3GPP TSG RAN WG1 #107-e R1-2112462

e-Meeting, November 11 – November 19, 2021

**Agenda item: 8.8.1.2**

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

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

**Document for: Discussion and Decision**

# 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 #107-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 and configuration options
    - Time domain resource determination for TBoMS for CG-PUSCH Type 2
    - Use of non-consecutive physical slots for paired spectrum
  + Single TBoMS structure
  + Rate matching
    - Time unit of the bit interleaving
    - Starting bit in each slot for the single TBoMS
  + UCI multiplexing
* **Mid priority aspects**
  + Time domain resource determination
    - Candidate values for N
    - Candidate values for M
  + Data rate calculation and UE behavior related to TBS determination
    - How to handle configuration of TBS larger than the size one CB
  + Retransmissions
* **Other aspects**
  + Time domain resource determination
    - Time domain resource determination for TBoMS for CG-PUSCH Type 1
  + Relationship with other channels and signals
    - Dropping rules
    - Timeline requirements
  + TBoMS repetitions
    - Slot mapping for TBoMS repetitions
  + FDRA
  + Transmission power determination
  + Frequency hopping
  + Application of DM-RS bundling to TBoMS
  + Interlaced 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 #107-e. Section 2.3 will collect all other aspects.

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

## High priority aspects

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

1. Time domain resource determination
   1. Use of the TDRA table and configuration options
   2. Time domain resource determination for TBoMS for CG-PUSCH Type 2
   3. Use of non-consecutive physical slots for paired spectrum
2. Single TBoMS structure
3. Rate matching
   * + 1. Time unit of the bit interleaving
       2. Starting bit in each slot for the single TBoMS
4. UCI Multiplexing

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.

#### [OPEN] **Use of the TDRA table and configuration options**

Companies’ preferences concerning the use of the TDRA table and possible configuration options are as follows:

* Dynamic switching between PUSCH Type A and TBoMS is not supported **[2]**:
  + *All entries in the table are either for PUSCH Type A repetition or TBoMS* **[2]**:
    - vivo [6], Ericsson [22]
* Dynamic switching between PUSCH Type A and TBoMS is supported **[4]**:
  + *Table entries can be partitioned to differentiate single-slot PUSCH and TBoMS transmission* **[1]**:
    - Intel [15]
  + *Dynamic switching of PUSCH Type A repetitions and TBoMS is supported (default)* ***[3]****:* 
    - CMCC [12], Qualcomm [17], Nokia/NSB [21].

Furthermore:

* One company (Nokia/NSB [21]) proposed that a condition to enable TBoMS is that available slot counting is also enabled.

FL’s comments on November 11

The following observations can be made from FL’s perspective:

* The following agreement for enabling the TBoMS feature and activate single-slot or multi-slot TBS determination for PUSCH already implies that N=1 is an agreed and supported value for TBoMS in Rel-17. In this sense, I am not sure further discussion is needed here, and we may simply defer it to a quick check in RRC parameters discussion next week.

|  |
| --- |
| **Agreement**  For TBoMS transmission in Rel-17:   * TBoMS feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.   + TBoMS transmission is enabled when N>1, where N is the number of allocated slots for a single TBoMS.   + Single-slot PUSCH transmission is enabled when N=1.   + Supported combinations of N and M that can be configured in the TDRA table, these combinations are constrained by retransmission are to be further discussed |

* Given the existing uncertainly related to how to handle the paired spectrum and SUL case (with reference to the discussions about the TS 38.214 CR, and companies’ proposals for #107-e), a discussion may be needed on the role of the RRC parameter *AvailableSlotCounting* for TBoMS.
* According to my understanding, only a minority of companies would like to introduce restrictions on the dynamic switching between PUSCH Type A repetition and TBoMS. The arguments brought forward to justify this position are:
  + If N=1 and N>1 are configured in a single TDRA table, it may limit the flexibility for NW scheduling on combinations of SLIV and number of repetitions.
  + gNB chooses one type over another on the basis of performance and implementation factors, instead of dynamic factors, such as radio condition, which may impact N and M for TBoMS or K for PUSCH repetition.

Conversely, at least 14 companies were in favour of such switching during #106b-e.

Consequently, FL proposes to start the discussion with two questions.

**2.1.1.1-Q1**. *Should dynamic switching between PUSCH type A repetition and TBoMS be prevented, i.e., all rows of the TDRA table can only have either N=1 or N>1? Please provide a justification to your position and, whenever possible, refer to the views expressed by companies who do not agree with you.*

**2.1.1.1-Q2**. *Should the TBoMS transmission be performed only subject to enabling AvailableSlotCounting at the UE?*

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

FL’s recommendation is to have a first round of discussion among companies about **2.1.1.1-Q1** and **2.1.1.1-Q2**. Two tables are added below to this end.

**2.1.1.1-Q1**

|  |  |
| --- | --- |
|  | Company’s name for the answer to 2.1.1.1-Q1 |
| **Yes** | LG, vivo, Ericsson (clarify that only {N=1,M=1} and {N>1,M>1} are allowed) |
| **No** | DCM, QC, Sharp, Nokia/NSB, Lenovo, Motorola Mobility, Intel, Panasonic,[SS], ZTE, Huawei, Hisilicon, CATT,TCL, Xiaomi |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.1-Q1. |
| QC | The TDRA framework provides this flexibility. Its up to the gNB on whether it wants to make use of it or not. |
| Sharp | From specification perspective, putting such a restriction is unnecessary. |
| LG | We don’t see the strong motivation of dynamic switching between PUSCH rep type A and TBoMS. Semi-static switching seems sufficient. |
| Nokia/NSB | It is too restrictive if the gNB has to make a decision on using either PUSCH repetition type A or TBoMS when configuring TDRA table. |
| Lenovo, Motorola Mobility | Such restriction is not needed and gives gNB the flexibility to dynamically indicate a row |
| Intel | It is not necessary to consider restriction for dynamic switching. |
| Panasonic | We don’t see the need to have restriction in the specification. It is just up to the network implementation. |
| SS | We think there is no need for the restriction. The TDRA table is enlarged rather than kept as 16 rows, so keep both N=1 and N>1 in the table is not a big problem now. We just want to align the understanding of FL’s question, specifically, “*all rows of the TDRA table can only have either N=1 or N>1?*” I guess, this is the case regardless of Q1, right? Because each of the row is anyway is configured with either N=1, or N>1, not both; so that both N=1 and N>1 can exist in one single table, this is not to prevent the switching, right? |
| vivo | In our understanding, the motivation of TBoMS is to achieve better coverage compared with type-A PUSCH repetition. Only when repetition type-A cannot fulfil the expected coverage, NW may enable TBoMS feature semi-statically. Hence, prefer semi-static switching between type-A and TBoMS. |
| ZTE | For different TBs, there is no need to introduce such limitation for gNB scheduling. |
| Huawei, Hisilicon | In RAN1#106bis-e, dynamic switching between type A PUSCH repetition and TBoMS is supported naturally based on the agreement of TDRA design.  There is no clear motivation and no obvious advantage to prevent it. So we support the dynamic switching. |
| CATT | Assuming this will not cause additional UE complexity, there is no need (and no benefit) to have such restriction.  Note that, even if there is no restriction by spec, the gNB can still only configure either TBoMS or repetition type A by implementation, if desired. |
| Ericsson | To share our understanding of the current situation: according to the agreement provided here by the FL, TBoMS is enabled when the TDRA table is configured with an entry with N>1, while PUSCH repetition Type A is not mentioned, and therefore it is still to be discussed if Type A and the combinations of N and M needed for Type A, can be dynamically indicated. If gNB configures both types in the TDRA table and postpones the choice to be made by dynamic signaling, the scheduling flexibility (number of rows in TDRA table) for both types is reduced compared with when only one type is configured in TDRA table.  As for retransmission, as we found in R1- 2112036 that only 4 out of 36 TBSs for N={2, 4, 8} and MCS indexes ranging from 0 to 9 can be configured with different combinations of N and MCS index. Thus, retransmission of a single TBoMS by TBoMS of a different N value or PUSCH repetition with the same TBS is only possible with very few configurations.  Also, TBoMS should perform as well as or outperform repetition type A, so we see no need to additionally configure repetition type A with TBoMS from a performance perspective. Therefore, configuring one transmission type between PUSCH repetition Type A and TBoMS (where single slot with {N=1,M=1} is supported as a fall back in TBoMS) is sufficient for both initial transmission and retransmission: it has lower overhead and the same or better performance |
| TCL | The restriction is not necessary, more flexible TDRA is needed. |
| Xiaomi | It is not necessary to restrict the flexibility of gNB scheduling. |

**2.1.1.1-Q2**

|  |  |
| --- | --- |
|  | Company’s name for the answer to 2.1.1.1-Q2 |
| **Yes** | Nokia/NSB |
| **No** | QC, Lenovo, Motorola Mobility, vivo, ZTE, Huawei, Hisilicon, Ericsson, TCL |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.1-Q2, if any. |
| NTT DOCOMO | Supporting TBoMS implies the support of available slot counting for TboMS, because TboMS is always counted on the basis of available slots. We are not sure why we need the parameter *AvailableSlotCounting* for TboMS. |
| QC | We should follow whatever counting method is configured for Type A repetitions and put it to use for TBOMS as well. |
| Sharp | It depends on decision at AI8.8.1.1. If available slot counting is not supported for FDD/SUL, availability of TboMS shouldn’t depend on whether available slot counting is enabled or not.  On the other hand, if available slot counting is supported for FDD/SUL, it’s straight forward to enable TboMS only when available slot counting is enabled. Our preference in AI 8.8.1.1 is that available slot counting is supported for FDD/SUL as well. |
| LG | We agree that TboMS transmission is supported with available slot based counting method only.  In order not to cause a configuration error issue (i.e., N>1 with disabling *AvailableSlotCounting*), we prefer that the UE always assume that *AvailableSlotCounting* is enabled when *N*>1, instead TboMS is enabled when N>1 and enabling *AvailableSlotCounting*. |
| Lenovo, Motorola Mobility | In our view, TboMS is based on available slot counting, so no need to explicit have this parameter |
| Intel | We share similar view as NTT DOCOMO. It is already agreed that TboMS transmission is based on available slots. Additional parameter is not needed. |
| Panasonic | We share similar view as DOCOMO. |
| Vivo | Since TboMS is always transmitted based on available slot, the parameter *AvailableSlotCounting* seems not necessary when TboMS is enabled. Probably available slot counting UE feature can be a precondition of the TboMS UE feature in the UE feature discussions, we’re open to discuss this in UE feature agenda. |
| ZTE | We share similar view as NTT DOCOMO. |
| Huawei, Hisilicon | No explicit signaling is needed to enable TBoMS counting based on available slot. |
| CATT | The current situation is whether ‘*AvailableSlotCounting*’ is ‘only applied to repetition type A’ or ‘applied to both repetition type A and TBoMS’.  We tend to prefer ‘*AvailableSlotCounting*’ is defined as ‘only applied to repetition type A’. We have already agreed that the slot of TBoMS must be counted based on available slot.  This is similar to the case of Msg3 PUSCH repetition in AI 8.8.3. Obviously there will not be RRC configuration of ‘*AvailableSlotCounting*’ when UE is transmitting Msg3, but the UE still transmit Msg3 repetition based on counting on available slot. |
| Ericsson | According to the following agreement in RAN1#106e, transmission of TBoMS is based on available slots, rather than physical slots. The RRC parameter *AvailableSlotCounting* only applies for Rel-17 PUSCH repetition Type A, if it is be configured in the TDRA table.  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 |
| TCL | For TBoMS, the parameter of *AvailableSlotCounting is no need.* |
| Xiaomi | Share the same view as NTT DOCOMO. Additional parameter is not needed. |

#### [OPEN] **Time domain resource determination for TBoMS for CG-PUSCH Type 2**

Several companies commented on this aspect. From FL’s perspective, two sub-aspects exist and are worth analyzing:

1. Whether the time duration for the transmission of a single TBoMS or TBoMS repetitions can be larger than the duration given by P.
2. The start of the initial transmission of a TB for a single TBoMS.

Companies’ preferences in these regards are as follows.

**Whether** **the time duration for the transmission of a single TBoMS or TBoMS repetitions can be larger than the duration given by P.**

* The time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the duration given by P, where:
  + *if N\*M is larger than the number of available slots in a CG period, the UE is expected to transmit K TBoMS transmission occasions where K<M.*
  + *If the UE cannot find N available slots in a CG period, the UE does not transmit TBoMS* **[1]**.
    - Interdigital [14].
* The UE is not expected to be configured with the time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the duration given by P **[3]**:
  + - Ericsson [22], Nokia/NSB [21], Panasonic [18].

**The start of the initial transmission of a TB for a single TBoMS.**

* An initial transmission of a transport block for TBoMS can start in a single TBoMS other than the first single TBoMS for a configured grant with startingFromRV0 not set to ‘off’ **[1]**:
  + - Sharp [24]
* The initial transmission of a transport block for TBoMS is restricted to begin from the first slot of a single TBoMS associated with RV0 **[1]**:
  + - Qualcomm [17]
* The initial transmission of a transport block for TBoMS can be performed according to legacy Rel-16 restrictions as defined in Clause 6.1.2.3.1 of TS 38.214 **[1]**:
  + - Nokia/NSB [21]
* Any slot associated with RV#0 can be deemed as an initial transmission position/slot **[1]**:
  + - Xiaomi [13]
* The initial transmission of a transport block for TBoMS does not start in the middle of the single TBoMS **[1]**:
  + - Panasonic [18]
* For TBoMS repetition with configured grant, a UE can be configured as startingFromRV0 = ‘off’ for the initial TO determination. Otherwise, only RV sequence {0, 0, 0, 0} can be configured even if startingFromRV0 is not provided or configured as startingFromRV0 = ‘on’ **[1]**:
  + - WILUS [7]

FL’s comments on November 11

From FL’s perspective, the following situation can be observed:

* **Whether the time duration for the transmission of a single TBoMS or TBoMS repetitions can be larger than the duration given by P.**
  + A clear majority exists for the companies who expressed a view on this aspect, however very limited number of preferences have been expressed overall.
* **The start of the initial transmission of a TB for a single TBoMS.**
  + Companies, preferences are all different but display some overlap.

Given the above, it may be best to propose three questions on these sub-aspects as well, before formulating any proposal.

**2.1.1.2-Q1**.  *Should the time duration for the transmission of a single TBoMS or TBoMS be repetitions larger than the duration given by P? Please provide a justification to your position and, whenever possible, refer to the views expressed by companies who do not agree with you.*

**2.1.1.2-Q2**. *Should the RRC parameter startingFromRV0 impact the determination of the time domain resource for the initial transmission of a transport block for TBoMS?*

**2.1.1.2-Q3**. *Which of the following options (only one) should be supported for the start of the initial transmission of a TB for a single TBoMS? Please provide a justification to your position and, whenever possible, refer to the views expressed by companies who do not agree with you.*

* 1. *The initial transmission of a transport block for TBoMS is restricted to begin from the first slot of a single TBoMS.*
  2. *The initial transmission of a transport block for TBoMS is restricted to begin from the first slot of a single TBoMS associated with RV0.*
     1. *FFS: implications related to whether and how the RRC parameter startingFromRV0 is set for TBoMS.*
  3. *Any slot can be deemed as a starting slot for an initial transmission of a transport block for TBoMS*
  4. *Any slot associated with RV0 can be deemed as a starting slot for an initial transmission of a transport block for TBoMS*
     1. *FFS: implications related to whether and how the RRC parameter startingFromRV0 is set for TBoMS.*
  5. *The initial transmission of a transport block for TBoMS can be performed according to legacy Rel-16 restrictions as defined in Clause 6.1.2.3.1 of TS 38.214*
  6. *Others [please describe in the Table below]*

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

FL’s recommendation is to have a first round of discussion among companies about **2.1.1.2-Q1** and **2.1.1.2-Q2** and **2.1.1.2-Q3**. Corresponding tables are added below to this end. Companies are invited to be constructive, given the very limited available time and the relevance of this matter. Thank you.

**2.1.1.2-Q1**

|  |  |
| --- | --- |
|  | Company’s name for the answer to 2.1.1.2-Q1 |
| **Yes** | InterDigital, TCL |
| **No** | QC, Sharp, LG, Nokia/NSB, Lenovo, Motorola Mobility, Intel, Panasonic,[SS], vivo, ZTE, CATT, Ericsson, WILUS |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.2-Q1, if any. |
| NTT DOCOMO | We have trouble getting the question due to typo.  The time duration for the transmission of a single TBoMS or TBoMS with repetitions should be shorter than the duration given by P. |
| QC | We pushed to change this in 8.8.1.1. but due to a sustained objection this change did not go through. As things stand currently a UE does not expect to be configured Type A repetitions that go past the period P. This same restriction should now apply to TBOMS as well irrespective of counting method.  If it does not apply, we ask that we agree to a change in 8.8.1.1 first for consistency. |
| LG | We would like to apply the aligned approach of PUSCH repetition type A to this issue.  In the last meeting, regarding the PUSCH repetition Type A with a configured grant based on available slot counting method, it was agreed that “The UE is not expected to be configured with the time duration for the transmission of K repetitions larger than the time duration derived by the periodicity P”. We prefer to apply the same mechanism for TBoMS with a configured grant. |
| Lenovo, Motorola Mobility | It doesn’t make sense or provide any benefit to have the TBoMS longer than P |
| Intel | We prefer same mechanism as defined for PUSCH repetition type A |
| Panasonic | For time domain resource determination including limitation of overall duration of TBoMS, the mechanism for PUSCH repetition Type A should be reused. |
| InterDigital | We identify several issues that creates difficulties to fit TBoMS repetitions in a CG period. There needs to be a number of available slots that is larger than multiples of N. In case CG period duration is short, all TBoMS repetitions may not fit in a period. Thus, duration for the transmission of TBoMS repetitions can be larger than the duration given by P to allow flexibility, allowing to transmit as many TBoMS occasions as possible in a given CG period. |
| Samsung | We can see the intention. Just hesitate to directly agree this, because the impact will be different. For repetitions, if it’s over the P, they can do drop easily; however, for TBoMS, if some of the slots are dropped, it will impact whole TB decoding. |
| vivo | This discussion is similar to that in AI 8.8.1.1 for PUSCH repetition type-A in previous meetings, the same mechanism can be reused. I.e. the total number of slots including those for repetitions of a TBoMS should be within the CG period. |
| ZTE | Similar restriction as defined in AI 8.8.1.1 for PUSCH repetition type A can be applied to TBoMS. |
| Huawei, Hisilicon | The question may need some clarification. One possible case is that when the configured available slot number N\*M is smaller than the periodicity P, however, according to the available slot counting, some of slots are out of the periodicity P. And for different periodicity, there may different available slot. And when configure N\*M slots for TBoMS transmission, in some of the periodicities, the transmission duration is within the periodicity, however in some of the periodicities, the available slots may be outside of the periodicity. How to address this case? |
| CATT | Similar discussion already happened in AI 8.8.1.1. The conclusion is this case is not allowed, which follows the legacy behavior. |
| Ericsson | We base our position considering two commonalities between TBoMS and Rel-17 PUSCH repetition Type A based on available slots. TBoMS is based on available slots too, and the maximum value of M\*N for TBoMS is no larger than the increased maximum number of repetitions for Rel-17 PUSCH repetition Type A. |
| TCL | For CG TBoMS, if some of slots is dropped, the capability of TBoMS will be decreased, thus, ensuring the total number of slots for TBoMS should be needed. |
| WILUS | Same view with majorities. Common rule with PUSCH repetition Type A can be applied. |

**2.1.1.2-Q2**

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| --- | --- |
|  | Company’s name for the answer to 2.1.1.2-Q2 |
| **Yes** | DCM, QC, Sharp, LG, Nokia/NSB, Lenovo, Motorola Mobility, Intel, Panasonic, vivo, Huawei, Hisilicon, CATT,TCL, WILUS，Xiaomi |
| **No** | Ericsson |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.2-Q2, if any. |
| NTT DOCOMO | If RRC parameter *startingFromRV0* is enabled, an initial transmission of a transport block for TBoMS can be only the first transmission occasion on each single TBoMS associated with RV0. |
| QC | Don’t see a strong need to introduce a new parameter. Open to considering this if it brings better clarity and is considered a good practice. |
| LG | Regarding the start of the initial transmission of a TB for a single TBoMS, we think that it is sufficient to follow the rule of PUSCH repetition Type A with a configured grant in the existing Rel-15/16.  In case of Rel-15/16 PUSCH repetition Type A with a configured grant, if a configured grant configuration is configured with *startingFromRV0* set to 'off', the initial transmission of a transport block may only start at the first transmission occasion of the *K* repetitions. Otherwise, the starting slot can be different with the first transmission occasion if the configured RV sequence is {0,3,0,3} or {0, 0, 0, 0}.  Thus, if the same mechanism is applied to TBoMS with a configured grant, the parameter *startingFromRV0* impact the determination of the time domain resource for the initial transmission of a transport block for TBoMS. |
| Panasonic | In Rel.16, if a configured grant configuration is configured with *startingFromRV0* set to ‘off’, the initial transmission of a transport block may only start at the first transmission occasion of the K repetitions. The same principle could be used such that if a configured grant configuration is configured with *startingFromRV0* set to ‘off’, the initial transmission of a transport block may only start at the first single TBoMS. Otherwise, the initial transmission of a transport block may start at other than the first single TBoMS depending on configured RV sequence. |
| vivo | The same mechanism as that for type-A PUSCH repetition can be reused. |
| ZTE | In our view, *startingFromRV0* can only be applied for cases that using RV cycling. For single TBoMS, only a single RV0 is used. We don’t see the need of applying *startingFromRV0.* For repetition of TBoMS, *startingFromRV0* should be applied following legacy rules. |
| Huawei, Hisilicon | The legacy principle should be reused. |
| CATT | We think following current mechanism is a natural choice, if no clear benefit can be brought by new mechanism. |
| Ericsson | We prefer that the UE transmits an entire TBoMS (with a given RV) each time. The setting of startingFromRV0 should not affect this behavior. |
| Xiaomi | For PUSCH repetition type A in rel-16, if a configured grant configuration(both type-1 and type 2 CG) is configured with *startingFromRV0* set to ‘*off*’, the transmission of a TB can only start ate the first transmission occasion of the K repetitions. Otherwise the initial transmission of a TB may start at the transmission occasions associated with RV#0 if the RV sequence is {0, 3, 0, 3} or {0, 0, 0, 0}.  For single TBoMS without repetition, only RV#0 is applied, one issue needs to be considered is whether the TBoMS will be transmitted if it is arriving at other than the first slot, just as the following figure shows. This issue is more like a PUSCH dropping rule, i.e. whether the subsequent slots will also be transmitted if the transmission on some of the first few slots is omitted due to the resources collision. From our point of view, if the subsequent slots can be always transmitted regardless of whether the first few slots are dropped, the transmission of a single TBoMS with a configured grant can also start at the non-first slot.  C:\Users\qiaoxuemei\Pictures\single tboms.png  For TBoMS with repetition, the RV cycling across repetitions is applied. The legacy rule in Rel-16, and the determination of the start slot associated with RV#0 mentioned above can be applied together. |

**2.1.1.2-Q3**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Company | A | B | C | D | E | F | Justification | |
| DCM |  | ✓ |  |  |  |  |  |
| QC |  | ✓ |  |  |  |  | Systematic bits are important. Partial transmissions without systematic bits don’t make much sense. Also the logic to execute starting bit determination needs to run before the first slot. This imposes restrictions on when we can start a single TBOMS transmission. |
| Sharp | ✓ | ✓ |  |  |  |  | Sharp’s intention of Option A is the same as Option B.  A single TBoMS should be treated as a set of transmission from the UE perspective. TboMS transmission at the middle of the single TboMS may put extra implementation effort without reasonable gain.  Specifically, we need to discuss them for each RV sequence.  For RV sequence {0,2,3,1}, the initial transmission of a TB can start at only a first slot of a first single TboMS among TboMS repetitions.  For RV sequence {0,3,0,3} or {0,0,0,0}, the initial transmission of a TB can start at a first slot of a single TboMS associated with RV0. |
| LG |  |  |  |  | ✓ |  | We think a transmission occasion in 6.1.2.3.1 can be interpreted as N slots of a single TboMS.  If the transmission occasion for the initial transmission is determined, TboMS transmission is started in the first slot of the transmission occasion. |
| Nokia/NSB |  |  |  |  | ✓ |  | We prefer to reuse the legacy ehaviour for CG-PUSCH type 2. |
| Lenovo, Motorola Mobility |  | ✓ |  |  |  |  | Share similar view as QC |
| Intel |  |  |  |  | ✓ |  | Share similar view as Nokia. |
| Panasonic |  | ✓ |  |  |  |  | If TboMS starts in the middle of the single TboMS, a lot of systematic bits may not be transmitted. |
| Vivo |  |  |  |  | ✓ |  | It’s enough to reuse legacy rules since compared to single slot TB, the whole TboMS PUSCH can be treated as a single transmission occasion already specified in 38.214. |
| ZTE |  | ✓ |  |  |  |  | We have similar views as QC. Partial transmission of one single RV should be avoided as it may cause loss of systematic bits. |
| Huawei, Hisilicon |  | ✓ |  |  |  |  | B: Considering that the systematic bits are covered in RV0, if CG-TBoMS is transmitted from RV0, it can improve the possibility of successful decoding at the first TBoMS repetition, and reduce the burden of blind detection.  A: Compared with B, it has more time domain resources to transmit CG-TBoMS through increasing positions of initial transmission. However, it may slightly increase the burden of blind detection and reduces the possibility of successful decoding at the first TBoMS transmission because the initial transmission may not be associated with RV0. Furthermore, it may also results in that there is no TBoMS transmission associated with RV0, and it cannot be decoded.  C/D: It will lead to that a single TBoMS lacks of some slots. In this case, how to coding/decoding should be further discussed. And it will greatly increase the burden of blind detection.  E: Considering that the definition of transmission occasion for TBoMS has not been defined, it will lead to different understanding, e.g., transmission occasion of TBoMS defined as physical slot, available slot, or all the slots during a single TBoMS transmission, will lead to different understanding. |
| CATT |  |  |  |  | ✓ |  | We acknowledge that system bits are important. But in our understanding, legacy Rel-16 restrictions is able to restrict that the TBoMS can only start with initial slot of RV0 by configuring *startingFromRV0*, i.e. avoid losing system bits. |
| Ericsson |  | x |  |  |  |  | While we think option E could work in principle, it is not crystal clear what reusing the restrictions in Clause 6.1.2.3.1 of TS 38.214 means. There the ‘K repetitions’ are probably meant to be the N slots of a TBoMS, but when there are multiple repetitions of the TBoMS, the situation becomes unclear. Also, the need for the *startingFromRV0* set to *'on'* that allows a start anywhere in the period P associated with RV0 is not so clear to us.  Therefore, we prefer option B. |
| TCL |  | ✓ |  |  |  |  | We have similar view as QC. |
| WILUS |  |  |  | ✓ |  |  | Regarding the TBoMS with repetitions, restriction on the first slot can cause long latency when the first slot associated with RV0 is invalid and the value of N\*M is large. Therefore, any slot associated with RV0 can be determined as a starting slot.  Additionally, it is unclear of UE behavior with Option E since legacy restrictions only cover single-slot PUSCH with repetitions. For now, both Option B and D seems to be interpreted as an extension of legacy restrictions to TBoMS. |
| Xiaomi |  |  |  |  |  |  | There is one issue need to be clarified to avoid misunderstanding: In rel-16, if the RRC parameter *startingFromRV0* is configured and set to ‘*off*’ then only the first transmission occasion in one CG period is determined as the initial transmission; while, if the RRC parameter is not configured or it is configured but set to ‘off’, the initial transmission occasion can be the transmission occasions associated with RV#0. Thus, we can’t choose from Option A and Option B, more clarification on the proposal may be needed.  Besides, just as our comment in **2.1.1.2-Q2,** if the TBoMS dropping rule is that the subsequent slots can always be transmitted regardless of whether the first few slots are dropped, then option D is our first choice. |

#### [OPEN] **Use of non-consecutive slots for paired spectrum**

One company commented explicitly on this aspect. More precisely, it is proposed that if no further agreement is made under AI 8.8.1.1 on how to handle the available slot counting for paired spectrum and SUL band, then only consecutive physical slots are supported for TBoMS in paired spectrum and SUL band.

FL’s comments on November 11

From FL’s perspective it is fair to say that some uncertainty may exist with respect to the available slot counting for paired spectrum and SUL band, given the questions companies asked to Editor of TS 38.214 during the CR review phase.

Available agreements and conclusion in this regard are as per Table below

|  |
| --- |
| 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:  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.   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**  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)  **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. |

It can be inferred from the above that indeed, as of today:

* Only consecutive slots for UL transmissions cam be used for TBoMS in case of paired spectrum and SUL band.
* Available slots for FDD or SUL cannot be identified using the two-step procedure unless the discussion in AI 8.8.1.1 clarifies this aspect. For instance, how the first step of the available slot determination procedure works in case of paired spectrum and SUL band may be considered unclear, unless it is assumed that available slots for TBoMS in this case are all the consecutive physical slots over which the same symbol allocation is applied (Rel-15/Rel-16 dropping rules then are used to identify the final transmitted slots).

At this stage of the discussion and given that this is the last meeting of WI, it may be then appropriate to adopt a conservative behavior, without relying that any further agreement will be made in AI 8.8.1.1 concerning the notion of available slots in case of paired spectrum and SUL. The idea would be to clarify this aspect among companies such that, if not further agreement is made for AI 8.8.1.1, an agreement can be made for TBoMS later during #107-e.

I would start with the following question.

**2.1.1.3-Q1***. Assuming no further agreement is made concerning the available slot determination in case of paired spectrum and SUL, would you agree with the following description of TBoMS ?*

*For paired spectrum or supplementary uplink band, the same symbol allocation is applied across the N\*K consecutive slots and the PUSCH is limited to a single transmission layer. The UE shall transmit the TB across the N\*K consecutive slots applying the same symbol allocation in each slot.*

*(If you do not agree with the above, please provide an alternative description for other companies to consider)*

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

FL’s recommendation is to have a first round of discussion among companies about **2.1.1.3-Q1**. Companies are invited to input their answer below, provide comments (if applicable) and be constructive.

**2.1.1.3-Q1**

|  |  |
| --- | --- |
|  | Company’s name for the answer to 2.1.1.3-Q1 |
| **Yes** | DCM, Nokia/NSB, Lenovo, Motorola Mobility, Intel, SS, vivo, TCL |
| **No** | QC, Ericsson (OK if clarified) |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.1.3-Q1s, if any. |
| QC | As things stand in 8.8.1.1, and after discussions on Redcap half-duplex UEs, our understanding is that R17 Cov Enh will impose no restrictions on the applicability of available slot counting to paired spectrum/SUL. This was also the reason why we steered clear of using the terms “paired” and “unpaired” in 8.8.1.3 when specifying the procedure to determine TDWs. |
| Sharp | We think further agreement for paired spectrum and SUL should be made in AI 8.8.1.1. Therefore, we’d like to suggest waiting the decision in AI 8.8.1.1. |
| LG | We share the view with Sharp. |
| Nokia/NSB | We share the same view with Sharp that a decision should be made in AI 8.8.1.1. However, the interpretation from the FL seems to be correct if “*no further agreement is made*” in any AI. |
| Intel | We are fine with the proposal. Our understanding is that for paired spectrum and SUL, consecutive slots are allocated for TBoMS. |
| Panasonic | If no further agreement is made in AI.8.8.1.1, i.e., available slot counting is not supported for paired spectrum and SUL, we agree with the proposed description. If AI. 8.8.1.1 concludes that available slot counting is also applied to paired spectrum and SUL, non-consecutive slot allocation should be supported. Therefore, it is better to wait the conclusion in AI 8.8.1.1. In our view, current conclusion is sufficient at this stage. |
| Samsung | I think for QC’s concern, the handling of the HD-FDD UE, some of the slots will not be transmitted, e.g., dropped. But it won’t impact the resource availability. |
| vivo | According to following agreements on available slot determination for Type A PUSCH repetition, the FL conclusion seems obvious to us, and we do not think a separate proposal or agreement on this is necessary.  Agreement   * Only *tdd-UL-DL-ConfigurationCommon*, *tdd-UL-DL-ConfigurationDedicated* and *ssb-PositionsInBurst* are considered for the determination of available slots.   + Any other RRC configuration is not considered for the determination of available slots.   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:  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) |
| ZTE | The mechanisms we defined could apply for all spectrum. And we share with QC and vivo that there is no need additional agreements in this agenda. |
| Huawei, Hisilicon | No further agreement is needed. The mechanism should be applicable to all spectrum. |
| CATT | FL’s proposal shall at least be ‘applied’ to FD-FDD UE, regardless counting based on available slot is ‘defined’ in paired spectrum or SUL or not.  In our understanding, even if counting based on available slot is ‘defined’ in paired spectrum, it can only be ‘applied’ to HD-FDD UE. |
| Ericsson | We agree with FL’s inferring that “available slots for TBoMS in this case are all the consecutive physical slots over which the same symbol allocation is applied (Rel-15/Rel-16 dropping rules then are used to identify the final transmitted slots).”  Regarding the proposed description, we would like to clarify that, while the ‘K’ may be used in 38.214 as the number of repetitions, in the context of TBoMS it is ‘M’.  Also, “The UE shall transmit the TB across” is not about available slot determination, but about PUSCH transmission (and since slots can be dropped, transmission is not the same thing as available slot determination). Therefore, we suggest the following refinement to the FL proposal:  For paired spectrum or supplementary uplink band, the same symbol allocation is applied across the ~~N\*K~~ M\*N consecutive slots and the PUSCH is limited to a single transmission layer. ~~The UE shall transmit the TB across the N\*K consecutive slots applying the same symbol allocation in each slot.~~ |
| Xiaomi | We share the same view as Sharp. |

### [OPEN] Single TBoMS structure

Two contributions ([5] and [22]) proposed to confirm the working assumption made on the single TBoMS structure, given its relevance and importance in the context of the CRs which have been prepared, and will be updated, by Editors.

FL’s comments on November 11

From FL’s perspective, it is important to confirm the WA on the single TBoMS structure, especially considering that this is being used to build all other aspects of the feature. That WA was made several meetings ago and was as follows:

|  |
| --- |
| 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. |

Subsequently, other working assumptions, agreements and conclusions were made, which clarified that the concept of TOT would not be used anymore, that the bit interleaving per slot is assumed, that RV cycling is used in case of TBoMS repetitions and so on. For all these reasons, I think it would be cleaner to stick to the important point and simply confirm that a single RV is used to transmit a single TBoMS and avoid confusion to Editors. The following proposal is then made.

**FL’s proposal 1**

**A single RV is used to transmit a single TBoMS.**

From FL’s perspective, the above proposal should not require any discussion to be approved and will thus be brought online during the GTW scheduled on November 11. I expect no discussion to occur, and I would appreciate if all companies avoided commenting further online about it, for the sake of an efficient use of the already very limited available time. Thank you.

### [OPEN] Rate Matching

This aspect has been discussed in detail in several contributions, with specific focus on the index of the starting coded bits in each slot for TBoMS. Irrespective of this, we still have two high-level sub-aspects that can be isolated as illustrated above. The reason is that the WA made during RAN1 #106b-e would need to be confirmed for it to be captured in the CRs of TS 38.212 and TS 38.214. The summary of companies’ preferences and opinions based on the contributions is organized accordingly.

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

Nine companies ([8], [9], [10], [12], [13], [16], [19], [20], [21]) proposed to confirm the WA made during RAN1 #106b-e, given its relevance and importance in the context of the CRs which have been prepared, and will be updated, by Editors.

FL’s comments on November 11

From FL’s perspective, it is important to confirm the WA on the time unit of the bit interleaving, especially considering that this is being used to build other aspects of the feature. That WA was made several meetings ago and was as follows:

|  |
| --- |
| **Working Assumption**  For TBoMS in Rel-17, the following is supported:   * Bit interleaving is performed per slot.          The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission.   * Transmission is limited to one CB only. * FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not * FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS     Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further. |

Given that the FFS are still open and the note still applies, FL’ suggestion is to confirm the WA as is.

**FL’s proposal 2**

**Confirm the following working assumption:**

**Working Assumption**

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

* **Bit interleaving is performed per slot.**

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

* **Transmission is limited to one CB only.**
* **FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not**
* **FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS**

**Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further.**

From FL’s perspective, the above proposal should not require any discussion to be approved and will thus be brought online during the GTW scheduled on November 11. I expect no discussion to occur, and I would appreciate if all companies avoided commenting further online about it, for the sake of an efficient use of the already very limited available time. Thank you.

#### [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:

* Option B: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot **[7]**:
  + Interdigital [14], Huawei/HiSi [3], ZTE [5], China Telecom [11], Intel [15], OPPO [9], LGE\* [28].
* Option C: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not **[16]**:
  + CMCC [12], NEC [25], Samsung [19], Sharp [24], Ericsson [22], NTTDOCOMO [26], Apple [16], Qualcomm [17], MediaTek [20], Nokia/NSB [21], vivo [6], Spreadtrum [23], Fujitsu [10], CATT [8], Panasonic [16], LGE\* [28].

Three companies ([16], [25] and [24]) provided alternative but equivalent ways of calculating the index of the starting coded bit according to Option C.

One company describes an alternative way to calculate the starting coded bits in each slot that may or may not result in a continuous extraction of bits from the circular buffer, depending on how a scaling parameter is configured by NW [17]. As such, it does not seem fully aligned with the scope of the previous agreement, nor with the spirit of the single RV transmission for the single TBoMS.

Finally, 5 companies expressed views on whether the index of the starting coded bit for each transmitted slot is expressed as a multiple integer of the lifting size Zc, as follows:

* Expressing the index of the starting coded bit as a multiple integer of the lifting size Zc is not necessary **[2]:**
  + vivo [6], Samsung [19].
* Expressing the index of the starting coded bit as a multiple integer of the lifting size Zc is necessary **[2]:**
  + Huawei/HiSi [3], NTTDOCOMO [26].
* Decision on this aspect should be left to the Editor **[1]**:
  + CATT [8].

FL’s comments on November 11

From FL’s perspective, the views expressed by companies so far show a clear majority in favor of Option C, which has the merit of being able to be fully compatible with existing UCI multiplexing rules and timeline requirements. Indeed, companies’ opinions concerning the impact on existing UCI multiplexing rules and timeline requirements of Option B. This aspect has been discussed for more than 1 meeting already and I doubt further technical discussions may result in all 15 (+1) companies in favor of Option C to change their opinion and support Option B.

Conversely, if we focus on Option B, we see that that main argument used to support this option is related to the possible performance degradation that Option C would entail as compared to Option B. However, if we look closely at the obtained and results, and companies comments we observe the following:

* Performance difference between Option B and Option C, when observed, is almost always in the order of few tenths of dB.
* The possibility of configuring TBoMS repetitions can recover such very limited performance loss, if present at all, rather effectively.

In this sense, from FL’s perspective, it seems fair to state that Option C is a very good way of reducing specification and implementation impact, while not impairing the success of TBoMS in terms of performance. I would urge companies in favor of Option B to reconsider their position, given all the above.

Switching the focus now on whether the index of the starting coded bit in each slot should be expressed as a multiple integer of the lifting size , I think that it is also fair to say that no clear majority exists in favor of or against it. Once again, companies’ opinions differ in this regard and do not seem to vary over time (they are the same as for the last meeting). From FL’s perspective it may make sense to ask one last question to companies about this to understand what the preference of companies is who did not express an opinion on this aspect yet. If a clear majority is not formed for either of the two directions, I would suggest dropping this discussion in the interest of an efficient use of our time. In this context, it is worth noting that I will not propose companies to express a preference in favor of “leave the decision up to the Editor”, because such decision may imply that an additional rounding operation is to be performed at least at the UE (at least according to some companies). As a result, it needs an agreement to be supported (or not).

Finally, and irrespective of the decision on “”, I would assume that any decision related to how to describe the continuous bit extraction from the buffer may be left up to the Editor, given that no ambiguity exists in this sense, and several equivalent formulations/descriptions can be found.

Given all the above, the following proposal and question are made.

**FL’s proposal 3**

**For the bit selection for each transmitted slot for TBoMS, the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.**

***2.1.3.2-Q1.*** *Should the index of the starting coded bit for each transmitted slot be expressed as a multiple integer of the lifting size Zc?*

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

FL’s recommendation is to have a first round of discussion among companies about **FL’s proposal 3** and ***2.1.3.2-Q1***.

Concerning**FL’s proposal 3**.I understand that this may not be a preferred outcome for the companies who expressed preference for Option B, however I’d like to invite all these companies to be pragmatic and acknowledge that solid arguments have been brought in favour of Option C, for which a very large majority exists. As I was saying before, performance difference may exist, but it does not seem significant and can be effectively nulled by simply configuring TBoMS with repetitions. It should be noted that RAN1 decided to support TBoMS repetitions exactly to ensure that systematic bits could be recovered via repetitions, irrespective of dropping/collisions/puncturing.

**FL’s proposal 3**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 3** | DCM, QC, Sharp, Nokia/NSB, Lenovo, Motorola Mobility, Panasonic, SS, vivo, CATT, Ericsson, Xiaomi |
| **Do not support FL’s Proposal 3** | LG, Intel, ZTE, Huawei, Hisilicon |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 3, if any. |
| LG | As shown in our evaluation results, the performance loss of Option C due to UCI multiplexing is never negligible, and we think it is necessary to try to minimize the performance loss of TBoMS by applying Option B.  However, in our understanding, adopting Option C can reduce specification and implementation impact while not cause error propagation problem as the FL descripted kindly.  In our view, while enjoying the benefits of Option C, it is necessary to make an effort to minimize the performance degradation issue.  Multiplexing of aperiodic CSI may be the biggest cause of Option C performance loss because it may be transmitted in the first slot of the first transmission of TboMS. On the other hand, multiplexing of aperiodic CSI on TboMS does not have a timeline issue and there is no possibility of misalignment of aperiodic CSI multiplexing.  Therefore, in the case of aperiodic CSI, it is considered that the starting bit of each slot of TboMS should be determined in consideration of UCI multiplexing. On the other hand, in the case of other UCI types, the starting bit can be determined without considering UCI multiplexing. |
| Intel | We do not agree that performance loss is negligible as shown in our results due to puncturing of some systematic bits in some slots. At least based on our simulation results, in some cases, consistent decoding failure can be observed for Option C. Regarding TboMS with repetition, we do not agree that subsequent repetition can recover performance loss due to cancellation of big portion of systematic bits in the initial transmission.  For coverage enhancement, our view is that the performance is important to determine which option is adopted for TboMS. |
| ZTE | We do not support the proposal based on the following reasons as also commented in GTW.   * Option C would introduce new UCI multiplexing procedures for UCI of more than 2 bits, with replacing rate-matching by puncturing. This would cause performance loss as commented by other companies, and also complicate both UE and gNB implementation as they need to handle two different UCI multiplexing procedures. * The main motivation of Option C is to resolve the error propagation issue due to missing DL DCI associated with a HARQ-ACK to be multiplexed on the TboMS. However, missing detection of DL DCI are corner cases thanks to the existing DAI mechanism. We should not introduce a scheme trying to solve the issues of corner cases while cause performance loss for most typical cases. This would make TboMS less attractive in practice. * UCI bits could always be known before the first transmission of TboMS at least for DG PUSCH. * Regarding the comments that if gNB knows there would be UCI multiplexing, it can leave to gNB implementation by scheduling lower MCS etc. We are not convinced. If gNB would know there could be UCI multiplexing, it is more reasonable for gNB to try to ensure no DCI missing and reuse legacy UCI multiplexing procedure.   Our proposal is to go with legacy multiplexing rules, i.e., puncturing for 1-2 bits UCI and rate-matching for more than 2 bits UCI, and reuse legacy multiplexing timeline for both DG and CG. This would not cause any issue for DG PUSCH, and the missing DCI issue could be regarded as corner case for CG PUSCH.  If we have to make some differentiation, instead of differentiating for different UCI types, we think it is more reasonable to differentiate between DG PUSCH and CG PUSCH. |
| Huawei, Hisilicon | In our understanding, the misalignment issue is only occurred by missing detection of DCI scheduling HARQ-ACK. For CSI report, there is no misalignment issue, as follows.   1. P-CSI reporting is configured by RRC. There is thus no misalignment issue. 2. Regarding to SP-CSI reporting, it can be carried on PUCCH or PUSCH.    * If SP-CSI reporting is carried on PUCCH, it is activated by MAC-CE. There is also no misalignment issue.    * If SP-CSI reporting is carried on PUSCH, it is triggered by DCI. In this case, SP-CSI reporting cannot be multiplexed with uplink data on PUSCH. And if the first PUSCH carrying on the SP-CSI reporting is overlapped in time with the second PUSCH that includes an UL-SCH, the first PUSCH carrying on the SP-CSI reporting should be dropped. So there is also no misalignment issue. 3. Regarding to A-CSI reporting, it is carried on PUSCH as triggered by DCI. There are two possible scenarios as follows.    * A-CSI reporting is triggered by DCI scheduling PUSCH which includes uplink data. In this case, A-CSI reporting will be multiplexed with uplink data on PUSCH. However, if DCI is missed, the PUSCH will also cannot be transmitted. So there is no misalignment issue.    * It is not a valid case that the first PUSCH carrying on A-CSI triggered by a DCI overlaps in time with the second PUSCH with dynamic and configured grant.   Furthermore, we considering the scenario that A-CSI reporting is triggered by DCI scheduling PUSCH repetition which includes uplink data. In this case, A-CSI will be multiplexed on the first repetition. For TBoMS, a lot of systematic bits are included in the first slot. So if A-CSI is multiplexed on the first slot allocated for TBoMS transmission by puncturing, its performance will be dramatically lost.  As discussed above, Option B with HARQ-ACK puncturing is a better method. It not only solves the misalignment issue of option B, but also has a better performance than option C.  Reference:  TS 38.214 Section 5.2.3: CSI reporting on PUSCH can be multiplexed with uplink data on PUSCH except that semi-persistent CSI reporting on PUSCH activated by a DCI format is not expected to be multiplexed with uplink data on the PUSCH. CSI reporting on PUSCH can also be performed without any multiplexing with uplink data from the UE.  TS 38.214 Section 5.2.5: If a UE would transmit a first PUSCH that includes semi-persistent CSI reports and a second PUSCH that includes an UL-SCH and the first PUSCH transmission would overlap in time with the second PUSCH transmission, the UE does not transmit the first PUSCH and transmits the second PUSCH. The UE expects that the first and second PUSCH transmissions satisfy the above timing conditions for PUSCH transmissions that overlap in time when at least one of the first or second PUSCH transmissions is in response to a DCI format detection by the UE.  TS 38.214 Section 6.1: For any HARQ process ID(s) in a given scheduled cell, the UE is not expected to transmit a PUSCH that overlaps in time with another PUSCH. For any two HARQ process IDs in a given scheduled cell, if the UE is scheduled to start a first PUSCH transmission starting in symbol *j* by a PDCCH ending in symbol *i*, the UE is not expected to be scheduled to transmit a PUSCH starting earlier than the end of the first PUSCH by a PDCCH that ends later than symbol *i*. The UE is not expected to be scheduled to transmit another PUSCH by DCI format 0\_0, 0\_1 or 0\_2 scrambled by C-RNTI or MCS-C-RNTI for a given HARQ process until after the end of the expected transmission of the last PUSCH for that HARQ process.  C:\Users\l00519916\AppData\Roaming\eSpace_Desktop\UserData\l00519916\imagefiles\229EE648-F868-462A-9198-8589899097FA.png |
| Ericsson | When we simulated with a reasonable number of CSI bits and with MCS states and TBS that are we think representative of TBoMS use cases, we did not find excessive loss from Option C as compared to Option B. Furthermore, Option B will have error propagation issues if there are missed DCIs, so Option B is not necessarily better performing than Option C. Option C is clearly less complex than Option B.  So in our view, Option C is the best choice. |
| Xiaomi | Since the performance gain can be obtained by TBoMS combining with other methods, such as PUSCH repetition type A, joint channel estimation, etc., the performance is not the main issue in the design of rate matching of TBoMS. Option B has non-negligible spec impact, that is, two different rate matching mechanisms should be maintained separately for single-slot TB and TBoMS when UCI multiplexing occurs. It will influence the complexity of UE’s implementation, and is not supported by us. |

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

**2.1.3.2-Q1**

|  |  |
| --- | --- |
|  | Company name |
| **Yes** | DCM, Huawei, Hisilicon |
| **No** | QC(from UE perspective), Sharp, Nokia/NSB, Intel,SS, vivo, ZTE, CATT, Ericsson, Xiaomi |

|  |  |
| --- | --- |
| Company | Additional comments related to 2.1.3.2-Q1, if any. |
| QC | We have checked internally on whether there are any benefits to doing this from an implementation standpoint and we have not been able to identify any from a UE Tx standpoint. Open to hearing views from gNB perspective. |
| Sharp | Rounding operation by Zc puts complexity without reasonable gain. |
| Nokia/NSB | We also share similar views with Qualcomm and Sharp that further restriction based on lifting size Zc is unnecessary. In addition, rounding with Zc may violate the WA that only a single RV is used for a single TBoMS, since it can be argued that any overlapping of the bits mapped on the slots allocated for a single TboMS can be considered as using different RVs. |
| Intel | Share similar view as Nokia that it seems not aligned with the previous agreements. |
| Samsung | At least for us, we have identify the necessity to have this alignment from both UE and gNB perspective. Again, TboMS is an independent transmission scheme. Some of the implementation is deemed to be modified to fit this transmission scheme, and we only reuse and add the necessary one. |
| Vivo | Since only one CB is transmitted in a TboMS, the coded bits in multiple slots is regarded as a whole at both encoder and receiver. Neither encoder nor receiver can see the boundary of coded bits caused by slot boundary. Hence, such restriction is not necessary. |
| ZTE | We also don’t identify any clear benefits by limiting the starting bits as an integer of Zc. From gNB perspective, no matter Option B or Option C, gNB will know the exact starting bit for each slot once scheduling TboMS. Using contiguous bits slot by slot could be even simpler for implementation. |
| Huawei, Hisilicon | First of all, looking at the current specification and UE implementation, rounding is a necessary steps to calculate the starting bit of each slot, regardless of retransmission or repetition type A or repetition type B, because for each slot transmission, the TBS and code blocks are with different size, the starting bit index needs to be calculated for each slot with rounding operation. From this point of view, we do not observe any complexity increase compared with the current specification, and implementation.  Secondly, this can reuse the type A repetition implementation as much as possible. (note: the index of the starting bit of each slot is multiple of the LDPC lifting size Zc 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 and this will requires modification of the chipset in gNB side. To reuse the type A repletion decoding at the gNB side, the starting bit should be the integer of the lifting size.  Thirdly, for each slot bit selection and interleaving, the starting bit will be anyway calculated and this calculation is already implemented by the gNB.  Fourthly, as commented online, the bits for each slot are already not continuous in reality due to the UCI multiplexing and starting bit calculation of option C. Then the bit selection and interleaving are performed slot by slot. From this point of view we do not see any difference complexity difference between with and without the rounding operation.  Finally if the rounding is operated by floor operation, then some of the bit punctured in the last slot will be transmitted in the current slot. There will be some coding gain due to less punctured systematic bits of bit selection option C. |
| CATT | To clarify, for the rounding function, we share the same views with many above companies that it is unnecessary.  For how to capture continuous bit mapping between slots, we think this can be up to editor. |
| Ericsson | Our understanding is that restricting the starting coded bit to be an integer of the lifting size can degrade performance. Also, it is not clear to us why gNB implementation would require this integer lifting size constraint presuming that gNB decodes after all slots of a TBoMS.  So at this stage, we do not see the benefit of the lifting size constraint. |

### [OPEN] UCI multiplexing

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

**Whether UCI multiplexing on PUSCH is supported for TBoMS**

* Support UCI multiplexing in TBoMS PUSCH **[3]**:
  + NEC [25], Samsung [9], InterDigital [14],

**Where and how to apply the UCI multiplexing**

* Legacy UCI multiplexing behaviour for PUSCH repetition type A is reused for TBoMS (UCI is multiplexed on the overlapping slot) **[11]**:
  + NEC [25], Samsung [9], LGE [28], Ericsson [21], NTT Docomo [26], Qualcomm [17], MediaTek [20], WILUS [7], China Telecom [11], Panasonic [18], Xiaomi [13]
* UCI repetition on multiple slots of TBoMS **[3]**:
  + InterDigital [14], Ericsson (for CSI or HARQ-ACK, if multiplexing in multiple slots is supported) [21], TCL [4]
* The REs occupied by UCI are evenly divided and mapped in each of the overlapped slots **[2]**:
  + CATT (the current UCI mapping rules can be reused for UCI multiplexing in one slot) [8], OPPO [9]
* One company (LGE [28]) proposed that, in case of aperiodic CSI reporting with TBoMS transmission, it is necessary to clarify the location of the slot resource for aperiodic CSI multiplexing among the N allocated slots of TBoMS.

**The number of coded modulation symbols per layer calculation**

* Two companies (LGE, Sharp) proposed that, for the determination of the number of coded modulation symbols per layer, is further multiplied by N, where N is the number of slots allocated for TBoMS.
* One company (Huawei/HiSi) proposed that the parameter should be redefined to compensate the coding rate as follows:
  + for HARQ-ACK;
  + for CSI part 1;
  + for CSI part 2;

where is the scaling factor to calculate for TBS determination, and the parameters , , and are the coding rate compensation parameters for HARQ-ACK, CSI part 1, and CSI part 2, respectively, configured in RRC.

* One company (NTT Docomo) proposed that how to calculate the number of coded modulation symbols for UCI in TBoMS PUSCH should be discussed.
* One company (WILUS) proposed that the number of coded modulation symbols for the UCI in a slot (Q’ACK, Q’CSI-1, and Q’CSI-2) can be determined with following methods for UCI multiplexing on single slot for a single TBoMS.
  + Alt 1: TBS, i.e., is scaled by 1/N, where N is the number of slots allocated for a single TBoMS.
  + Alt 2: The number of coded modulation symbols for the UCI in a slot is determined based on the number of available PUSCH resource across N slots, i.e., .
* One company (vivo) proposed using the following equation for calculating the number of symbols for UCI multiplexing on a single TBoMS.

Where is the total number of OFDM symbols of the PUSCH across N slots for a single TBoMS, including all OFDM symbols used for DMRS; and is the total number of OFDM symbols of the PUSCH within one slot for TBoMS, including all OFDM symbols used for DMRS.

* One company (CATT) proposed that the number of available slots for TBS determination can be used to determine the data rate for UCI resource computation and the number of available overlapping slots between PUCCH and TBoMS can be used to determine the upper bounder of UCI resource on TBoMS.
* One company (Panasonic) proposed that and should be calculated per slot basis and for the calculation of , TB size before multiplying scaling factor K should be used.
* One company (NEC) proposed that, when calculating 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 (LGE) proposed that is the number of symbols for TBoMS in a corresponding slot in which UCI is multiplexed for determination of the values of , , , and .

FL’s comments on November 11

From FL’s perspective, two major aspects can be isolated in this discussion:

* How UCI is multiplexed on PUSCH for TBoMS (e.g., according to legacy approach or not)
* Whether the number of coded modulation symbols per layer for UCI multiplexing on a single TBoMS should be calculated differently from its PUSCH repetition Type A counterpart (and how, if applicable)

I suggest discussing the two aspects in this order, and one conditioned to the other. In other words, I would first discuss about the how UCI is multiplexed on PUSCH for TBoMS, to then move to the second aspect, if needed.

In this context, it is rather evident to me that most companies (i.e., 11) prefer reusing existing approaches for UCI multiplexing on PUSCH for TBoMS, with no specific optimizations. From FL’s perspective, this approach is not only reasonable but also more aligned with the scope of the WID, for the following reasons:

* Time domain resource determination for TBoMS is built upon its PUSCH repetition Type A counterpart. Signalling and logics are reused. Why would TBoMS need to handle UCI multiplexing differently from PUSCH repetition Type A is unclear, especially considering the specification impact of such change.
* The scope of AI 8.8.1.2 is to specify the support of TB processing over multi-slot PUSCH:
  + Enhancing coverage/structure of UCI is not within the scope of AI 8.8.1.2
  + Performance of UCI over multiple slots has not been studied in detail during the SI nor ever considered to be a possible candidate for inclusion in the WID.
  + All other enhancements related to control channel in AI 8.8.2 are related to dynamic repetition factor indication and DM-RS bundling.

Given all the above, it is rather natural from FL’s perspective to propose reusing the existing legacy UCI multiplexing behaviour for PUSCH repetition type A is reused for TBoMS (UCI is multiplexed on the overlapping slot). The following proposal is made.

**FL’s proposal 4**

**Existing legacy UCI multiplexing behaviour for PUSCH repetition type A is reused for TBoMS (UCI is multiplexed on the overlapping slot).**

**FFS: details on the calculation of the number of coded modulation symbols per layer for UCI multiplexing on a single TBoMS**

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

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

**FL’s proposal 4**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 4** | DCM, QC, Sharp, Nokia/NSB, Lenovo, Motorola Mobility, Panasonic, SS, vivo, Ericsson, WILUS, Xiaomi |
| **Do not support FL’s Proposal 4** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 4, if any. |
| Sharp | With the above proposal, no timeline related discussion would be required. |
| LG | We’d like to clarify that the ‘existing legacy UCI multiplexing behaviour’ in the proposal is only for ‘UCI is multiplexed on the overlapping slot’ or include other aspects on UCI multiplexing. We are ok with the proposal if the first sentence means ‘UCI is multiplexed on the overlapping slot’ only.  In addition, we suggest to clarify the slot resource for aperiodic CSI multiplexing. |
| Intel | Need clarification on the “Existing legacy UCI multiplexing behaviour” whether timeline is included in the proposal. If this is the case, suggest to defer the discussion once the agreement for single TBoMS structure is made. |
| InterDigital | We have the same clarification question as LG, i.e., whether we are agreeing on the part "UCI is multiplexed on the overlapping slot" or the PUSCH type A repetition multiplexing is to be reused. |
| ZTE | We think all the following legacy UCI multiplexing behaviors could be reused, including   * UCI is multiplexed on the overlapping slot * Legacy UCI multiplexing timeline for both DG and CG * Puncturing for 1-2 bits UCI and rate-matching for more than 2 bits UCI. |
| CATT | Considering the limited time left, we can compromise to this proposal. |

## Mid priority aspects

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

1. Time domain resource determination
   * 1. Candidate values for N
     2. Candidate values for M
2. Data rate calculation and UE behavior related to TBS determination
   * 1. How to handle configuration of TBS larger than the size of one CB
3. Frequency hopping
4. Retransmission

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.

### [OPEN] Time domain resource determination

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

Companies’ preferences concerning other candidate values for N are as follows.

|  |  |  |
| --- | --- | --- |
| Candidate value | Support | Not support |
| **1** | InterDigital [14], Huawei/HiSi [3], OPPO [9], CMCC [12] | CATT [8] |
| **3** | CMCC [12], Ericsson [22], | CATT [8] |
| **5** | CMCC [12], | CATT [8] |
| **6** | CMCC [12], Ericsson [22], | CATT [8] |
| **12** | Ericsson [22], | CATT [8] |
| **16** | Ericsson [22], ChinaTelecom [11], | CATT [8] |

In addition, one company (Huawei/HiSi [3]) proposed that N=1 should be the default value if N is not configured.

FL’s comments on November 11

From FL’s perspective, the usage of N = 1 was already agreed in RAN1#106bis-e meeting, implicitly via this agreement.

|  |
| --- |
| **Agreement**  For TBoMS transmission in Rel-17:   * TBoMS feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.   + TBoMS transmission is enabled when N>1, where N is the number of allocated slots for a single TBoMS.   + Single-slot PUSCH transmission is enabled when N=1.   + Supported combinations of N and M that can be configured in the TDRA table, these combinations are constrained by retransmission are to be further discussed |

Given that discussions on supporting the above remaining candidate values for N were carried out during RAN1#106bis-e meeting without reaching consensus and that discussions on this aspect for TBoMS may not be as paramount as discussions on the higher priority aspects in Section 2.1, FL suggests postponing discussions on this topic until need arises.

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

Companies’ preferences concerning other candidate values for N are as follows.

* All combination for N\*M should be supported **[6]**:
  + CMCC [12], Samsung [19], Sharp [24], ~~Panasonic [18],~~ ZTE [5], vivo [6],
* N\*M does not exceed 32 **[5]**:
  + ZTE [5], Huawei/HiSi [3], vivo [3], CATT [8], CMCC [12], Panasonic [18]
* For Rel-17 TBoMS transmission in both dynamic grant and configured grant, if the parameter *numberOfRepetitions* is not configured in the TDRA table, then the number of repetitions M of a single TBoMS is equal to 1 **[1]**:
  + Nokia/NSB [21]

FL’s comments on November 11

No restriction to the values that that combination of N\*M can take have been proposed by companies. This leaves the only agreed limitation to be that N\*M does not exceed 32. On the other hand, one company focuses the attention on a configuration implication which may need to be worked out in view of the upcoming update of the CR for TS 38.214, i.e., the default value of M when *numberOfRepetitions* is not configured in the TDRA table. The following proposal is thus formulated.

**FL’s proposal 5**

**For TBoMS repetitions, if the parameter *numberOfRepetitions* is not configured in the TDRA table, then the number of repetitions M of a single TBoMS is equal to 1.**

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 5**. Companies are invited to input their views in the corresponding table below. Constructive attitude in this regard is greatly appreciated. In this sense, if you cannot support the proposal, please propose an alternative formulation which considers the current spirit of the proposal.

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 5** | DCM, LG, Nokia/NSB, Lenovo, Motorola Mobility, Intel, Panasonic, SS, vivo, ZTE, Huawei, Hisilicon, CATT, Ericsson,TCL, WILUS |
| **Do not support FL’s Proposal 5** |  |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 5, if any. |
| QC | Needs discussion/clarification.  Are we envisioning a scenario where N is included in the TDRA table but not M?  Is this trying to clarify behavior when R15 TDRA tables are used? Our assumption was that if the UE does not support enhanced TDRA tables, then TBOMS cannot be used. |
| Sharp | We are fine with the proposal. On the other hand, it can be up to RAN2 since it is just a default value of a RRC parameter. |
| Panasonic | Our preference on N\*M is updated. Our view is that all combinations of and with are supported. |
| Xiaomi | Why RRC parameters *pusch-aggregationFactor* and *repK* designed in Rel-15 can’t be applied for TBoMS? We suggest the following proposal:  **For TBoMS, if the parameter *numberOfRepetitions* is not configured in the TDRA table, and the RRC parameter *pusch-aggregationFactor* for DG is not configured or *repk* for CG is equal to 1, then the number of repetitions M of a single TBoMS is equal to 1.** |

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

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

One company (LGE [28]) proposed that the UE behaviour when the calculated TBS exceeds the maximum TBS for single CB transmission should be discussed.

FL’s comments on November 11

From FL’s perspective, the discussion on this topic is relevant given that UE behavior in case the calculated TBS exceeds the maximum TBS for single CB transmission should be clarified to complete the feature. For instance, one natural consequence of the WA RAN1 made on rate-matching is that the case for which the calculated TBS exceeds the maximum TBS for a single CB transmission could be considered as an error case, i.e., the UE does not expect to be scheduled with TBoMS transmission and the TBS exceeding the maximum TBS for a single CB transmission. FL suggests starting this discussion after the WA has been confirmed, as per discussion in 2.1.3.1.

### [OPEN] Retransmissions

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

Four companies (Ericsson [22], Nokia/NSB [21], CATT [8], Intel [15]) proposed that partial retransmission is not supported for TBoMS (i.e., only TB-based retransmission is supported for TBoMS).

Two companies (Lenovo/Motorola [27], TCL [4]) proposed that retransmission procedure and signaling should be enhanced to support retransmission of only partial slots from the 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

One company (CMCC [12]) proposed that at least single slot PUSCH and TBoMS with and without repetition could be used for the retransmission of TBOMS.

One company (Apple [16]) proposed that it’s up to gNB scheduling to determine the TBoMS re-transmission is by TBoMS, or by repetition, or by single slot transmission.

FL’s comments on November 11

From FL’s perspective, the discussion on this topic is relevant given that RAN1 should decide on one approach on the retransmission of TBoMS in Rel-17 to complete the feature. If no further enhancement for the retransmission of TBoMS is agreed, it is a natural consequence to adopt the TB-based retransmission approach for TBoMS, i.e., gNB reschedules resource for the retransmission of the single TBoMS with or without repetition. Therefore, it is FL’s recommendation to adopt this approach as a baseline. Whether other approaches for TBoMS retransmission are also considered or not can be further discussed. Therefore, **FL’s proposal 6** and **question 2.2.3-Q1** are formulated as follows.

**FL’s proposal 6**

**The following approach is used as a baseline for the retransmission of a single TBoMS with or without repetition in Rel-17:**

* **The whole TB is scheduled for retransmission following at least Rel-17 TBoMS transmission with or without repetition.**
* **The gNB reschedules resource for the retransmission of the TB.**

A question is also added to start the discussion on whether other approaches for TBoMS retransmission are also considered or not.

**2.2.3-Q1** *Should the following additional retransmission schemes be supported for TBoMS?*

* *A TB initially transmitted by TBoMS is later retransmitted by a single-slot PUSCH*
* *A TB initially transmitted by TBoMS is later retransmitted by PUSCH repetition type A*
* *A TB initially transmitted by TBoMS is later partially retransmitted by resending only a portion of the slots from the initial transmission.*

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

FL’s recommendation is to have a first round of discussion about **FL’s proposal 6** and **2.2.3-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.

**FL’s proposal 6**

|  |  |
| --- | --- |
|  | Company name |
| **Support FL’s Proposal 6** | DCM, LG, Nokia/NSB, Intel, Panasonic, vivo, ZTE, CATT, Ericsson, Xiaomi |
| **Do not support FL’s Proposal 6** | QC, Lenovo, Motorola Mobility, TCL |

|  |  |
| --- | --- |
| Company | Additional comments related to FL’s Proposal 6, if any. |
| QC | Why do we need this? Are there any such restrictions between Type A and Type B repetitions? Lets leave it up to gNB. |
| Sharp | Intention of “the whole TB is scheduled” is not clear to us. Does it just exclude CBG-based scheduling? If so, we don’t need to agree Proposal 6 since it’s clear given we agreed only one CB is supported for TBoMS. |
| Lenovo, Motorola Mobility | We don’t think it is efficient to retransmit entire TBoMS, but rather partial retransmission is more suitable, Similar concept as CBG could be applied, where the minimum unit of retransmission can be one slot. |
| TCL | Partial retransmission is more efficient. |

**2.2.3-Q1**

|  |  |  |
| --- | --- | --- |
|  | Support | Not support |
| A TB initially transmitted by TBoMS is later retransmitted by a single-slot PUSCH | DCM, QC, Sharp, Nokia/NSB, Intel, Panasonic, InterDigital, CATT | LG, Ericsson, Xiaomi |
| A TB initially transmitted by TBoMS is later retransmitted by PUSCH repetition type A | DCM, QC, Sharp, Nokia/NSB, Intel, Panasonic, CATT | LG, Ericsson, Xiaomi |
| A TB initially transmitted by TBoMS is later partially retransmitted by resending only a portion of the slots from the initial transmission. | Sharp, ~~LG~~, Lenovo, Motorola Mobility, InterDigital, TCL | DCM, Nokia/NSB, Intel, Panasonic, [SS], vivo, ZTE, CATT, Ericsson, Xiaomi |

**Further comments on 2.2.3-Q1**

|  |  |
| --- | --- |
| Company | Views |
| QC | For retransmission, gNB must be allowed to pick any of the TDRA rows it wishes to use. No further restrictions are necessary. Rest is left to gNB discretion. We are assuming the use of implicit MCS here. No need to recalculate TBS.  If implicit MCS is not used, then the onus is on the gNB to make sure that the TBS calculation results in the same TBS as the first tx. Ensuring this works out is up to gNB. If gNB is able to make this work using Type A repetitions/single slot PUSCH, it should be allowed. |
| Lenovo, Motorola Mobility | Same comment as for Proposal 6 |
| SS | Question to the 3rd methods, the CRC is not inserted to each slot, how to do the only portion of the slots to be transmitted? To us, for TBoMS, either it’s entirely decoded correctly and declared to be wrong. Then Re-tx is for the whole TB. |
| vivo | Depending on discussion in section 2.1.1.1, if dynamic switching between N>1 and N=1 is supported in a single TBoMS and dynamic switching between TBoMS and slot based PUSCH is supported, mixed TBoMS and slot based PUSCH in initial transmission and restransmission can be supported. |
| LG2 | We have a clarification question on the third one. We think the value of N for retransmission of TBoMS can be changed depending on the network indication, since resource allocation for the retransmission is independent with the initial transmission in Rel-15/16 PUSCH. However, we don’t support slot level retransmission which allow retransmission of a part of slots selectively.  Thus, if the question implies slot level retransmission, we’d like to be excluded from the supporting company since slot level retransmission and independent indication of N for retx are different in our understanding. |
| ZTE | Regarding the first two cases, we don’t have strong preference but would like to hear companies’ views about the benefits of enabling such scheduling since it seems gNB cannot perform joint decoding by using both initial and re-transmission in these cases. |
| CATT | For the allocated resource of retransmission, we think it should be up to gNB scheduling. Just similar to Rel-16. No need to introduce restriction.  For the 3rd sub-bullet, we have the same understanding with LG. We think it only means retransmitting part of the TB is not supported. But the gNB is free to schedule a different N for retransmission than initial transmission, while keeping TBS unchanged. (Align with current principle) |
| Ericsson | As we show in R1- 2112036, there are very few MCS states that would allow retransmission with a different N than the one used in original transmission. We do not see the need to support retransmissions of TBoMS using single slot and repetition Type A, or in general to use a different value of N in a retransmission.  Regarding partial transmission of a TB, this seems pretty complex, and we are not so clear on its need given that HARQ operation with smaller values of N is possible rather than retransmission of part of a large N. |
| Xiaomi | We think the first 2 restrictions are not needed which can be achieved by the gNB’s scheduling. |

## Others

As discussed at the beginning of Section 2, discussions on different aspects of TBoMS have been prioritized to ensure that constructive discussions and effective progress can be achieved during RAN1 #107-e. Priority has been given to the aspects and topics discussed in sections 2.1 and 2.2. All other aspects are listed in this section, i.e, 2.3, where proposals made by companies in their contributions are reported and described in detail.

These aspects may not be handled during RAN1 #107-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

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

One company (Xiaomi [13]) proposed reusing the RRC parameters pusch-aggregationFactor and repK to indicate the number of repetitions of TBoMS.

One company (Huawei/HiSi [3]) proposed that, for TBoMS transmission with type 1 configured grant, a new field should be introduced in IE ConfiguredGrantCofig to indicate the number of allocated slots for a single TBoMS transmission.

* For TBoMS transmissions with type 1 and type 2 configured grant, is provided by a new field in IE ConfiguredGrantConfig and is provided by the indexed row in the TDRA table if it is present in the TDRA table, respectively.
* When TBoMS transmission is enabled, the field repK is used to indicate the number of TBoMS repetitions.

FL’s comments on November 11

From FL’s perspective, discussions on these aspects may not be as paramount as discussions on the higher priority aspects in Sections 2.1-2.2. In addition, relevant discussions on this topic may be needed under AI 8.8.1.1 first. Therefore, FL suggests postponing discussions on this topic until need arises.

### [CLOSED] Relationship with other channels and signals

#### [CLOSED] **Dropping rules**

One company (InterDigital [14]) proposed that, in case of uplink cancellation, the UE resumes the TBoMS transmission in the next allocated 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).
* 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.

One company (TCL [4]) proposed that only dropping the overlapped slot(s) should be considered for TBoMS transmission when collision happen.

One company (OPPO [9]) proposed that slot dropping can puncture those slots after interleaving and bit selection.

One company (Intel [15]) proposed that TBoMS is considered as low priority uplink transmission.

FL’s comments on November 11

From FL’s perspective, the basic framework of dropping rules applied for TBoMS was agreed in RAN1#106bis-e meeting as in the following agreement.

|  |
| --- |
| **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) |

Given that discussions on this aspect for TBoMS may not be as paramount as discussions on the higher priority aspects in Sections 2.1 and 2.2, FL suggests postponing discussions on this topic until need arises.

#### [CLOSED] **Timeline requirements**

Timeline requirement is applied for the overlapping slot (legacy timeline requirement): Samsung [19], InterDigital [14], Huawei/HiSi [3], vivo [6], Spreadtrum [23]

One company (Intel [15]) proposed that two options can be considered for UCI multiplexing timeline.

* Option 1: UCI multiplexing timeline is determined based on the first symbol of TBoMS transmission.
* Option 2: UCI multiplexing timeline is determined based on the first symbol of the overlapped slot for TBoMS transmission.

FL’s comments on November 11

From FL’s perspective, discussions on these aspects would already occur in Sections 2.1.3.2 and 2.1.4, if needed. FL suggests postponing further elaborations on the timeline to a later time, should any specific need arise.

### [CLOSED] TBoMS repetitions

#### [CLOSED] **Slot mapping for TBoMS repetitions**

One company (InterDigital [14]) proposed that both non-interleaved and interleaved slot mapping are applied for TBoMS repetitions when DM-RS bundling is enabled and disabled, respectively.

### [CLOSED] FDRA

Three companies (Samsung [19], TCL [4], Xiaomi [13]) proposed that the maximum number of PRBs for TBoMS is limited.

FL’s comments on November 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 2.2.2.1. Therefore, FL suggests postponing discussions on this topic until need arises.

### [CLOSED] Transmission power determination

One company (InterDigital [14]) proposed that the transmission power determination of TBoMS is based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.

One company (Ericsson [22]) proposed reusing Rel-16 transmission occasion of power determination for TBoMS.

One company (Huawei/HiSi [3]) proposed that 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.

FL’s comments on November 11

In RAN1#106bis-e meeting, the following agreements were made:

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| **Agreement**   * For transmission power determination of TBoMS transmission in Rel-17, RAN1 to down-select one of the following two options: * Option 1: The transmission power determination of TBoMS should be based on all the REs allocated in one available slot for the TBoMS transmission, excluding the overhead of reference signals * Option 2: The transmission power determination of TBoMS should be based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals. * FFS: details on BPRE   **Agreement**  BPRE for TBOMS is calculated as  where N is the number of slots allocated for a single TBOMS and  is the number of allocated REs in one allocated slot of a single TBOMS.  Note: How this equation or its equivalent is captured in the specification is left to the editor |

Given that a definition of the BPRE for TBoMS has been agreed, the need to discuss the definition of transmission occasion for power control of TBoMS is unclear. Given that the relevance of this definition is w.r.t. to the DM-RS bundling / JCE, it would seem more reasonable to discuss it in the corresponding AIs. Now, since no discussion is occurring in AI 8.8.1.3 and 8.8.2 about this, then FL does not see any urgency to complicate the discussion and introduce “noise” that does not seem to be needed to have a clean and working feature. Given that two comments out of three with comments seem to support this understanding, FL’s recommendation is not to discuss this aspect any longer and reuse the available definition in the specification.

### [CLOSED] Frequency hopping

Many contributions acknowledged the importance of this aspect and discussed details in their contributions. Expressed preferences are summarized in the following table.

|  |  |  |
| --- | --- | --- |
|  | Support | Not support |
| Inter-slot frequency hopping with inter-slot bundling for a single TBoMS with DM-RS bundling | CATT [8], China Telecom [11], Panasonic [18], Intel [15] |  |
| Inter-slot frequency hopping with inter-slot bundling for a single TBoMS without DM-RS bundling | TCL [4] |  |
| Inter-repetition FH for TBoMS repetitions | Intel [15] | Vivo [6] |
| Intra-TB frequency hopping for TBoMS | Xiaomi [13] |  |

FL’s comments on November 11

From FL’s perspective, it is more relevant to discuss the inter-slot frequency hopping with inter-slot bundling for a single TBoMS with DM-RS bundling (which was proposed by four companies as summarized above) under AI 8.8.1.3 and/or AI 8.8.2. In addition, discussions on supporting the above remaining frequency hopping scenarios were carried out during RAN1#106bis-e without reaching consensus. Given that the legacy inter-slot and intra-slot FH schemes were agreed to be supported for TBoMS in RAN1#106bis-e already, discussions on FH may not be as paramount as discussions on the high and mid priority aspects in Sections 2.1 and 2.2.

### 2.3.7 [CLOSED] Application of DM-RS bundling to TBoMS

One company (InterDigital [14]) proposed that joint channel estimation for TBoMS repetition is supported.

### 2.3.8 [CLOSED] Interlaced TBoMS transmission

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

# 3 Proposals for GTW

**FL’s proposal 1**

**A single RV is used to transmit a single TBoMS.**

**FL’s proposal 2**

**Confirm the following working assumption:**

**Working Assumption**

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

* **Bit interleaving is performed per slot.**

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

* **Transmission is limited to one CB only.**
* **FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not**
* **FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS**

**Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further.**

**FL’s proposal 3**

**For the bit selection for each transmitted slot for TBoMS, the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.**

**FL’s proposal 4**

**Existing legacy UCI multiplexing behaviour for PUSCH repetition type A is reused for TBoMS (UCI is multiplexed on the overlapping slot).**

**FFS: details on the calculation of the number of coded modulation symbols per layer for UCI multiplexing on a single TBoMS**

**FL’s proposal 5**

**For TBoMS repetitions, if the parameter *numberOfRepetitions* is not configured in the TDRA table, then the number of repetitions M of a single TBoMS is equal to 1.**

**FL’s proposal 6**

**The following approach is used as a baseline for the retransmission of a single TBoMS with or without repetition in Rel-17:**

* **The whole TB is scheduled for retransmission following at least Rel-17 TBoMS transmission with or without repetition.**
* **The gNB reschedules resource for the retransmission of the TB.**

# 4 Agreements during RAN1 #107-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. R1-2110790 Discussion on TB processing over multi-slot PUSCH, Huawei, HiSilicon
4. R1-2111204 Discussion on TB processing over multi-slot PUSCH, TCL Communication Ltd.
5. R1-2110919 Discussion on TB processing over multi-slot PUSCH, ZTE
6. R1-2111028 Remaining issues on PUSCH TB processing over multiple slots, vivo
7. R1-2112390 Discussion on TB processing over multi-slot PUSCH, WILUS Inc.
8. R1-2111272 Discussion on TB processing over multi-slot PUSCH, CATT
9. R1-2111329 Further considerations for TB over multi-slot PUSCH, OPPO
10. R1-2111149 Views on TB processing over multi-slot PUSCH, Fujitsu
11. R1-2111427 Remaining issues on TB processing over multi-slot PUSCH, China Telecom
12. R1-2111621 Discussion on TB processing over multi-slot PUSCH, CMCC
13. R1-2111585 Discussion on TB processing over multi-slot PUSCH, Xiaomi
14. R1-2111793 TB processing over multiple slots, InterDigital, Inc.
15. R1-2111508 Discussion on TB processing over multi-slot PUSCH, Intel Corporation
16. R1-2111888 Discussion on TB processing over multi-slot PUSCH, Apple
17. R1-2112231 TB processing over multi-slot PUSCH, Qualcomm Incorporated
18. R1-2111438 Discussion on TB processing over multi-slot PUSCH, Panasonic Corporation
19. R1-2111752 TB processing over multi-slot PUSCH, Samsung
20. R1-2112316 Discussion on TB Processing over multi-slot, MediaTek Inc.
21. R1-2110864 Transport block processing for PUSCH coverage enhancements, Nokia, NSB
22. R1-2112036 Remaining issues for TB Processing over Multi-Slot PUSCH, Ericsson
23. R1-2111107 Discussion on TB processing over multi-slot PUSCH, Spreadtrum Communications
24. R1-2112020 Transport block processing over multi-slot PUSCH, Sharp
25. R1-2111693 Discussion on TB processing over multi-slot PUSCH, NEC
26. R1-2112120 TB processing over multi-slot PUSCH, NTT DOCOMO, INC.
27. R1-2111949 Enhancements for TB processing over multi-slot PUSCH, Lenovo, Motorola Mobility
28. R1-2111979 Discussions on TB processing over multi-slot PUSCH, LG Electronics

# Appendix A: Proposals from contributions aggregated by topic

## A.1 Time domain resource determination

**TDRA Table**

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| **R1-2112036 Ericsson**  **Proposal 3.** All the entries in a Rel-17 TDRA list are either for PUSCH repetition or for TBoMS. An exception is N=1 and M=1 for single-slot PUSCH is included in the TDRA table for TBoMS.  **R1-2111508 Intel**  **Proposal 2**   * TDRA table partitioning can be employed to differentiate single-slot PUSCH and TBoMS transmission.   Number of rows allocated for single-slot PUSCH transmission can be configured as part of TDRA table. |

**Candidate values for N**

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| --- |
| **R1-2111621 CMCC**  **Proposal 3:**  Slot number of 3,5,6 should be supported for TBoMS.  **R1-2111793 Interdigital**  **Proposal 1**: A TDRA table can include the value N=1 along with values of N>1.  **R1-2112036 Ericsson**  **Proposal 5.** {3, 6, 12, 16} can be considered for the candidate numbers of slots for a single TBoMS.  **R1-2110790 Huawei/HiSi**  **Proposal 1:** should be supported as a candidate value of the number of allocated slots for a single TBoMS transmission.   * should be the default value if is not configured.   **R1-2111272 CATT**  **Proposal 7:** No other values beyond {2, 4, 8} is supported for number N of allocated slots for a single TBoMS.  **R1-2111329 OPPO**  **Proposal 2:** For Rel-17 N=1 is also supported in addition to N>1 for the TRRA table, and its TBoMS transmission feature is enabled or disabled by N.  The TB size determination, Rate matching, RE mapping, PC and others can be process based on N with one framework.  **R1-2111427 ChinaTelecom**  **Proposal 1:** The maximum value of allocated slots for the single TBoMS is at least 16. |

**Candidate values for M**

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| **R1-2111621 CMCC**  **Proposal 4:**  All the combinations that N\*M below 32 should be supported for TBoMS.  **R1-2111752 Samsung**  **Proposal 1**: no further limitation on the combination of N\*M.  **R1-2112020 Sharp**  **Proposal 4**: No other values other than 1,2,3,4,7,8,12,16 are not supported for indicating M.  **Proposal 5**: No other restriction on the combination of N and M is necessary.  **R1-2110790 Huawei/HiSi**  **Proposal 2:** The further constraints on are not supported besides is no more than the maximum repetition factor supported in AI 8.8.1.1, e.g., is a valid value of repetition factor supported in AI 8.8.1.1.  **R1-2110919 ZTE**  **Proposal 4:** On top of existing agreed values for N and M, there is no need to restrict the combination of M and N in TDRA table, except for the condition of N\*M 32.  **R1-2111028 vivo**  **Proposal 1:** All combinations of N\*M based on candidate values of N and M can be supported, as long as N\*M is not greater than 32.  **R1-2111272 CATT**  **Proposal 8:** No other constraint is specified for combination of {N, M} beyond the restriction of N\*M≤32.  **R1-2111438 Panasonic**  **Proposal 1:** No further constraints on is necessary.  **R1-2110864 Nokia/NSB**  **Proposal 7.** For Rel-17 TBoMS transmission in both dynamic grant and configured grant, if the parameter numberOfRepetitions is not configured in the TDRA table, then the number of repetitions M of a single TBoMS is equal to 1. |

**Time domain resource determination for TBoMS for CG-PUSCH Type 2**

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| **R1-2111793 Interdigital**  **Proposal 8**: For TBoMS repetitions, the UE can be configured with N\*M is larger than the number of available slots in a CG period  **Proposal 9**: For TBoMS repetitions, if N\*M is larger than the number of available slots in a CG period, the UE is expected to transmit K TBoMS transmission occasions where K<M.  **Proposal 10**: If the UE cannot find N available slots in a CG period, the UE does not transmit TBoMS.  **R1-2112020 Sharp**  ***Proposal 6***: The UE should be possible to start an initial transmission of a transport block in a single TBoMS other than the first single TBoMS for a configured grant with startingFromRV0 not set to ‘off’.  **R1-2112036 Ericsson**  **Proposal 12.** The UE is not expected to be configured with the time duration for the transmission of a single TBoMS or TBoMS repetitions larger than the time duration derived by the periodicity P.  **R1-2112231 Qualcomm**  **Proposal 8:** For CG-TBOMS with or without repetitions, the transmission is restricted to begin from the first slot of a single TBOMS associated with RV0.  **R1-2112390 WILUS**  **Proposal 3**: For TBoMS repetition with configured grant, a UE can be configured as startingFromRV0 = ‘off’ for the initial TO determination.   * + Otherwise, only RV sequence {0, 0, 0, 0} can be configured even if startingFromRV0 is not provided or configured as startingFromRV0 = ‘on’.   **R1-2110864 Nokia/NSB**  **Proposal 5.** For a single TBoMS or TBoMS repetitions with configured grant, the UE is not expected to be configured with the time duration for N\*M transmissions larger than the time duration derived by the periodicity P.  **Proposal 6.** For TBoMS repetitions with configured grant, the legacy Rel-16 restrictions as defined in Clause 6.1.2.3.1 of TS 38.214 at least on the initial transmission of a transport block are applied.  **R1-2111438 Panasonic**  **Proposal 8:** For TBoMS for CG-PUSCH, the domain resource determination including limitation of overall duration for PUSCH repetition Type A is reused.  **Proposal 9:** TBoMS for CG-PUSCH does not start in the middle of the single TBoMS.  **R1-2111585 Xiaomi**  **Proposal 6:** Each slot associated with RV#0 can be deemed as an initial transmission position/slot. |

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

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| **R1-2111585 Xiaomi**  **Proposal 3:** Reuse the RRC parameters pusch-aggregationFactor and repK to indicate the number of repetitions of TBoMS.  **R1-2110790 Huawei/HiSi**  **Proposal 3:** For TBoMS transmission with type 1 configured grant, a new field should be introduced in IE ConfiguredGrantCofig to indicate the number of allocated slots for a single TBoMS transmission.   * For TBoMS transmissions with type 1 and type 2 configured grant, is provided by a new field in IE ConfiguredGrantConfig and is provided by the indexed row in the TDRA table if it is present in the TDRA table, respectively.   When TBoMS transmission is enabled, the field repK is used to indicate the number of TBoMS repetitions. |

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

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| **R1-2110864 Nokia/NSB**  **Proposal 4.** If no further agreement is made under AI 8.8.1.1 on how to handle the available slot counting for paired spectrum and SUL band, then only consecutive physical slots are supported for TBoMS in paired spectrum and SUL band. |

**Others**

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| **R1-2112036 Ericsson**  Proposal 1. Reuse resource determination and signaling of Rel-15/16 PUSCH repetition as much as possible to avoid specifying duplicate functionality.  **R1-2111508 Intel**  **Proposal 4**   * For out of order handling for TBoMS:   + Consider Case A), B) and C) in Figure 2 as out of order scheduling.     Figure . Out of order handling between TBoMS and single-slot PUSCH |

## A.2 Single TBoMS structure

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| **R1-2110864 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.  **R1-2110919 ZTE**  **Proposal 1:** Confirming the WA on single TBoMS structure of Option 3, i.e., a single RV is used. |

## A.3 Rate-matching

**Bit interleaving time unit**

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| **R1-2111621 CMCC**  **Proposal 6:**  Single slot level bit interleaving is preferred.  **R1-2111752 Samsung**  ***Proposal 3****: the above working assumption is confirmed.*  **R1-2111888 Apple**  **Proposal 1**: Confirm the working assumption on bit interleaving for TBoMS.  **R1-2112316 MediaTek**  **Proposal 1**: Confirm the working assumptions as below:  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.   **R1-2110864 Nokia/NSB**  **Proposal 2.** RAN1 to confirm the working assumption made in RAN1#106bis-e meeting on bit interleaving size and CB segmentation, i.e., bit interleaving is performed per slot and transmission is limited to one CB only.  **R1-2111149 Fujitsu**  **Proposal 1:**  Confirm the working assumption that bit interleaving is performed per slot, and reuse the existing rules for UCI multiplexing.  **R1-2111272 CATT**  **Proposal 3:** Confirm the working assumption of performing bit interleaving per slot for TBoMS.  **R1-2111329 OPPO**  **Proposal 3:** Bit interleaving and selection are performed per slot and in order of physical slots, based on the available slots  **R1-2111585 Xiaomi**  **Proposal 1:** Support rate-matching per slot for TBoMS. |

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

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| **R1-2111621 CMCC**  **Proposal 7:**  The option C without consideration UCI multiplexing is preferred as it is uncertain whether UCI multiplexing will happens in the later part of TBoMS.  **R1-2111693 NEC**  ***Proposal 4***: For the bit selection for each transmitted slot for TBoMS, support option C.   * More specifically, 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 in 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.   ***Proposal 5***: RAN1 should further discussion whether date rate calculation of TBoMS will be changed based on number of slots N for TBoMS.  **R1-2111752 Samsung**  ***Proposal 4****: option C is preferred.*  ***Proposal 5****: the index of the starting coded bit for each transmitted slot is not needed to be expressed as a multiple integer of the lifting size Zc.*  **R1-2111793 Interdigital**  **Proposal 6**: For the bit selection for each transmitted slot for TBoMS, the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot (Option B).  **R1-2111888 Apple**  **Proposal 2**: Option C is adopted for bit selection for each transmitted slot for TBoMS.  **R1-2111979 LGE**  **Proposal 1**: To apply Option B, timeline requirement for A/N multiplexing on TBoMS needs to be modified so that it can be determined whether or not to transmit UCI before the start of TBoMS transmission.  **Proposal 2**: To apply Option C, it is necessary to consider aperiodic CSI multiplexing to determine the starting coded bit in each slot of TBoMS transmission.  **Proposal 3**: Discuss the UE behavior when the calculated TBS exceeds the maximum TBS for single CB  **R1-2112020 Sharp**  ***Proposal 1***: The index of the starting coded bit kn-10 in the circular buffer for nth slot in a single TBoMS is the next bit of the last bit for (n-1)th slot. The last bit for (n-1)th slot is represented by kn-10+En-1 where En-1 is the rate-matching sequence length in (n-1)th slot.  ***Proposal 2***: The UE assumes no HARQ-ACK bits multiplexed in any slot in a single TBoMS in determination of the starting coded bit index kn0 for nth slot in the single TBoMS.  **R1-2112036 Ericsson**  **Proposal 2.** From the perspective of gNB scheduling flexibility and error propagation, Option C is preferred.  **R1-2112120 NTT DOCOMO**  **Proposal 3**: Support continuous bit selections with ignoring UCI multiplexing effects (Option C) to avoid the error propagation issue caused by DCI miss-detection.  **Proposal 4**: The starting point of each bit selection should be floored with a LDPC lifting size.  **R1-2112231 Qualcomm**  **Proposal 1:** The following principles are used to predetermine the starting bit location:   1. The same behavior is specified for CG-TBOMS and DG-TBOMS 2. To avoid error propagation, any dynamic information or behavior is not taken into account for starting bit determination    * 1. For e.g., sp-CSI activation/deactivation is a dynamic event that could cause misalignment, and any information related to sp-CSI multiplexing should be discouraged from being included in the procedure for starting bit determination. 3. The overall design should be forward compatible to future changes to UCI multiplexing rules.    * 1. R17 TEI is discussing changes to relax HARQ ACK/NACK multiplexing on DG-PUSCH repetitions. TBOMS design should be amenable to such changes in the future   **Proposal 2:** TBOMS for shared spectrum is not triggered through configured grants. CG-UCI is not taken into account for starting bit determination of TBOMS.  **Proposal 3:** With forward compatibility and a unified design across CG-TBOMS and DG-TBOMS in mind, it is suggested that the overhead of ACK-NACK UCI not be directly taken into account to determine the starting bit indices for TBOMS.  **Proposal 4:** Due to variation in the size of CSI Part 2, the overhead due to CSI Part 2 cannot be determined beforehand for all slots of TBOMS. It is suggested that the overhead of CSI Part 2 not be directly taken into account to determine the starting bit indices for TBOMS.  **Proposal 5:** Due to the dynamic nature of spCSI activation, it is suggested that UCI overhead due to sp-CSI not be directly taken into account to determine the starting bit indices for TBOMS.  **Proposal 6:** The index of the starting coded bit for the kth slot of a single TBOMS is given by where  and  ,  where is the modulation order and is the number of REs available in the (k-1)th slot for transmission and . represents the nominal fraction of resources that are likely to be available for SCH transmission after allocation of resources for UCI multiplexing. The value of is configured via RRC. is set to be the starting bit index of the RV associated with the single TBOMS.  **R1-2112316 MediaTek**  **Proposal 2**: Option C (indexing of the s tarting bits regardless of UCI multiplexing) is supported due to potential error propagation issue for Option B caused by reception failure of DCI about dynamic UCI multiplexing.  **R1-2110790 Huawei/HiSi**  **Proposal 5:** For the determination of starting bit for TBoMS transmission, option B (the index of the starting bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot) is preferred with minor modifications as follows:   * HARQ-ACK is multiplexed on TBoMS transmission by puncturing.   **Proposal 6:** The index of the starting bit should be defined as multiple integer of LDPC lifting size that is nearest to but not exceed the position of the last bit selected in the previous allocated slot.  **R1-2110864 Nokia/NSB**  **Proposal 3**. For the bit selection for each transmitted slot for TBoMS, the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.  **R1-2110919 ZTE**  **Proposal 2:** For bit selection for each transmitted slot for TBoMS, Option B is preferred, i.e., the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot.   * No other optimization is considered compared to the legacy UCI multiplexing procedure for PUSCH repetition type A.   **R1-2111028 vivo**  **Proposal 4:** The index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.  **Proposal 5:** Restricting the index of the starting coded bit in each slot of TBoMS to be multiples of lifting size Zc is not necessary.  **R1-2111107 Spreadtrum**  **Proposal 1.** UCI multiplexing bits do not have to be known prior to the determination of the index of the starting coded bit for each transmitted slot. They have to obey the legacy timeline reference to the allocated slot that is overlapping with PUCCH.  **Proposal 3.** Support Option C: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.  **R1-2111149 Fujitsu**  **Proposal 2:** The index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.  **R1-2111272 CATT**  **Proposal 1:** For the bit selection for each transmitted slot for TBoMS, Option C is supported.   * The index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.   **Proposal 2:** It is up to editor whether the index of the starting coded bit for each transmitted slot is expressed as a multiple integer of the lifting size Zc.  **R1-2111427 ChinaTelecom**  **Proposal 2:**   * Option B: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot.   **R1-2111438 Panasonic**  **Proposal 2:** For the bit selection for each transmitted slot for TBoMS, take Option C.   * Option C: The index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.   **Proposal 3:** For the realization of Option C, following method is supported.   * The index of starting coded bit 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 index of starting coded bit in the circular buffer on -th slot in a single TBoMS can be given by , where 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.   **R1-2111508 Intel**  **Proposal 1**   * For the bit selection for each transmitted slot for TBoMS, Option B is supported.   **R1-2111329 OPPO**  **Proposal 6:** UCI multiplexing bits of coded bits is known prior to the determination of the index of the starting coded bit for all transmitted slots of TBoMS. |

**Others**

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| **R1-2110790 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. |

## A.4 Data Rate calculation and UE behavior related to TBS determination

**Data rate calculation**

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| **R1-2111693 NEC**  ***Proposal 5***: RAN1 should further discussion whether date rate calculation of TBoMS will be changed based on number of slots N for TBoMS.  **R1-2110919 ZTE**  **Proposal 3:** The maximum TBS can be limited by the conditions of data rate limitations DataRate and DataRateCC.  **R1-2111204 TCL**  **Proposal 3:** The maximum TBS for TBoMS should be limited based on DataRateCC.  **R1-2111272 CATT**  **Proposal 9:** No need to specify other constraints to limit the TBS of a single TBoMS, due to the restriction on one CB, single layer and maximum 8 slots for a single TBoMS. |

**Others**

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| **R1-2111979 LGE**  **Proposal 3**: Discuss the UE behavior when the calculated TBS exceeds the maximum TBS for single CB transmission. |

## A.5 FDRA

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| **R1-2111752 Samsung**  **Proposal 2**: The maximal number of PRB allocated in time domain is reduced for TB over multi-slot.  **R1-2111204 TCL**  **Proposal 4:** The maximum number of PRBs can be limited when TBoMS is enabled.  **R1-2111585 Xiaomi**  **Proposal 4:** Limit the number of RBs allocated for TB processing over multi-slot PUSCH by gNB scheduling. |

## A.6 TBoMS repetitions

**Slot mapping for TBoMS repetitions**

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| **R1-2111793 Interdigital**  **Proposal 12**:Support type 1(non-interleaved) when DMRS bundling is enabled and type 2 (interleaved) mapping for TBoMS repetitions when DMRS bundling is disabled shown in Figure 1    Figure 1 Examples of TBoMS repetition mapping : Type 1 (non-interleaved mapping) vs. Type 2 (interleaved mapping) for N=4, M=2 |

**Others**

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| **R1-2111329 OPPO**  **Proposal 1:** The TBoMS repetition should apply fixed RV sequence cycling among different actual repetitions of TBoMS.  The cycling unit is based on TBoMS instead of slot. |

## A.7 Transmission power determination

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| **R1-2111793 Interdigital**  **Proposal 7**: The transmission power determination of TBoMS is based on all the REs allocated in the N available slots for the TBoMS transmission, excluding the overhead of reference signals.  **R1-2112036 Ericsson**  **Proposal 11.** Reuse Rel-16 transmission occasion of power determination for TBoMS.  **R1-2110790 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. |

## A.8 Frequency hopping

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| **R1-2111028 vivo**  **Proposal 2:** Inter-repetition frequency hopping is not supported for TBoMS.  **R1-2111107 Spreadtrum**  **Proposal 4.** Support Inter-slot FH (same as the legacy PUSCH repetition Type A) for TBoMS.  **R1-2111585 Xiaomi**  **Proposal 5:** Support intra-TB frequency hopping for TB processing over multi-slot PUSCH.  **R1-2111204 TCL**  **Proposal 8:** The bundling of inter-slot frequency hopping should be supported for TBoMS**.**  **R1-2111272 CATT**  **Proposal 11:** Inter-bundling hopping is supported for TBoMS for the case when DMRS bundling is applied.  **R1-2111427 ChinaTelecom**  **Proposal 4:** Both inter-slot frequency hopping and inter-slot frequency hopping with inter-slot bundling to enable joint channel estimation should be supported for TBoMS.  **R1-2111438 Panasonic**  **Proposal 7:** The determination of inter-slot frequency hopping pattern and precoder cycling pattern for PUSCH repetition Type A is reused for TBoMS.   * For TBoMS with joint channel estimation, the inter-slot frequency hopping is performed per configured 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 and/or 8.8.2.   **R1-2111508 Intel**  **Proposal 5**   * In case of DMRS bundling, inter-slot frequency hopping with inter-slot bundling is supported for TBoMS. * For repetition of a single TBoMS transmission, inter-repetition frequency hopping is supported. |

## A.9 Retransmissions

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| **R1-2111621 CMCC**  **Proposal 5**:  At least single slot PUSCH and TBoMS with and without repetition could be used for the retransmission of TBOMS.  **R1-2111888 Apple**  **Proposal 3**: It’s up to gNB scheduling to determine the TBoMS re-transmission is by TBoMS, or by repetition, or by single slot transmission.  **R1-2111949 Lenovo/Motorola**  **Proposal 1**: For PUSCH coverage enhancements in NR Rel-17 with TBoMS, retransmission procedure and signaling should be enhanced to support retransmission of only partial slots from the TBoMS.  **Proposal 2**: 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   **R1-2112036 Ericsson**  **Proposal 6.** Only TB-based retransmission is supported for TBoMS.  **R1-2110864 Nokia/NSB**  **Proposal 8.** Discussion on partial retransmission should be deprioritized, given the limited available time before the end of the discussions for Rel-17.  **R1-2111204 TCL**  **Proposal 2.** A slot or a set of slots retransmission for TBoMS should be supported.  **R1-2111272 CATT**  **Proposal 10:** For retransmission, reuse the current principle that the TBS of TBoMS follows the TBS of initial transmission.  **Proposal 12:** For TBoMS retransmission, retransmitting the whole single TBoMS should be supported as the baseline.  **R1-2111508 Intel**  **Proposal 3**   * CBG based transmission is not supported for TBoMS. * In case of TBoMS retransmission, partial TB based transmission is not supported. |

## A.10 UCI multiplexing and dropping rules

**UCI multiplexing**

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| **R1-2111693 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.  **R1-2111752 Samsung**  **Proposal 6**: UCI multiplexing in TBoMS PUSCH is supported in Rel-17 CE,  **Proposal 7**: The timeline requirement is applied for the actual overlapped slot in the TBoMS.  **Proposal 8**: Re-use only legacy UCI multiplexing behavior (rate-matching and puncturing).  **R1-2111793 Interdigital**  **Proposal 2**: Support UCI multiplexing with TBoMS transmission.  **Proposal 3**: Support UCI repetition on multiple slots of TBoMS.  **Proposal 4**: Timeline constraint to multiplex UCI is based on the start of a slot within the allocated slots of TBoMS.  **R1-2111979 LGE**  **Proposal 4**: In case of collision between TBoMS and PUCCH without repetition, UCI is multiplexed on the TBoMS in the overlapped slot.  **Proposal 5**: In case of aperiodic CSI reporting with TBoMS transmission, it is necessary to clarify the location of the slot resource for aperiodic CSI multiplexing among the N allocated slots of TBoMS.  **Proposal 6**: is the number of symbols for TBoMS in a corresponding slot in which UCI is multiplexed for determination of the values of , , , and .  **Proposal 7**: To determine the values of , , , and , is multiplexed by N, where N is the number of slots allocated for TBoMS.  **R1-2112020 Sharp**  ***Proposal 3***: In determination of Q’, the reciprocal number of the effective coding rate is multiplied by the beta offset and N.  **R1-2112036 Ericsson**  **Proposal 9.** Reuse Rel-16 UCI multiplexing on PUSCH by puncturing for TBoMS.  **Proposal 10.** If UCI multiplexing in multiple slots of TBoMS is supported, CSI or HARQ-ACK can be repeated in all slots of a TBoMS.  **R1-2112120 NTT DOCOMO**  **Proposal 1**: 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.  **Proposal 2**: How to calculate the number of coded modulation symbols for UCI in TBoMS PUSCH should be discussed.  **R1-2112231 Qualcomm**  **Proposal 9:** Reuse R15/R16 framework for UCI multiplexing on PUSCH for each slot of a single TBoMS as well.  **R1-2112316 MediaTek**  **Proposal 3**: 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.  **R1-2112390 WILUS**  **Proposal 1**: UCI multiplexing is performed on single slot for a single TBoMS.  **Proposal 2**: The number of coded modulation symbols for the UCI in a slot (Q’ACK, Q’CSI-1, and Q’CSI-2) can be determined with following methods for UCI multiplexing on single slot for a single TBoMS.   * + Alt 1: TBS, i.e., is scaled by 1/N, where N is the number of slots allocated for a single TBoMS.   + Alt 2: The number of coded modulation symbols for the UCI in a slot is determined based on the number of available PUSCH resource across N slots, i.e., .   **R1-2110790 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 7:** The legacy UCI multiplexing in Rel-15/16 should be reused as much as possible, and at least the basic principles below should be followed:   * UCI should be multiplexed on only one slot. * Legacy timeline for UCI multiplexing should be followed.   + where is defined as the earliest symbol of PUCCH and PUSCH in the overlapped slot.   **Proposal 8:** For UCI multiplexing on TBoMS transmission, the parameter should be redefined to compensate the coding rate as follows:   * for HARQ-ACK; * for CSI part 1; * for CSI part 2;   where is the scaling factor to calculate for TBS determination, and the parameters , , and are the coding rate compensation parameters for HARQ-ACK, CSI part 1, and CSI part 2, respectively, configured in RRC.  **R1-2111028 vivo**  **Proposal 7:** Following equation is used to calculate the number of symbols for UCI multiplexing on a single TBoMS.   * Where is the total number of OFDM symbols of the PUSCH across N slots for a single TBoMS, including all OFDM symbols used for DMRS; and is the total number of OFDM symbols of the PUSCH within one slot for TBoMS, including all OFDM symbols used for DMRS.   **R1-2111204 TCL**  **Proposal 5:** UCI multiplexing is performed by puncturing or rate-matching depending on the determination time is before or latter the starting time of PUSCH preparation.  **Proposal 6:** If UCI multiplexing is performed by puncturing， may differ from rate-matching for UCI multiplexing.  **Proposal 7:** If UCI multiplexing in TBoMS is supported, UCI repetition should be considered.  **R1-2111272 CATT**  **Proposal 4:** 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 5:** The UCI should be coded and rate matched based on the total number of REs for UCI multiplexing on TBoMS.  **Proposal 6:** For UCI multiplexing in multiple slots of TBoMS, the REs occupied by UCI are evenly divided and mapped in each of the overlapped slots and the current UCI mapping rules can be reused for UCI multiplexing in one slot.  **R1-2111329 OPPO**  **Proposal 5:** UCI is equally multiplexed into all slots of TBoMS transmission.  **R1-2111427 ChinaTelecom**  **Proposal 3:** Legacy R15/R16 framework for UCI multiplexing with PUSCH should be reused as much as possible. Other enhancements can only be considered, if justified necessary.  **R1-2111438 Panasonic**  **Proposal 4:** The legacy Rel.15/16 framework of UCI multiplexing on PUSCH should be reused as a baseline (i.e., reuse the per slot UCI multiplexing).  **Proposal 5:** For UCI resource determination for TBoMS, and should be calculated per slot basis.  **Proposal 6:** For UCI resource determination for TBoMS, for the calculation of , TB size before multiplying scaling factor K should be used.  **R1-2111585 Xiaomi**  **Proposal 2:** Reuse the UCI multiplexing rule designed for PUSCH repetition in Rel-16 for TBoMS. |

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

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| **R1-2111793 Interdigital**  **Proposal 5**: In case of uplink cancellation, the UE resumes the TBoMS transmission in the next allocated slot.  **R1-2112036 Ericsson**  **Proposal 7.** PUCCH repetition can override the transmission of a single TBoMS or repetitions of TBoMS in the overlapping slot(s).  **Proposal 8.** 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.  **R1-2111204 TCL**  **Proposal 1:** Only dropping the overlapped slot(s) should be considered for TBoMS transmission when collision happen.  **R1-2111329 OPPO**  **Proposal 4:** Slot dropping can puncture those slots after interleaving and bit selection.  **R1-2111508 Intel**  **Proposal 7**   * TBoMS is considered as low priority uplink transmission. |

**Timeline requirements**

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| **R1-2111028 vivo**  **Proposal 6**: The same timeline for UCI multiplexing on type-A PUSCH repetition, as that in Rel-16, is reused for UCI multiplexing on TBoMS.  **R1-2111107 Spreadtrum**  **Proposal 1.** UCI multiplexing bits do not have to be known prior to the determination of the index of the starting coded bit for each transmitted slot. They have to obey the legacy timeline reference to the allocated slot that is overlapping with PUCCH.  **Proposal 2.** Cancellation/dropping of coded bit do not have to be known prior to the determination of the index of the starting coded bit for each transmitted slot. They have to obey the legacy timeline reference to the starting symbol in the allocated slot that is cancelled.  **R1-2111508 Intel**  **Proposal 6**   * Two options can be considered for UCI multiplexing timeline.   + Option 1: UCI multiplexing timeline is determined based on the first symbol of TBoMS transmission.   + Option 2: UCI multiplexing timeline is determined based on the first symbol of the overlapped slot for TBoMS transmission. |

## A.11 Additional indicators and configuration options

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| **R1-2111621 CMCC**  **Proposal 1:**  It is proposed that the dynamic switching between TBoMS and single slot PUSCH with and without repetition.  **Proposal 2:**  N=1 should be supported for the switching between TBoMS and single slot PUSCH.  **R1-2112036 Ericsson**  **Proposal 3.** All the entries in a Rel-17 TDRA list are either for PUSCH repetition or for TBoMS. An exception is N=1 and M=1 for single-slot PUSCH is included in the TDRA table for TBoMS.  **R1-2112231 Qualcomm**  **Proposal 7:** Impose no restrictions on dynamic switching between legacy (R15/R16) PUSCH repetitions and TBOMS. Allow the desired mode of transmission to be chosen based on the signaled or configured row index of the TDRA table.  **R1-2110864 Nokia/NSB**  **Proposal 9.** In Rel-17, single-slot PUSCH transmission is enabled when N = 1 and M =1. PUSCH repetition Type A is enabled when N = 1 and M > 1, where N and M are configured in TDRA table as agreed the context of Rel-17 TBoMS, at least for the case in which UE is configured for counting based on available slots for PUSCH repetition Type A.  **Proposal 10.** TBoMS feature is enabled when the number of allocated slots for a single TBoMS (N) is configured in a row of the TDRA table and the parameter AvailableSlotCounting is configured and set to enable, at least for unpaired spectrum.  **R1-2111028 vivo**  **Proposal 3:** N=1(type-A PUSCH repetition) and N>1(TBoMS) cannot be configured simultaneously in a single TDRA table.  **R1-2111508 Intel**  **Proposal 2**   * TDRA table partitioning can be employed to differentiate single-slot PUSCH and TBoMS transmission.   + Number of rows allocated for single-slot PUSCH transmission can be configured as part of TDRA table. |

## A.12 Application of DM-RS bundling to TBoMS

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| **R1-2111793 Interdigital**  **Proposal 11**: Support joint channel estimation for TBoMS repetition. |

## A.13 Interlaced TBoMS transmissions

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| **R1-2112231 Qualcomm**  **Proposal 10:** Interlaced TBoMS transmissions (carrying different TBs) are not permitted. A UE does not expect a TBoMS transmission in a component carrier to begin before the completion of an ongoing TBoMS transmission in the same component carrier. |

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

Working assumption: 🡪 Agreement:

For TBS determination of TBoMS:

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

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

Agreement:

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

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

**Working assumption**

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

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

Agreement:

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

Agreement:

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

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

**Working assumption**

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

Agreement:

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

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

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

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

Agreement:

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

* FFS: details.

Agreement:

The following approach is used to calculate NInfo for TBoMS:

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

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

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

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

Agreement:

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

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

Working Assumption

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

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

Agreements**:**

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

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

Agreement:

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

Agreement:

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

Agreement:

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

Agreement:

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

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

Agreement:

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

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

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

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

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

Agreement:

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

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

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

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

Agreement

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

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

Agreement

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

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

Agreement

TBoMS is supported for both configured grant and dynamic grant.

Working Assumption

Single TBoMS structure of Option 3 is selected

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

**Agreement**

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

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

FFS: details related to the indication of K.

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

**Agreement**

Repetitions of a single TBoMS are supported, where:

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

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

**Agreement**

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

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

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

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

**Agreement**

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

**Agreement**

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

**Agreement**

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

* FFS: other frequency hopping schemes.

**Agreement**

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

**Agreement**

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

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

**Agreement**

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

* 

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

FFS: other values, if any.

FFS: further constraints on N\*M

**FL’s proposal 13**

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

* 

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

**Agreement**

BPRE for TBOMS is calculated as  where N is the number of slots allocated for a single TBOMS and  is the number of allocated REs in one allocated slot of a single TBOMS.

Note: How this equation or its equivalent is captured in the specification is left to the editor

**Agreement**

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

* FFS: other frequency hopping schemes.

**Working Assumption**

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

* Bit interleaving is performed per slot.

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

* Transmission is limited to one CB only.
* FFS: whether UCI multiplexing bits or cancellation/dropping of coded bits, if any, have to be known prior to the determination of the index of the starting coded bit for each transmitted slot or not
* FFS: Performance with UCI multiplexing on single and multiple slots of a single TBoMS

Note: How UCI multiplexing and cancellation/dropping of coded bits influence the sequence of coded bits transmitted in each slot of a single TBOMS is to be further discussed. Some knowledge on UCI to be multiplexed or cancellation/dropping of coded bits in each slot of a single TBOMS may be known prior to the start of a single TBOMS transmission. How this is to be handled is to be discussed further.

**Agreement**

For the bit selection for each transmitted slot for TBoMS, one of the following is to be down selected in RAN1 #107-e for determining the index of the starting coded bit in the circular buffer:

* Option B: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot.
* Option C: the index of the starting coded bit in the circular buffer is the index continuous from the position of the last bit selected in the previous allocated slot, regardless of whether UCI multiplexing occurred in the previous allocated slot or not.

FFS: whether the index of the starting coded bit for each transmitted slot is expressed as a multiple integer of the lifting size Zc

Note: Dropping/cancellation rules are not considered for the starting bit position determination in both Option B and Option C.

**Agreement**

For TBoMS transmission in Rel-17:

* TBoMS ~~transmission~~feature is enabled (or disabled) by configuring (or not) the number of allocated slots for a single TBoMS (N) in a row of the TDRA table.
* ~~Dynamic switching between at least TboMS transmission and the legacy single-slot PUSCH transmission, by using a row in the TDRA table, is supported.~~
  + TBoMS transmission is enabled when N>1, where N is the number of allocated slots for a single TBoMS.
  + Single-slot PUSCH transmission is enabled when N=1.
  + Supported combinations of N and M that can be configured in the TDRA table, these combinations are constrained by retransmission are to be further discussed