[94e-38-R17-CovEnh-WI] - Version 0.0.4
RAN

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

1 – Nokia Corporation We support the way forward from the moderator, i.e. adopt option C. This is the most likely outcome in any case and deciding it now will save precious time for RAN1 in January Ad-Hoc meeting.
2 – Ericsson LM We also support moderator proposal. We share same view as Nokia that such guidance from plenary saves indeed RAN1's time which is appreciated by all irrespective of preference.
3 – InterDigital France R&D We support the moderator's proposal.
4 – Samsung Research America Support moderator's proposal.

5 – SHARP Corporation

We support Moderator's proposal.

6 – NTT DOCOMO INC.

We support the proposal.

7 – Qualcomm Incorporated

We support the moderator's proposal.

8 – CATT

We support the proposal.

9 – vivo Communication Technology

we suppport moderator's proposal.

10 – Apple Computer Trading Co. Ltd

We support the moderator's proposal.

11 – China Telecommunications

We support Moderator's proposal.

12 – HUAWEI TECHNOLOGIES Co. Ltd.

We have concern with the proposal.

1. It seems the concern from Qualcomm on Alt 1d is that if the starting point of the second slot has dependence on correctly receiving DL grants, it will result in losing the whole sequence of transmissions for TBoMS if there is DL grant missing. However, we think it is not true. In our understanding, with Alt 1d, starting from the third slot the starting bit will be determined assuming there is no UCI multiplexing operation in the previous slots, which means that there is no any impact on the transmissions starting from third slot from the DCI missing. Maybe we can consider to add the following note under Alt 1d to clarify this.

Note: for the slot with starting bit calculation based on option C, the calculation assumes that there is no UCI multiplexing operation in the previous slots for the TBoMS transmission.

2. As we expressed in the previous round, we don't think the misalignment due to DCI missing is a big problem, since DCI missing is a corner case and it will only impact the first two slots for TBoMS transmission under Alt 1d, and actually the same issue exists in the current mechanism in Rel-15/16 already. Therefore, the misalignment due to DCI missing issue should not be used as the critical criteria to decide what option to choose.

3. As we expressed in the previous round, Alt 1b (i.e. option C) 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. Especially for the case of two slots (N=2) are scheduled for TBoMS, then with option C, many of the systematic bit will be dropped, and this N=2 is very common case for TDD carrier due

to fewer uplink slots available. 1. According to the evaluations, about 1 dB gain can be achieved by option B compared to option C in some cases, please note that 1 dB gain is significant for coverage, since actually most of the features developed under coverage can only provide gain in this order. Therefore, we think performance is the very critical aspect to decide what option to choose.

13 – Panasonic Corporation

We support the proposal

14 – China Mobile Com. Corporation

Support moderator's proposal. If this is the majority view, we propose to conclude the issue in RAN plenary and leave the details to the working group.

15 – Intel Deutschland GmbH

We do not support this proposal. We still have concern on the performance for Option C for UCI multiplexing on TBoMS. As discussed extensively in the RAN1 meeting and also shown in our contribution, performance degradation can be observed for Option C due to puncturing of systematic bits in case of UCI multiplexing on TBoMS. In some cases, this may lead to complete decoding failure of TBoMS.

We support Alt. 1d, which would address the issue on performance loss of Option C. If we cannot conclude this in RAN Plenary, our view is that we will continue to discuss this in the next RAN1 meeting.

16 – Spreadtrum Communications

We support the proposal

17 – Guangdong OPPO Mobile Telecom.

We have concern on the proposals. It is not based on the compromised solution of the updated discussion results in RAN1 meeting. Then it does not help for RAN1 to make a proper conclusion.

The key problem is also shown in some companies contribution to the plenary. If some number of UCI bits multiplexed into TBoMS by option C, the coverage is not enhanced and even could be reduced. Thus, this option is even worse than not multiplexing UCI to TBoMS at all.

So we can not accept the conclusion and believe one more WG level further discussion could help.

18 – MediaTek Inc.

We support the proposal

19 – ZTE Corporation

Compared to Alt 1b, our understanding is Alt 1d, as a good compromise between Option B and Option C, is more acceptable among companies based on previous discussion. So, we prefer either to support Alt 1d or leave to RAN1 with one more meeting to finalize this issue.

Regarding the error propagation issue of Option B due to missing DL grants, we would like to highlight again as discussed in RAN1 that the issue only happens for CG PUSCH with UCI multiplexing for more than 2 bits HARQ-ACK, when the following two corner cases occur.

- More than 3 consecutive DCIs are missed at the same time. Assuming the possibility of missing one DL DCI is about 1%, then missing 4 DCIs would be 10E-8.

- The last DCI is missed. In such case, it would cause lots of problems even in Rel-15/16. Because gNB and UE would even have a different understanding about which PUCCH resource is chosen.

20 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility : We support the moderator's proposal

21 – VODAFONE Group Plc

We support the way forward

22 – Nokia Corporation

We would like to reinforce our views that option C is the only sensible way forward. The concerns raised by Huawei, Intel, and OPPO above have been extensively debated in RAN1 already, and they are not seen as factors blocking adoption of option C. The fact that vast majority of companies maintain their support to option C just confirms this observation.

Just quickly addressing the technical points raised by those companies above, TBoMS design is robust enough to deal with the UCI multiplexing using option C. The few pathological cases where issues could arise can be easily avoided by gNB. To start with, the very large UCI in first slot is not a sensible operation point for a coverage limited UE, as pointed out by Panasonic in previous round already. Even in that case, TBoMS repetition would eliminate the problem in this extreme situation as well, so that is not a real issue in practice.

Again, all these aspects have been discussed extensively in RAN1 over the past few meetings, and there is no reason to believe the discussion will be any different if this is continued in January ad-hoc meeting. We also note that option C is a **complete and functional solution** to the problem, and the discussion moving forward can be only on adopting the solution in option C or a further optimized version of it. This means that **if RAN1 cannot agree to the further optimized version (as it is clear already), the only option available to RAN/RAN1 is to adopt option C.**

23 – vivo Communication Technology

We agree with analysis from Nokia #22, the arguements have been brought up in RAN1#107e and repeating here again. Repeating again in next RAN1 isn't helpful hence we prefer making agreement in RAN#94e and focus on essential CRs to stabilize Rel-17 spec in upcoming RAN1 meetings.

3.2 Intermediate Round Summary

Here is the summary of responses to intermediate round proposal. 23 responses were provided to the intermediate round proposal to adopt Alt1 b (option C).

Support the proposal (18)

– Nokia, Ericsson, InterDigital, Samsung, Sharp, NTT Docomo, Qualcomm, CATT, vivo, Apple, China Telecom, Panasonic, CMCC, Spreadtrum, MediaTek, Lenovo, Motorola Mobility, Vodafone •

Don't support the proposal (4)

- Huawei, Intel, OPPO, ZTE
- These companies support Alt1d (hybrid option B-C, i.e. FL's proposal 12-v3 at RAN1#107e)

It is therefore difficult to conclude on adopting option C at RAN#94e.

Some of the companies re-iterated the technical concerns on both alternatives, without convincing each other. It was again pointed out that the hybrid option B-C (Alt1d) is not a complete solution, while it is not clear that all companies would agree with that statement. One company suggested a clarification to Alt1d (Note: for the slot with starting bit calculation based on option C, the calculation assumes that there is no UCI multiplexing operation in the previous slots for the TBoMS transmission).

The moderator believes that asking for adopting Alt1d without further details at RAN#94e would likely not be acceptable to some companies. One possibility is thus to try and progress on the understanding of what work RAN1 would still need to do to complete hybrid option B-C if it is not a complete solution already.

It also still seems the case as in the initial round comments that most companies don't want a conclusion of no support for TBoMS or to support TBoMS without UCI multiplexing. Therefore either RAN#94e adopts Alt 1b (option C), or RAN1 should be tasked to continue the discussion between option C and hybrid option B-C, hoping for a resolution by RAN#95e.

If no better progress can be made in the final round, the moderator may have to suggest taking the discussion on GTW after the final round. For the final round, the moderator plans to check whether RAN#94e can instead agree on a guidance to RAN1 with further work on both alternatives, and to check companies' understanding on the completeness of hybrid option B-C.

4 Final Round

Please provide your answers to the question below by the deadline of 11:30 UTC on Thursday December 16th.

4.1 Final round questions

Question 1: what details (if any) are missing for hybrid option B-C (i.e. FL's proposal 12-v3 from R1-2112688) to be a complete solution addressing concerns expressed so far?

Feedback Form 3: Response to question 1

1 – Ericsson LM

We have answered this question already in our contribution where we provided complete analysis of the situation. Hence, for the answer, companies can find the information in our contribution.

It is a bit difficult to understand the intention of this question at this round.

There was no concern made on Option C in previous round as Moderator correctly and clearly reflected in the status status which had the majority of support without concern.

Now, the situation is reversed because some companies forgot to mention concern?

Or, are we going to do technical analysis here to see which one is more complete?

2 – vivo Communication Technology

This question shouldn't be discussed here, all the arguements pros and cons have been laid bare in RAN1#107e and in above discussion. Not sure what is the motivation of this question.

3 – CATT

Techinically speaking, different UCI multiplexing behaviors based on the index of slots (other than the first slot) in the same scheduling is uncomfortable, and may cause unpredictable spec impact in corner case, e.g. CA case with different SCS of PUCCH and TBoMS.

Non-technically speaking, making RANP an extention of RAN1 is also uncomfortable.

4 – Guangdong OPPO Mobile Telecom.

The detailed technical discussion of the Option B and Option C was done in RAN1. We see the problem of option C remains.

Option B-C will mostly solve the performance problem of Option C and we don't see the additional issues. Option B-C was questioned by few companies that the exact rate-matching need to be clarified in the 1st slot. But this should be anyway done as the current CSI is rate-matched. We think the problem is solved. Due to this trivial issue the compromised proposal was blocked.

5 – ZTE Corporation

FL's proposal 12-v3 from R1-2112688 is a complete solution. It was not agreed in RAN1 because few companies proposed some additional optimization, i.e., Option B2 in FL's proposal 12-v4 for the starting coded bit for the second slot. However, Option B itself is clear and compete, and the current wording for Option B can be directly incorporated into specs without any equations.

Note that, companies could always propose some additional optimization for a complete solution (including Option C). From our perspective, arguing one solution is not complete because of possible optimization is not reasonable.

6 – Intel Deutschland GmbH

This was extensively discussed in the last RAN1 meeting. We think FL's proposal 12-v3 is already a complete solution.

7 – Qualcomm Incorporated

Surprised to see this round of the discussion. We already said that this proposal (Alt. 1d) was not acceptable to us, so the only thing we can do is repeat ourselves.

Regarding what is missing in the definition of Alt 1d, it is, among other things, whether the accommodation of the rate matched bits is based on semi-static information or based on dynamic information. This resulted in debating which one of the two candidate equations to adopt at the last meeting, with no hope of conclusion. Unclear what is assumed to have changed.

8 – HUAWEI TECHNOLOGIES Co. Ltd.

In our understanding, the current hybrid option B-C (i.e. FL's proposal 12-v3) is complete, i.e. option B is exactly as the definition agreed in RAN1.

According to the agreed definition of option B, the starting point of the second slot would depend on the UCI to be transmitted in the first slot, which got concern from Qualcomm because they think it would result in losing the whole sequence of transmissions for TBoMS if there is DL grant missing. However, as

we explained in the previous round it is not true, since starting from the third slot the starting bit will be determined assuming there is no UCI multiplexing operation in the previous slots, which means that there is no any impact on the transmissions starting from third slot even there is DCI missing, specifically when determining the starting index of coded bits for the third slot it will assume no UCI multiplexing operation in the first two slots. In addition, as explained by several companies, DCI missing is a corner case and it should not be used as the critical criteria to decide what option to take.

In addition, we want to express again that performance should be used as the critical criteria to decide which option to take. According to the evaluations, up to 1 dB performance loss with option C compared to option B or even not decodable. Note that 1 dB gain is significant for coverage, since actually most of the features developed under coverage can only provide gain in this order.

Question 2: is the proposal below acceptable?

Proposal 2:

- RAN1 is tasked to work on a complete solution for hybrid option B-C, striving to address the concerns expressed on FL's proposal 12-v3 from R1-2112688
- RAN1 is tasked to decide between the complete hybrid option B-C above and option C by RAN#95e
- If RAN1 cannot decide, RAN1 should strive to provide CRs for both option C and the complete hybrid option B-C, and RAN#95e will aim to decide which CR to adopt for Rel-17

Feedback Form 4: Response to question 2 on proposal 2

1 – Nokia Corporation

Unfortunately this proposal is **unacceptable**, and it is the only thing really worse than sending the issue back to RAN1 without any guidance. It doubles the amount of work for RAN1, under the false pretence of a divided group. The positions are very clear, 18x4 supporting option C (75%). We also addressed the concerns from the companies with concerns in the previous round, and those concerns have been debated already in previous RAN1 meetings. We don't think the moderator proposal is actually reflecting the status of the discussion so far, as many companies indicated they have strong concerns on tasking RAN1 with extra work for this topic.

2 – Ericsson LM

We prefer Moderator proposal from previous round and have concern with this proposal.

For the proposal in general, specially 1st bullet, please see our comment to previous question as well for the 1st bullet.

For second bullet, we question the benefit of RAN plenary intervention. The whole exercise was to avoid the deadlock in RAN1 and focus on the design and not debating which option to go. If that is still remains, then nothing has changed for RAN1.

For 3rd bullet, it increases RAN1 work even more being tasked to prepare two CRs and basically work on two parallel designs. We fail to understand the motivation.

I hope that clarifies why the proposals in final rounds seem to be counterproductive and deviating with the spirit of any valuable guideline from plenary as opposed to the Moderator's proposal in previous round.

3 – InterDigital France R&D

For progress, we are ok with the moderator's proposal in the final/intermediate round.

4 – Motorola Mobility Germany GmbH

Lenovo, Motorola Mobility : We also share similar concern as Nokia and it seems like just delaying the decision and repeating the discussion in RAN1. Therefore, we also strongly support making a conclusive decision in this meeting and taking option option C.

5 – vivo Communication Technology

It is clear from initial and intermediate discussion, companies understand the technical details, pros and cons. This proposal is asking even more work in RAN1. With Option C the system is not broken and majority of companies support. If it is to be discussed in GTW then the proposal in intermediate round should be presented for discussion.

6 – CATT

Observing the exhausive debate in RAN1 and RANP(unfortunately), we believe Option C is the most direct way to save TBoMS and the most efficient way to release RAN1's burden. RAN1 should be tasked to continue the work based on Option C.

The hybrid Option B-C is NOT preferred.

7 – Guangdong OPPO Mobile Telecom.

We think the first sub-bullet of Proposal 2 would be good enough. Other bullets is not needed. Otherwise, Option B should be also equally worked on. We already state that one have the best performance.

On the other hand, it seems we have very detailed technical decision in RAN. The comments from other companies seems are very curious about what technical decision to make. Thus, we are also OK to have general guidance that a decision have to be made in the Jan. WG meeting.

8 – Samsung Research America

To have real progress in this RAN discussion we should agree to a solution. Option C seemed to be widely supported in the previous round but no consensus. If instead we would agree to task RAN1 to decide between Option C and Option hybrid B-C, further discussion would be needed in RAN1 – it seems no progress from last RAN1 meeting. We can try to converge to Option C, otherwise we suggest to agree to the following:

Proposal 1: RAN1 is tasked to complete the remaining normative work for Rel-17 CovEnh by Q1 of 2022
• All RAN1 decisions that impact other WGs should be finalized in RAN1#107bis-e

9 – NTT DOCOMO INC.

As many companies suggested, we prefer to decide going with Option C. Option B (including hybrid OptionB-C) provides better performance at the exchange of complexity only when the number of allocated slots is small and code rate is high, which is not typical scenario for cell-edge UE at all. Also, the following restriction has already been agreed for TBoMS.
"The index of the starting coded bit for each transmitted slot is predetermined prior to the start of the TBoMS transmission."
For sp-PUCCH carrying Type I CSI with sub-band frequency granularities, the payload size for CSI part2

depends on RI in CSI part1. It implies supporting Option B (including hybrid OptionB-C) is against the above agreement, as it assumes that UCI payload is known beforehand.
Since RAN1 has discussed intensively these two options, we prefer supporting Option C and not procrastinating the decision .

10 – ZTE Corporation

We are fine with the first bullet of Proposal 2. As other companies commented, RAN1 workload would not be relieved with the presence of the last two sub-bullets.

With the discussion ongoing, we are involving in more and more technical details in RAN-P. However, such technical debates could be more appropriate to be carried out in RAN1. So, we suggest to go with the proposal discussed in Monday's GTW session, i..e, RAN tasks RAN1 to make decision in January 2022 meeting.

11 – Intel Deutschland GmbH

As mentioned above, we do not think RAN1 needs to continue to work on hybrid option B-C as this is already a complete solution. Our view is that this is the only outstanding issue for NR coverage enhancement WI according to status report with 98% completion rate. Given that technical discussions should be more appropriate to be conducted in RAN WG level, instead of RAN-P level, we are fine with the 2nd bullet to continue the discussion in RAN1.

We suggest to update the proposal as follows:

- ~~RAN1 is tasked to work on a complete solution for hybrid option B-C, striving to address the concerns expressed on FL's proposal 12-v3 from R1-2112688~~
- RAN1 is tasked to decide between the complete hybrid option B-C above and option C by RAN#95e
- If RAN1 cannot decide, RAN1 should strive to provide CRs for both option C and the complete hybrid option B-C, and RAN#95e will aim to decide which CR to adopt for Rel-17

12 – SHARP Corporation

Technical discussion for each alternative has been done already in RAN1. Given the situation in the intermediate round that the majority supports Option C, Option C should be supported.

13 – Apple Computer Trading Co. Ltd

In initial round and intermediate round discussion, Option C got supports from majority companies, and no companies object this option. It make sense Option C is supported. With the final round proposal 2, it only increase the RAN1 work load and doesn't provide any help to RAN1 discussion, it gives the impression this issue anyway is to be solved in RAN#95-e meeting.

14 – China Mobile Com. Corporation

Thanks for FL's proposal.

For the 1st bullet, we have no problem that RAN1 should finish the detailed job in the next meeting.

For the 2nd bullet, I do not think it is a good approach to return the same two options to RAN1 without additional guidance from plenary, since RAN1 was stuck among them in the last meeting. Plenary's guidance are appreciated to smooth the discussion and relieve the load of RAN1.

For the 3rd bullet, we appreciate Moderator's intention to setup a backup plan for the candidate solutions. But I am a little hesitated to support doubling the CR work just due to no agreements have been reached.

15 – Qualcomm Incorporated

Again, sorry for repeating ourselves, but we cannot accept this proposal. There was a majority support of Option C with no objections, we have no clear understanding of why we have this round of discussion.

There are a number of disagreeable points regarding the current proposal, first among them is that it doesn't even try to reduce the RAN1 work.

Based on comments by Huawei, it appears that there is more misunderstanding/disagreement on how Option B-C would be applied. According to the agreed definition of Options B and C, a misalignment in the first slot would result in misalignment in all subsequent slots, so there seems to a misunderstanding there.

Repeating the definitions:

- 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.

Please note that the definition says "previous allocated slot" as opposed saying "previous allocated slots", therefore while the starting position of the 3rd slot doesn't depend on whether there is UCI in the 2nd slot, it does depend on the starting bit position in the 2nd slot, which in turn depends on whether there was UCI in the first slot. Therefore a misalignment in the first slot does make all subsequent slots misaligned.

Regarding the arguments about performance loss, they could all be avoided by applying a semi-static 'rewind' offset. That would avoid all systematic bit loss and also avoid the possibility of rate matching misalignment. Compared to this, Option B or Option B-C are clearly worse and more complex to implement, so we see no benefit in adopting either.

Based on the previous rounds of discussions, it appears that Option C should be adopted.

16 – China Telecommunications

We don't think tasking RAN1 to provide CRs for both options is a good guidance, which may even double RAN1 workload as commented by many other companies. Considering the current situation, we suggest to make decision which option is supported in this RAN plenary or RAN plenary concludes that at least up to 2 bit UCI multiplexing is supported for TBoMS.

17 – VODAFONE Group Plc

We have concerns regarding doubling the work at RAN1 with this proposal by focusing on both the hybrid solution and option C. With this said, we prefer moderator's previous intermediate proposal

18 – HUAWEI TECHNOLOGIES Co. Ltd.

A few points to clarify the comments from other companies:

1. As we explained to the first question, starting from the third slot the starting bit will be determined assuming there is no UCI multiplexing operation in the previous slots, which means that there is no any impact on the transmissions starting from third slot even there is DCI missing, specifically when determining the starting index of coded bits for the third slot it will assume no UCI multiplexing operation in the first two slots as well, and thus the starting coded bit for the third slot is determined according to the starting index of coded bits in the second slot, which is determined assuming no UCI multiplexing in the first slot. Therefore, we don't think the misalignment in the first slot would result in misalignment in all the subsequent slots as what Qualcomm said.

2. For the 'rewind' offset mentioned Qualcomm, it doesn't belong to the current option C in our understanding, it would be some further optimized solution on top of option C, which would need more discussion in RAN1.

3. For TDD, the number of small allocated slots is typical (e.g. N=2) since under many DL/UL TDD configuration the available uplink slots is limited, in which case the performance loss will be big since many of the systematic bit will be dropped.

4.2 Final round summary

The moderator's intent with this round of discussion was to seek for clarification on points were there was no common understanding in previous rounds, namely on the completeness of the hybrid option B-C (Alt 1d), and since there was no consensus in intermediate round on adopting option C, the intent was also to see whether continuing the technical discussion in RAN1 could be a possible alternative while limiting RAN1 time debating between the two solutions but rather focusing on working on the technical completeness of the solutions. Apparently, this intent was not well understood by companies and responses provided to the final round did not help in reaching a common understanding on the completeness of Alt 1d.

Not many responses were provided to the questions asked in final round, and the answers indicate again a lack of common understanding on the completeness of hybrid option B-C.

On the question asking for clarifications on the completeness of hybrid option B-C (i.e. FL's proposal 12-v3 from R1-2112688). Several companies answered that all technical arguments have already been provided in RAN1 or in Tdocs to RAN#94e or in previous responses or that RAN plenary should not have this technical discussion, and thus did not provide a clear answer to the question. Several companies answered that hybrid option B-C (i.e. FL's proposal 12-v3 from R1-2112688) is already a complete solution and only some further optimizations discussed in RAN1 are incomplete. One company re-iterated that Alt1d is not a complete solution (missing among other things whether the accommodation of the rate matched bits is based on semi-static information or based on dynamic information), and another company stated that option B goes against a RAN1 agreement.

On the question to task RAN1 to work on both option C and on a complete solution for hybrid option B-C, the proposal was not acceptable to 14 companies, and only partially acceptable to 4 companies. The main concerns on proposal 2 where that a majority support option C, that tasking RAN1 to work on two options is increasing workload, and that the proposal does not provide sufficient guidance for RAN1 (e.g. no deadline).

Samsung suggested that if RAN cannot agree on option C, then the following proposal be considered instead:

- RAN1 is tasked to complete the remaining normative work for Rel-17 CovEnh by Q1 of 2022
    - All RAN1 decisions that impact other WGs should be finalized in RAN1#107bis-e

5 Conclusion

If RAN plenary is not able to decide on a solution, it seems the only guidance that may be provided by RAN plenary for TBoMS is a deadline (RAN1#107b-e meeting) for decisions that impact other WGs, although several companies have expressed concerns with sending this back to RAN1.

The strongest guidance that RAN plenary could provide is to decide between option C and hybrid option B-C (FL's proposal 12-v3 from R1-2112688).

While the different rounds of discussion have shown that there are concerns for each option, there is stronger support for option C (18 support, 4 not).

The final summary of the discussion has been provided in RP-213615.

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