3GPP TSG RAN Meeting #94-e   *DRAFT* RP-213615

Electronic Meeting, Dec 06-17, 2021

Source: **RAN1 Vice-Chair (Huawei)**

Title: **Moderator's summary for [94e-38-R17-CovEnh-WI]**

Agenda item: **9.3.1.5**

Document for: **Discussion and decision**

1   Introduction

The Status Report for the Rel-17 work item on NR coverage enhancements in RP-213075 [7] claims 98% completion for RAN1, and lists the following option issue:

  – "How to identify the index of the starting bit of each a slot for TBoMS in case of UCI multiplexing."

The corresponding WID objective is:

  – 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.

Eight companies provided contributions specifically addressing this open issue. The proposals are copied in annex 1 of this document. Annex 2 provides a list of options discussed in RAN1. All eight companies believe that there is enough time to complete the design for UCI multiplexing with TBoMS in Rel-17, either in RAN plenary or in RAN1.

Adopting option C is supported as first preference by Apple, Samsung, Qualcomm and Ericsson. Adopting hybrid option B-C is supported by Intel as first preference, and by Ericsson as second preference. Intel, Ericsson, CATT and ZTE have a preference to continue the technical discussion in RAN1. One company stated that option B is not a complete solution, while another company pointed out that RAN1 discussions didn't have sufficient quantitative comparisons.

The moderator's understanding is that it is not the intent for RAN#94e to approve CRs solving this open issue, so a RAN TSG decision would either provide a guidance to RAN1 or a decision to stop the work on TBoMS.

In summary, the following options were provided for handling this open issue at RAN#94e:

- Alt1: RAN TSG tasks RAN1 to conclude in 2022Q1 and report to RAN#95e, with guidance according to one of the alternatives below:

  - Alt 1a: continue discussion in RAN1 without any specific guidance
  - Alt 1b: adopt option C and provide the corresponding CR(s) to RAN#95e
  - Alt 1c: adopt option B and provide the corresponding CR(s) to RAN#95e
  - Alt 1d: adopt hybrid option B-C with Option B used for the second slot (FL's proposal 12-v3) and provide the corresponding CR(s) to RAN#95e
  - Alt 1e: support only multiplexing of UCI payload of 1 2 bits by puncturing TBoMS in a slot, and provide the corresponding CR(s) to RAN#95e
  - Alt 1f: TBoMS does not support UCI multiplexing, and provide the corresponding CR(s) to RAN#95e

- Alt2: RAN#94e to conclude that TBoMS is not supported in Rel-17

Given the limited input at the start of the meeting, the initial round of discussion will ask all companies to provide their preference(s) in terms of the alternatives above, and whether other alternatives should also be considered in the discussion at RAN#94e.

2   Initial Round

Please provide your answers to the questions below by the deadline of 11:30 UTC on Tuesday December 14th.

2.1   Initial Round Questions

Q1: please provide your preference among the following alternatives, and reasons for your preference. You may also provide an additional alternative if any.

- Alt1: RAN TSG tasks RAN1 to conclude in 2022Q1 and report to RAN#95e, with guidance according to one of the alternatives below:

  - Alt 1a: continue discussion in RAN1 without any specific guidance
  - Alt 1b: adopt option C and provide the corresponding CR(s) to RAN#95e
  - Alt 1c: adopt option B and provide the corresponding CR(s) to RAN#95e
  - Alt 1d: adopt hybrid option B-C with Option B used for the second slot (FL's proposal 12-v3) and provide the corresponding CR(s) to RAN#95e
  - Alt 1e: support only multiplexing of UCI payload of 1 2 bits by puncturing TBoMS in a slot, and provide the corresponding CR(s) to RAN#95e

- Alt 1f: TBoMS does not support UCI multiplexing, and provide the corresponding CR(s) to RAN#95e

– Alt2: RAN#94e to conclude that TBoMS is not supported in Rel-17

Feedback Form 1: Responses to question 1 above

---

1 – MediaTek Inc.

Alt. 2 or Alt. 1b. At least Alt. 1b can work well with minor spec/implementation impact. Further optimization is not necessary at this stage. And Option C has been supported widely in RAN1 discussion.

---

2 – TELECOM ITALIA S.p.A.

Same view as Mediatek. more in detail:

It should be made very clear to companies in RAN1 that timeplan has to be respected. therefore Alt 2 is the preferred.

However, since it seems there is some consensus on alt. 1b, this could be an acceptable exception.

Alt 1a is absolutely not acceptable (RAN must take a decision, since RAN1 is not able to converge).

---

3 – Apple Computer Trading Co. Ltd

Our preferences are in the following order: At1 1b, then Alt 1d, then Alt 1a, then Alt 1e

Alt 1d is compromised solution between Option C and Option B. But it could have potential confusions. Our understanding is Alt 1d is following legacy UE rate matching behaviour in the first slot, i.e., PDSCH REs are pictured for HAR-ACK bits up to 2, PDSCH REs are rate matching around HARQ-ACK bits (larger than 2) and CSI bits. Then the starting bits of the second slot is determined according to the first slot RE mapping. If this is not the common understanding, we prefer Alt 1d is dropped.

We can't accept Alt2, Alt 1f, Alt 1c.

One question for clarification, if Alt 2 and Alt 1f are not agreeable, does it implicit mean another Alternative is supported, such as

Alt 1a': continue discussion in RAN1 and UCI multiplexing on TBoMS is supported.

---

4 – Tejas Networks Ltd.

Alt 1b has minimal implementation impact. So prefer Alt 1b.

---

5 – vivo Communication Technology

We are fine with alt 1b or alt 1e. Option C has been discussed in RAN1 and there were good support. If consensus cannot be reached on alt 1b, at least alt 1e shall be supported, which is similar to Rel-15. We have strong concern on alt 1a. If RAN1 to make decision in next meeting, RAN to provide guidance to RAN1 to select between option B and option C. No new options should be considered.

---

6 – Guangdong OPPO Mobile Telecom.

We prefer Alt-1C as the option B already provide the best performance. We can accept Alt-1D , as it balance the complexity of UE processing and performance. We don't want the coverage gain gone for the UCI multiplexing by simple puncturing.

If the technical decision can not made, it is OK to have continuous discussion in WG and this does not have not impact on the completeness of the WI.

7 – VODAFONE Group Plc

Our preference is Alt-1B, according with the discussion in RAN1, it is already a complete solution with minimum specification impact and the impact on gain can be compensated by enabling TBoMS repetitions.

8 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility : Our preference is Alt 1b i.e. adopt option C. This options has the majority support in RAN1. Also, from technical perspective, option B has one major issue of error propagation across entire TBOMS, when DL DCI associated with HARQ-ACK is missed (option C doesn't have that issue). Also, we don't think, any further discussion in RAN1 is needed, as companies had sufficient opportunity to put forward any technical arguments.

9 – KT Corp.

KT prefers Alt 1b. KT believes majority in RAN1 prefers Option C and this has minimum specification impact.

10 – China Mobile Com. Corporation

From our perspective, Alt 2 and Alt 1f are not different. A TBOMS without UCI multiplexing would be very limited and remains only as a paper work.

Alternative 1e provide a way forward by accepting the common part of option B and option C. But maximum 2 bits UCI cannot fulfill the requirements of TDD configuration, such as 7D1S2U.

Alt 1c and 1d, both containing option B, still need RAN1's discussion and the subsequent solutions under option B are still diverse.

Considering the work load and limited time, Alt 1b is preferred and RAN plenary should provide some guidance for the further work.

Alt 1a is not acceptable to us.

11 – China Telecommunications

As companies have spent great efforts on TBoMS, it would be very unfortunate if we finally go for Alt 2 or Alt 1f. If this RAN plenary to conclude the issue, we should go for majority views, i.e., either Alt 1b or compromised Alt 1d. If we cannot make decision in this RAN plenary, it would be helpful if RAN TSG can provide guidance to RAN1. For instance, at least up to 2 bit UCI multiplexing is supported for TBoMS, RAN1 to finalize the issue on multiplexing of UCI payload larger than 2 bits in Q1 2022. If no consensus can be reached in RAN1 in Q1 2022, multiplexing of UCI payload larger than 2 bits is not supported for TBoMS.

12 – Panasonic Corporation

Our preference is Alt 1b as it works simple and works well for target scenario. We are OK with alt 1a. Not acceptable to Alt 1e, 1f, alt 2 as all our past effort are lost.

13 – Nokia Corporation

Based on all the discussions so far, it is clear that Alt 1b provides a complete solution that is supported by the vast majority of companies. It is possible to optimize it further, but such optimizations should not prevent the conclusion of this feature. Hence, a reasonable way forward is to agree already this week in RAN that option C (i.e. Alt 1b above) is the default solution in case RAN1 is unable to decide in January meeting.

14 – Intel Deutschland GmbH

Our preference is Alt 1d or modified Alt 1a. As discussed in our contribution, Alt 1d or hybrid options can provide good balance between performance and implementation in case of UCI multiplexing on TBoMS. We do not think RAN Plenary is a good place to discuss this detailed issue. In our view, modified Alt 1a is also preferred: RAN1 can continue the discussion and make final decision in Q1/2022. If there is no conclusion in January AH, the scope will be dropped in Rel-17.

We do not support Alt 2. RAN1 has made good progress for Coverage Enhancement WI and it is really unfortunate that UCI multiplexing on TBoMS is not supported in Rel-17.

15 – InterDigital France R&D

Although our preference is Alt. 1c, as a compromise, we can support either Alt. 1d or Alt. 1b

16 – Ericsson LM

As we stated in our contribution, we support Alt-b which seems to have the majority of the support. In case of compromise, we would be OK with Alt-d, if it is necessary.

We do not support Alt-2.

17 – Samsung Research America

We prefer Alt.1b - it was discussed in RAN1 and was supported by the majority of companies.

We would be also OK with Alt.1a because we don't think such details should be discussed in RAN, but in the interest of time we prefer Alt.1b to close this issue and save some time in next RAN1 meeting.

18 – SHARP Corporation

For TBoMS without UCI piggyback, or with UCI piggyback for at most 2 HARQ-ACK bits, TBoMS feature is complete. Therefore, Alt.2 shouldn't be adopted.
Among Alt 1, we prefer Alt.1b which has technical benefit.

19 – NTT DOCOMO INC.

Our preference order is to Alt 1b > 1a > 1d.
Although we believe it is possible to reach the consensus, having the fallback plan never hurts just in case that there is no agreement regarding this issue. As the fallback plan, we would rather support Alt 1e than Alt 1f or 2.

20 – ZTE Corporation

We prefer Alt 1c or Alt 1d or modified Alt 1a.

As discussed in GTW, we suggest RAN tasks RAN1 to address the issue in January 2022 meeting, and if still no consensus can be reached, we can then conclude to not support TBoMS with UCI multiplexing.

Alt 1f and Alt 2 are not acceptable for us. If Alt 1e would be pursued, we suggest to also conclude to support multiplexing of CSI bits by rate matching with TBoMS in a slot. Because, there is no misalignment on the number of CSI bits among gNB and UE, i.e., no error propagation issue for CSI multiplexing by using rate-matching as legacy. For HARQ-ACK with more than 2 bits, it could be further discussed in RAN1.

21 – WILUS Inc.

Our preference is Alt 1b which has been supported by the majority of company in RAN1 discussion. We can also support either Alt 1d or Alt1e. We do not support both Alt-2 and Alt-1f which makes much effort in vain for TMoMS feature on Coverage enhancement in Rel-17.

22 – Qualcomm Incorporated

We prefer Alt 1b, i.e. adopt Option C, which has had majority support in multiple discussion rounds already.

We cannot accept Alt 1c. The claims by other companies that Alt 1c (i.e. Option B) has optimum performance ignore the problems caused by missing grants, which would be greatly amplified by losing the extended number of slots committed to TBoMS.

We cannot accept Alt 1d either as long as the starting point of the second slot has the same dependence on correctly receiving DL grants as Alt 1c. Any error would result in losing the whole sequence of transmissions.

The other options we could potentially accept, although non-preferred, listed in order of decreasing preference (least preferred last) : Alt 1e, Alt 1a, Alt 1f, Alt 2.

23 – CATT

We support Alt 1b or Alt 2. Option C was discussed in RAN1 and supported by majority companies. If RAN can agree on Alt 1b (i.e. Option C) would save RAN1 time for further debating. If the views cannot converged in RAN meeting, we prefer to let RAN1 to further discuss in next quarter. Alt 2 would make the feature of TBoMS much less useful in practice so we do not support Alt 2.

24 – CATT

Sorry for the typo above. Please find the updated comments from us.

We support Alt 1b or Alt 1a. Option C was discussed in RAN1 and supported by majority companies. If RAN can agree on Alt 1b (i.e. Option C) would save RAN1 time for further debating. If the views cannot converge in RAN meeting, we prefer to let RAN1 to further discuss in next quarter. Alt 2 would make the feature of TBoMS much less useful in practice so we do not support Alt 2.

25 – HUAWEI TECHNOLOGIES Co. Ltd.

Our preference is Alt 1d, which is a compromised solution of option B and option C after long debate in RAN1, and indeed it provides good tradeoff among the pros and cons of option B and option C. Especially, it can avoid the case of significant performance loss by avoiding puncturing large amount of systematic bits in the first slot. As to the misalignment due to DCI missing, we don't think it is a big problem, since DCI missing is a corner case and it will only impact the first two slots for TBoMS transmission, and actually the same issue exists in the current mechanism in Rel-15/16 already.

Option 1b will result in puncturing PUSCH always, which would result in significant performance degradation for PUSCH, especially when the UCI payload size is large and in the first few slot(s) for TBoMS transmission, in which many systematic information bits are transmitted. In addition, we don't think option 1b is simpler than option 1d, since anyway UE needs to calculate the actual number of coded bits transmitted in all the slots considering with/without UCI transmission, and thus no additional effort needed for alt 1d.

We don't accept Alt 2 and Alt 1f, considering the huge effort we have spent on this TBoMS features in RAN1.

26 – Spreadtrum Communications

Our preference order is to Alt 1b > 1d > 1a. We think Option C was majority view during RAN1 discussion. We cannot accept Alt 2 and Alt 1f.

27 – LG Electronics Inc.

From the LLS evaluation, it is observed that there is a potential problem which is option C brings performance degradation when size of UCI payload is larger. We think the problem should be resolved if UCI multiplexing is supported for TBoMS.

We think **Alt.1d which was proposed in RAN1#107-e can be a solution.**

Also, we are fine with **Alt.1a (i.e., continue discussion in RAN1**) because this is a RAN1 specific topic.

And, we think **if there is no consensus to adopt an alternative for supporting UCI multiplexing for TBoMS, it can be concluded that TBoMS does not support UCI multiplexing** rather than TBoMS is not supported in Rel-17.

28 – Panasonic Corporation

Although it would be repeating RAN1 discussion, we don't understand why gNB schedules large UCI payload in the first slot in the coverage limited scenario. If large UCI needs to be sent in the coverage limited scenario, UCI only PUSCH would be more reasonable gNB scheduler operation than to multiplex with data in the first slot of TBoMS as the power (= amount of payload) is limited in coverage limited scenario. I think it would be one of the reason majority support alt 1b (= option C).

29 – Xiaomi Communications

We prefer alt.1b which has least spec impact and more friendly for UE implimentation optimization.

2.2 Initial Round Summary

The summary of companies' preferences in initial round for the various alternatives is shown below.

Table 1: Companies' preferences for the various alternatives expressed in initial round

Alternatives	Support (with ordered preference)	Not acceptable
Alt 1a (continue discussion in RAN1)	Apple (3), OPPO (3), Panasonic (2), Samsung (2), NTT Docomo (2), ZTE (2), Qualcomm (3), CATT (2), Spreadtrum (3), LGE (2)	TIM, vivo, CMCC

Alt 1b (option C)	Apple (1), Samsung (1), Qualcomm (1), Ericsson (1), MediaTek (1), TIM, Tejas Networks, vivo (1), Vodafone, Motorola Mobility, KT, CMCC, China Telecom, Panasonic (1), Nokia, InterDigital (2), Sharp, NTT Docomo (1), WILUS (1), CATT (1), Spreadtrum (1), Xiaomi	
Alt 1c (option B)	OPPO (1), InterDigital (1), ZTE (1)	Apple, Qualcomm
Alt 1d (hybrid option B-C)	Intel (1), Ericsson (2), Apple (2), OPPO (2), China Telecom, InterDigital (2), NTT Docomo (3), ZTE (1), WILUS (2), Huawei (1), Spreadtrum (2), LGE (1)	Qualcomm (if the starting point of the second slot has the same dependence on correctly receiving DL grants)
Alt 1e (support only multiplexing of UCI payload of 1 2 bits by puncturing TBoMS in a slot)	Apple (4), vivo (2), WILUS (2), Qualcomm (2) ZTE (if adopted, then support multiplexing of CSI bits by rate matching with TBoMS in a slot)	Panasonic
Alt 1f (TBoMS does not support UCI multiplexing)	ZTE (if RAN1 cannot reach a conclusion at the January ad-hoc meeting), Qualcomm (4)	Apple, Panasonic, ZTE, WILUS, Huawei, Spreadtrum
Alt2: RAN#94e to conclude that TBoMS is not supported in Rel-17	MediaTek, TIM (1), Qualcomm (5)	Apple, Intel, Ericsson, CATT, ZTE, Panasonic, Intel, Sharp, WILUS, CATT, Huawei, Spreadtrum

In summary:

- 27 companies responded to the initial round question on possible alternatives.

- Only 4 companies can accept a conclusion of no support for TBoMS or support without UCI multiplexing like Alt2 or Alt1f.

- Some companies stated that the minimum (some say the default) is Alt 1e (support only multiplexing of UCI payload of 1 2 bits).

- It is no company's first preference to simply send the discussion back to RAN1 without any guidance.

- Option B is supported by just 3 companies and objected by 2 companies, so option B needs to be excluded from further discussion.

- 12 companies support option B+C, including 4 as first preference.

- 22 companies support option C, including 11 as first preference

- Concerns were expressed on option B+C by several companies, although it may still be possible to work on details to address those concerns, and one company indicated that option B+C is not acceptable under some condition (if the starting point of the second slot has the same dependence on correctly receiving DL grants).

- Concerns were expressed on option C by several companies, although no company explicitly stated that option C is not acceptable.

Given the strong majority supporting to adopt option C at RAN#94e, and so far no company said that they cannot accept option C, while there is at least one company who cannot accept any of the other options, the moderator would like to propose adopting option C at RAN#94e, and task RAN1 to work on the corresponding CR(s) for RAN#95e.

3   Intermediate Round

Please provide your answers to the question below by the deadline of 11:30 UTC on Wednesday December 15th.

3.1   Intermediate Round Questions

Intermediate proposal:

For the determination of the index of the starting coded bit in a transmitted slot for TBoMS:

- adopt option C at RAN#94e

- task RAN1 to work on the corresponding CR(s) for RAN#95e

Feedback Form 2: Comments on intermediate proposal

3.2   Intermediate Round Summary

4   Final Round

5   Conclusion

6   Annex 1 – Summary of proposals in contributions to RAN#94e

Intel RP-212909

Observation 1

- FL's proposal 12-v3 is a mixed solution of Option B and C, which can provide good compromise and balance between performance and implementation.

Proposal 1

- RAN1 to complete bit selection of TBoMS transmission in Q1 2022.

Ericsson RP-212985

Proposals:

- Up to 2 bit UCI multiplexing in TBoMS PUSCH is supported using Rel-15/16 mechanisms.

- If RAN decides to refer the UCI multiplexing issue back to RAN1 (our first preference)

    ○ RAN1 is tasked to complete their work on UCI multiplexing for TBoMs in the maintenance phase, with increased focus on quantitative comparisons.

- If RAN decides to conclude on the UCI multiplexing issue

    ○ Either option C is specified (our first preference) or hybrid option B-C with Option B used for the second slot is specified (our second preference)

Apple RP-212999

Proposal 1: Option C is selected for determining the index of the starting coded bit in the circular buffer for TBoMS.

Proposal 2: If no decision is made in RAN plenary, RAN provides the guidance to RAN1 to move forward.

Samsung RP-213013

Observation: Without the determination of the starting coded bit in a slot for TBoMS, Rel-17 RAN1 work on Coverage Enhancement cannot be completed.

Proposal: For the determination of the starting coded bit in a slot for TBoMS in Rel-17 NR coverage enhancement, Option C is supported

Qualcomm RP-213053

Proposal: It is recommended that the most straightforward design to complete the feature be adopted in RAN[1]94e so that this feature can be considered complete.

- There is no strong need for RAN1 to further discuss this issue.

- It is recommended that this feature not be left incomplete.

Proposal: For starting bit determination of each slot of a TBOMS, adopt Option C.

vivo RP-213257

Proposal:

- For UCI multiplexing with TBoMS, down select between option B and C;

- If no consensus can be reached, at least support multiplexing of UCI payload of 1 2 bits by puncturing TBoMS in a slot;

- Rel-17 Coverage Enhancement WI is declared functionally completed from RAN1 perspective.

CATT RP-213306

Proposal: Consider the following alternatives to handle TBoMS in Rel-17 NR_cov_enh,

- Alt.1 (first preference): RAN1 continues the discussion on bit-selection and UCI multiplexing of TBoMS in 2022Q1.

- Alt.2 (second preference): RANP concludes that TBoMS does not support UCI multiplexing.

- Alt.3 (last preference): RANP concludes that TBoMS is down-scoped from Rel-17 NR_cov_enh.

ZTE RP-213417

Proposal 1: RAN1 targets to solve the remaining UCI multiplexing issues for TBoMS in RAN1 January 2022 meeting. If no consensus can be reached still, the conjunction of TBoMS and UCI multiplexing is dropped.

- Note: the target completion time for Core Part of Rel-17 CE WI is kept as RAN#95.

7   Annex 2 – Summary of options for TBoMS discussed in RAN1

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.

FL's proposal 12-v3 (hybrid option B-C)

For the determination of the index of the starting coded bit in a transmitted slot for TBoMS:

- For the first TBoMS repetition:

    ○ For the first allocated slot for the first TBoMS repetition, the index of the starting coded bit is determined based on the applied redundancy version.
    ○ For the second allocated slot for the first TBoMS repetition, Option B is used.
    ○ For the i-th slot allocated for the first TBoMS repetition, with $2 < i \leq N$, Option C is used.

- For all other TBoMS repetitions, if any:

    ○ For the first allocated slot for all other TBoMS repetitions, the index of the starting coded bit in determined based on the applied redundancy version.
    ○ For the i-th slot allocated for all other TBoMS repetitions, with $1 < i \leq N$, Option C is used.

Note that **FL's proposal 12-v4 in R1-2112688** provided additional details on top of FL's proposal 12-v3, with two sub-options regarding the offset used with option B.

---

8   References

1. RP-212909   On potential down-scoping for Rel-17 NR Coverage Enhancement Intel Corporation

2. RP-212973   CR Pack, Introduction of coverage enhancements in NR RAN1

3. RP-212985   UCI Multiplexing for TB Processing over Multi-Slot PUSCH   Ericsson

4. RP-212999   On Rel-17 NR coverage enhancements   Apple

5. RP-213013   On the status of Rel-17 NR coverage enhancement work in RAN WG1   Samsung

6. RP-213053   Views on CovEnh Rel-17 conclusion   Qualcomm Incorporated

7. RP-213075   Status report of WI: NR coverage enhancements; rapporteur: China Telecom RAN1

8. RP-213257   Discussion on UCI multiplexing with TBoMS   vivo

9. RP-213306   On leftover of NR coverage enhancements in Rel-17   CATT

10. RP-213417   Discussion on Progress of Rel-17 Coverage Enhancements   ZTE, Sanechips

11. R1-2112688   Final FL summary of TB processing over multi-slot PUSCH (AI 8.8.1.2) Moderator (Nokia, Nokia Shanghai Bell), RAN1#107-e