3:*** *The TMoMS repetition should apply fixed RV sequence cycling among different repetitions of TBoMS. The dropping rules should reuse Rel-15 rules.***R1-2109241 CATT****Proposal 10:** For repetition of TBoMS, RV indices are cycled across the M repeated TBoMS, reusing the legacy cycling order.**R1-2109248 China Telecom****Proposal 4:** RV cycling mechanism for PUSCH repetition Type A can be reused for TBoMS by replacing one PUSCH repetition with N slots, i.e., a single TBoMS.**R1-2109296 CMCC****Proposal 4:** The RV indication and cycling mechanism could be reused at most.**R1-2109505 Samsung*****Proposal 1:*** *for TBoMS PUSCH repetition:** *Two columns in TDRA table to indicate the number of slots for one TBoMS and the number of repetition of TBoMS, respectively;*
* *Largest number of repetition could be 16;*
* *Support re-cycling the RV over the M groups;*

**R1-2109625 Intel****Proposal 4*** *RV cycling mechanism for single-slot PUSCH repetition can be reused for TBoMS repetition.*

**R1-2109887 Nokia/NSB****Proposal 12.** For the repetition of a single TBoMS, the legacy Rel-15/16 RV cycling can be reused.**R1-2110001 Sharp*****Proposal 7:*** *RV cycling over TBoMS repetition is supported.***R1-2110123 Ericsson****Proposal 6**. The methods of RV cycling for PUSCH repetition based on available slots can be reused for repetition of a single TBoMS, with the difference being one RV applied to a single TBoMS. |

**Slot mapping for TBoMS repetitions**

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| **R1-2110153 Interdigital****Proposal 5**: Support both type 1(non-interleaved) and type 2 (interleaved) mapping for TBoMS repetitions shown in Figure 1**Figure 1** Examples of TBoMS repetition mapping : Type 1 (non-interleaved mapping) vs. Type 2 (interleaved mapping) for N=4, M=2 |

**Others**

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| **R1-2110138 Lenovo Motorola Mobility*****Proposal 6:*** *For PUSCH coverage enhancements in NR Rel-17 with TBoMS, if repetition of TBoMS is supported, then only PUSCH repetition Type A should be considered.* |

## A.7 Transmission power determination

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| **R1-2108739 Huawei/Hisi*****Proposal 4:*** *Each available slot identified by UE is considered as a transmission occasion for TBoMS transmission, and the transmission occasion based power control, UCI multiplexing, rate matching in the current specification is reused.****Proposal 10:*** *For power control of TBoMS transmission,* $BPRE$ *should be divided by the scaling factor* $K$ *to compensate the power control error caused by the large TB scaled by* $K$*, i.e.,** $BPRE={\left(\sum\_{r=0}^{C-1}{K\_{r}}/{N\_{RE}}\right)}/{K}$

*where* $C$ *is a number of transmitted CBs,* $K\_{r}$ *is a size for CB* $r$*, and* $N\_{RE}$ *is a number of REs in one slot.***R1-2108846 ZTE*****Proposal 7:*** *For TBoMS, the transmission power determination should be based on the total number of REs within all slots for TB processing with excluding the overhead of reference signals.***R1-2109241 CATT****Proposal 14:** The transmitted power of a single TBoMS remains unchanged during the transmission.**R1-2109329 TCL Communication*****Proposal 4:*** *The transmission power determination of TBoMS should be based on all of REs excluding the overhead of reference signals.***R1-2110123 Ericsson****Proposal 16**. Reuse Rel-16 transmission occasion of power determination for TBoMS.**R1-2110328 WILUS** * ***Proposal 5:*** *It should be further discussed how to determine the number of REs for UCI multiplexing and UL transmission power in case of TBoMS.*
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## A.8 Rank of TBoMS transmission

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| **R1-2108990 vivo****Proposal 7:** PUSCH with TB processing over multiple slots should be limited to single transmission layer.**R1-2110123 Ericsson****Proposal 14**. TBoMS is transmitted with a single layer.**R1-2110202 Qualcomm****Proposal 8:** Restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock). Furthermore, restrict TBoMS transmission to single layer transmissions.  |

## A.9 Frequency hopping

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| **R1-2108920 Spreadtrum*****Proposal 3:*** *Only support Intra-slot and inter-slot frequency hopping for TBoMS transmission.***R1-2108990 vivo****Proposal 4:** Frequency hopping granularity is at least one slot for TBoMS.* Intra-slot frequency hopping is not supported for TBoMS.

**R1-2109241 CATT****Proposal 15:** For TBoMS without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced.**R1-2109248 China Telecom****Proposal 6:** Both inter-slot frequency hopping and inter-slot frequency hopping with inter-slot bundling should be supported for TBoMS.**R1-2109329 TCL Communication*****Proposal 10:*** *Intra-slot and inter-slot frequency hopping should be supported for TBoMS.****Proposal 11:*** *The bundling of inter-slot frequency hopping should be supported for TBoMS.***R1-2109425 Xiaomi****Proposal 6:** Support intra-TB frequency hopping for TB processing over multi-slot PUSCH.**R1-2109456 Panasonic****Proposal 8:** The determination of inter-slot frequency hopping pattern and precoder cycling pattern for PUSCH repetition Type A is reused for TBoMS.* For TBoMS without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced, i.e., hopping pattern is determined by the absolute slot number and hopping is performed per slot.
* For TBoMS with joint channel estimation, the inter-slot frequency hopping is performed per configured or actual TDW which is determined based on configured/indicated TDW length and semi-static TDD configuration. The details including configured or actual TDW determination is according to discussion in AI 8.8.1.3.

**R1-2109625 Intel****Proposal 5*** *For a single TBoMS transmission, inter-slot frequency hopping and inter-slot frequency hopping with inter-slot bundling are supported.*
* *For repetition of a single TBoMS transmission, inter-repetition frequency hopping is supported.*

**R1-2109887 Nokia/NSB****Proposal 11.** For TBoMS transmission without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced.**R1-2110001 Sharp*****Proposal 6:*** *Inter-/intra-slot frequency hopping as in Rel-16 is supported for a single TBoMS and TBoMS repetition.***R1-2110202 Qualcomm****Proposal 11:** Reuse the frequency hopping framework used in PUSCH Type A repetitions for TBoMS transmissions. |

## A.10 CB segmentation

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| **R1-2109456 Panasonic****Proposal 3:** For CB segmentation if TBoMS, either of following should be supported. Our first preference is Alt.1.* Alt.1: To limit only one CB case for TBoMS
* Alt.2: Multiple CBs are interleaved per-slot manner and interleaved multiple CBs are concatenated per slot.

**R1-2109571 MediaTek** ***Proposal 2:*** *All the CBs corresponding to the TB as part of single TBoMS is expected to be transmitted on each slot partially (or completely).****Proposal 3:*** *Bits which are selected from each CB for the given slot are interleaved in per-slot basis to maintain consistency with existing specs and current hardware design.***R1-2109693 NTT DOCOMO****Proposal 8:** CB segmentation should not be applied, when PUSCH is transmitted with TBoMS.**R1-2109887 Nokia/NSB****Proposal 2.** RAN1 should make the decision on rate-matching and CB segmentation together by down-selecting the following three options:* Option 1: Rate-matching is performed per slot and CB segmentation is not considered for TBoMS.
* Option 2: Rate-matching is performed per TBoMS and CB segmentation is not considered for TBoMS.
* Option 3: Rate-matching is performed per TBoMS and CB segmentation per TBoMS is considered.

**R1-2110123 Ericsson****Proposal 3**. CB segmentation is supported for TBoMS in order to reuse Rel-15/16 LDPC coding.**R1-2110202 Qualcomm****Proposal 8:** Restrict TBoMS transmissions to TB sizes that permit single codeblock transmissions (i.e., entire TB can be encoded as a single codeblock). Furthermore, restrict TBoMS transmission to single layer transmissions.  |

## A.11 Retransmissions

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| **R1-2109241 CATT****Proposal 5:** For retransmission, TBS of TBoMS follows the TBS of initial transmission.**Proposal 16:** For TBoMS retransmission, retransmitting the whole single TBoMS should be the baseline.* FFS whether/how to retransmit part of the slots of a single TBoMS.

**R1-2109296 CMCC****Proposal 5:** The retransmission of TBOMS should follow the same procedure as single slot scheduling and repetitions at most.**R1-2109505 Samsung*****Proposal 1:*** *for TBoMS PUSCH repetition:** *Two columns in TDRA table to indicate the number of slots for one TBoMS and the number of repetition of TBoMS, respectively;*
* *Largest number of repetition could be 16;*
* *Support re-cycling the RV over the M groups;*
* *Adopt TB based re-transmission only for TBoMS*

**R1-2109887 Nokia/NSB****Proposal 13.** Discussion on partial retransmission should be deprioritized, given the limited available time before the end of the discussions for Rel-17.**R1-2110047 Apple****Proposal 4:** It’s up to gNB scheduling to determine the TBoMS re-transmission is by TBoMS, or by repetition, or by single slot transmission.**R1-2110123 Ericsson****Proposal 15**. Only TB-based retransmission is supported for TBoMS.**R1-2110153 Interdigital****Proposal 7:** Support enhanced retransmission mechanisms to avoid the retransmission of the entire TBoMS. **R1-2110202 Qualcomm****Proposal 4:** For retransmissions of TBOMS, support shorter duration transmissions by also allowing values of $\leq K$ . This ensures the same TB size can be determined for a retransmission even if the number of slots for a single TBOMS is reduced.**R1-2110138 Lenovo Motorola Mobility*****Proposal 5:*** *For PUSCH coverage enhancements in NR Rel-18 with TBoMS, if retransmission for duration shorter than the overall duration of TBoMS is supported, then implicit/explicit configuration of the portion (duration) should be supported with portion indication in the retransmission DCI. Exact duration of the portion can be as follows:** *Explicitly configured to the UE*
* *Implicitly determined by UE depending on the duration of TBoMS, number of TOTs, duration of TOTs*
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## A.12 UCI multiplexing and dropping rules

**UCI multiplexing**

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| **R1-2108739 Huawei/Hisi*****Proposal 4:*** *Each available slot identified by UE is considered as a transmission occasion for TBoMS transmission, and the transmission occasion based power control, UCI multiplexing, rate matching in the current specification is reused.****Proposal 9:*** *For UCI multiplexing on TBoMS transmission, the parameter* $β\_{offset}^{PUSCH}$ *should be redefined to compensate the coding rate as follows:** $β\_{offset}^{PUSCH}=K∙β\_{offset}^{HARQ-ACK}$ *for HARQ-ACK;*
* $β\_{offset}^{PUSCH}=K∙β\_{offset}^{CSI-part1}$ *for CSI part 1;*
* $β\_{offset}^{PUSCH}=K∙β\_{offset}^{CSI-part2}$ *for CSI part 2;*
* $β\_{offset}^{PUSCH}=K∙β\_{offset}^{CG-UCI}$ *for CG-UCI;*
* $β\_{offset}^{PUSCH}=K∙β\_{offset}^{HARQ-ACK}$ *for HARQ-ACK and CG-UCI.*

*where* $K$ *is the scaling factor to calculate* $N\_{info}$ *for TBS determination, and the parameters* $β\_{offset}^{HARQ-ACK}$*,* $β\_{offset}^{CSI-part1}$*,* $β\_{offset}^{CSI-part2}$*, and* $β\_{offset}^{CG-UCI}$ *are the coding rate compensation parameters for HARQ-ACK (or HARQ-ACK and CG-UCI), CSI part 1, CSI part 2, and CG-UCI, respectively, configured in RRC.***R1-2108990 vivo****Proposal 6:** For UCI multiplexing on TBoMS, the number of modulated symbols in the TBoMS for UCI should be same/close to that multiplexed in a single slot PUSCH, following options can be considered* Opt-1: Re-define the parameter $N\_{symb,all}^{PUSCH}$ as number of symbols per slot allocated for TBoMS;
* Opt-2: BetaOffset and scaling ($α$) is scaled by 1/N, where N is the number of slots for a TBoMS.

**R1-2109035 Fujitsu****Proposal 2**: UCI multiplexing and collision handling should be performed per slot.**R1-2109089 OPPO*****Proposal 5:*** *UCI is equally multiplexed into all slots of TBoMS transmission.***R1-2109133 NEC*****Proposal 1:*** *Support TBoMS and UCI multiplexing. Legacy PUSCH repetition and UCI multiplexing behavior can be baseline.****Proposal 2:*** *When PUCCH transmission without PUCCH repetition overlaps with PUSCH TBoMS transmission, UCI multiplexed with TBoMS within a slot.****Proposal 3:*** *When to calculate ratio of resources for UCI in PUSCH in a slot, additional scaling factor based on scaling factor K used for TBoMS TB size determination should be considered.***R1-2109241 CATT****Proposal 6:** For time domain resource allocation of a single TBoMS, a new RRC IE is introduced in the TDRA entry to indicate the number of allocated slots for a single TBoMS.**Proposal 8:** For repetition of TBoMS, reuse *numberOfRepetitions* in the TDRA entry to indicate the number of repetition of a single TBoMS.**Proposal 10:** For repetition of TBoMS, RV indices are cycled across the M repeated TBoMS, reusing the legacy cycling order.**Proposal 11:** To determine the number of REs for UCI multiplexing on TBoMS, the following are supported:* The number of available slots for TBS determination can be used to determine the data rate for UCI resource computation;
* The number of available overlapping slots between PUCCH and TBoMS can be used to determine the upper bounder of UCI resource on TBoMS.

**Proposal 12:** For UCI multiplexing in one slot of TBoMS, the current UCI mapping rules can be reused. For UCI multiplexing in multiple slots of TBoMS, the REs occupied by UCI are evenly divided and mapped in each of the overlapped slots.**R1-2109248 China Telecom****Proposal 2:** Legacy R15/R16 framework for UCI multiplexing with PUSCH should be reused as much as possible. If justified necessary, additional enhancements, e.g., puncturing or repeating UCI in multiple slots of TBoMS can be considered.**R1-2109329 TCL Communication*****Proposal 5:*** *UCI multiplexing is performed by puncturing or rate-matching depending on the determination time is before or latter the starting time of PUSCH preparation.****Proposal 6:*** *If rate matching is performed per-TOT or cross all allocated slots of TBoMS,*$ S\_{0}$ *should be redefined.****Proposal 7:*** *If UCI multiplexing is performed by puncturing，*$S\_{0}$ *may differ from rate-matching for UCI multiplexing.****Proposal 8:*** *For per-TBoMS rate-matching, the calculation formula of* $Q\_{ACK}^{'}$ *should be scaled by k/N, or* $β\_{offset}^{PUSCH}$ *| α scaled by k/N to keep the UCI resources close to the current specification.****Proposal 9:*** *If UCI multiplexing in TBoMS is supported, UCI repetition should be considered.***R1-2109505 Samsung*****Proposal 6:*** *Parallel transmission of PUCCH and TBoMS PUSCH is not preferred due to power splitting during CE situation****.******Proposal 7:*** *UCI multiplexing in TBoMS PUSCH is supported in Rel-17 CE,****Proposal 8:*** *The timeline requirement is applied for the actual overlapped slot in the TBoMS.***R1-2109571 MediaTek** ***Proposal 5:*** *UCI multiplexing and collision handling on the slots enabled for TBoMS can be carried out similar as legacy approach in R15/16 repetition Type A.***R1-2109625 Intel****Proposal 6*** *UCI multiplexing on TBoMS is supported.*

*FFS details.* **R1-2109693 NTT DOCOMO****Proposal 6:** Reuse legacy Rel-15/Rel-16 framework for UCI multiplexing with PUSCH as much as possible for TBoMS, unless new rules are necessary to operate TBoMS PUSCH.**R1-2109887 Nokia/NSB****Proposal 4.** The legacy Rel-15/16 rules for collision handling and UCI multiplexing should be kept as much as possible regardless of which rate-matching approach is adopted for TBoMS.**R1-2110001 Sharp*****Proposal 1:*** *UCI multiplexing is performed per slot.***R1-2110097 LGE*****Proposal 2:*** *In case of collision between TBoMS and PUCCH without repetition, UCI is multiplexed on the TBoMS in the overlapped slot.****Proposal 3:*** *Aperiodic CSI can be multiplexed on the TBoMS in the first actual slot of the TBoMS transmission.****Proposal 5:*** $N\_{symb,all}^{PUSCH}$ *is the number of symbols for TBoMS in a corresponding slot in which UCI is multiplexed for determination of the values of* $Q\_{ACK}^{'}$*,* $Q\_{CSI-part 1}^{'}$*,* $Q\_{CSI-part 2}^{'}$*, and* $Q\_{CG-UCI}^{'}$*.****Proposal 6:*** *To determine the values of* $Q\_{ACK}^{'}$*,* $Q\_{CSI-part 1}^{'}$*,* $Q\_{CSI-part 2}^{'}$*, and* $Q\_{CG-UCI}^{'}$*,* ${\sum\_{l=0}^{N\_{symb,all}^{PUSCH}-1}M\_{sc}^{UCI}\left(l\right)}/{\sum\_{r=0}^{C\_{UL-SCH}-1}K\_{r}}$ *is multiplexed by N, where N is the number of slots allocated for TBoMS.* **R1-2110123 Ericsson****Proposal 12**. If UCI multiplexing in TBoMS is supported, HARQ-ACK can be included in any overlapping slot by puncturing, and CSI or HARQ-ACK can be repeated in all slots of a TBoMS. **R1-2110153 Interdigital****Proposal 6:** Support UCI multiplexing with TBoMS. FFS whether UCI is repeated on the multiple slots of TBoMS.**R1-2110202 Qualcomm****Proposal 9:** Reuse R15/R16 framework for UCI multiplexing on PUSCH for each slot of a single TBoMS as well. **R1-2110328 WILUS** * ***Proposal 5:*** *It should be further discussed how to determine the number of REs for UCI multiplexing and UL transmission power in case of TBoMS.*
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**Dropping rules, e.g., collision handling**

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| **R1-2109035 Fujitsu****Proposal 2**: UCI multiplexing and collision handling should be performed per slot.**R1-2109571 MediaTek** ***Proposal 5:*** *UCI multiplexing and collision handling on the slots enabled for TBoMS can be carried out similar as legacy approach in R15/16 repetition Type A.***R1-2109887 Nokia/NSB****Proposal 4.** The legacy Rel-15/16 rules for collision handling and UCI multiplexing should be kept as much as possible regardless of which rate-matching approach is adopted for TBoMS.**R1-2110123 Ericsson****Proposal 10**. Rel-17 PUSCH dropping rules include PUCCH repetition can override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s).**Proposal 11**. Rel-17 PUSCH dropping rules include the case that one particular slot is determined as an available slot for multiple time-overlapping UL channels or signals (including TBoMS, Type A PUSCH repetition enhancement option 2, A-SRS, or SPS HARQ-ACK). RAN1 is to define the priority of the multiple time-overlapping UL transmissions. The UE only transmits the channel or signal with the highest priority in overlapping symbols in the slot.**R1-2110202 Qualcomm****Proposal 10:** Reuse R15/R16 framework for collision handling between PUSCH and other channels/signals for collision handling between a each slot of a TBoMS and other channels/signals. |

**Timeline requirements**

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| **R1-2110097 LGE*****Proposal 4:*** *Discuss timeline requirement for UCI multiplexing on TBoMS in slot #n based on a) the first symbol of the first slot allocated for the TBoMS or b) the first symbol of the slot #n allocated for the TBoMS.* |

## A.13 Additional indicators and configuration options

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| **R1-2108739 Huawei/Hisi*****Proposal 3:*** *An enhanced TDRA table is preferred.** *The TBoMS transmission is enabled if* $N$ *is configured in PUSCH-Allocation while* $N>1$*; otherwise, it is disabled.*

**R1-2109625 Intel****Proposal 3*** *Dynamic switching between TBoMS and single-slot PUSCH transmission is supported.*
	+ *N = 1 can be configured in one row of TDRA table to indicate single-slot PUSCH transmission.*

**R1-2109887 Nokia/NSB****Proposal 14.** RAN1 to specify an indication method for enabling TBoMS transmission per PUSCH scheduling/configuration. FFS: Details of the indication method.**R1-2110097 LGE*****Proposal 9:*** *Support dynamic enabling/disabling of TBoMS transmission using explicit indication or implicit indication using the value of N or K.***R1-2110123 Ericsson****Proposal 7**. For a UL grant, the transmission type between TBoMS and PUSCH repetition can be indicated by higher layers.**R1-2110202 Qualcomm****Proposal 7:** Introduce a new R17 TDRA table that supports both legacy PUSCH transmission and TBOMS. A new column is introduced to the existing R16 TDRA table to specify the number of slots, N, of a single TBOMS. When N=1, legacy PUSCH transmission is assumed.**R1-2110138 Lenovo Motorola Mobility*****Proposal 7:*** *For PUSCH coverage enhancements in NR Rel-17 with TBoMS, semi-static and/or dynamic configuration of TBoMS feature for PUSCH should be supported, and independent from PUSCH repetition.* |

## A.14 Interleaved TBoMS transmissions

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| **R1-2110202 Qualcomm****Proposal 12:** Interleaved TBoMS transmissions (carrying different TBs) are not permitted. A UE does not expect a TBoMS transmission in a component carrier to begin before the completion of an ongoing TBoMS transmission in the same component carrier. |

## A.15 Application of DM-RS bundling to TBoMS

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| **R1-2109241 CATT****Proposal 15:** For TBoMS without joint channel estimation, no new inter-slot frequency hopping mechanism is introduced.**R1-2109329 TCL Communication*****Proposal 11:*** *The bundling of inter-slot frequency hopping should be supported for TBoMS.* |

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

Working assumption: 🡪 Agreement:

For TBS determination of TBoMS:

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

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

Agreement:

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

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

**Working assumption**

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

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

Agreement:

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

Agreement:

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

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

**Working assumption**

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

Agreement:

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

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

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

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

Agreement:

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

* FFS: details.

Agreement:

The following approach is used to calculate NInfo for TBoMS:

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

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

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

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

Agreement:

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

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

Working Assumption

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

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

Agreements**:**

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

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

Agreement:

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

Agreement:

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

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

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

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

Agreement:

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

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

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

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

Agreement

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

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

Agreement

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

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

Agreement

TBoMS is supported for both configured grant and dynamic grant.

Working Assumption

Single TBoMS structure of Option 3 is selected

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

**Agreement**

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

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

FFS: details related to the indication of K.

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

**Agreement**

Repetitions of a single TBoMS are supported, where:

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

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

**Agreement**

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

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

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

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