**3GPP TSG RAN WG1#116bis R1-24xxxxx**

**Changsha, China, April 15th – 29th, 2024**

Source: Moderator (Nokia)

Title: [116bis-Pre-R18-NR] Summary of UCI multiplexing on PUSCH when simultaneousHARQ-ACK-CSI is not provided

Agenda Item: 7

Release: Release 15

WI code: NR\_newRAT-Core

Document for: Discussion and Decision

# Introduction

RAN1#116 discussed a clarification text proposal [R1-2400950] for the specification to clearly state that UCI should not be multiplexed on Msg3 PUSCH. The discussion summary is recorded in [R1-2401691].

RAN1#116 made the following agreement:

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| **Agreement**  TP in R1-2400950 is agreed for Release 18 in principle. Final CR to be submitted after additional relevant issues are discussed in future meetings. |

6 contributions were submitted to RAN1#116bis, the table below summarizes the proposals made in the submitted documents:

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| **Ref** | **Proposals** |
| Samsung [1,2] | **Proposal 1: RAN1 should consider the following additional impacts for Msg3 PUSCH overlapping issue.**   * **Overlapping between PUSCH (with or without repetiton) and Msg3 PUSCH (with or without repetiton) in the same serving cell** * **Overlapping between PUCCH (with or without repetiton) and Msg3 PUSCH (with or without repetiton)**   **Proposal 2: Support the following two text proposals for TS 38.213 in Rel-18.** [truncated]  - PRACH transmission on a candidate cell, if any, as described in Clause 21  - PRACH transmission or Msg3 PUSCH transmission on the PCell  - PUCCH or PUSCH transmissions other than Msg3 PUSCH transmission with larger priority index  - For PUCCH or PUSCH transmissions other than Msg3 PUSCH transmission with same priority index  …  A UE excludes an Msg3 PUSCH transmission for resolving an overlapping for PUCCH and PUSCH transmissions, including repetitions, unless otherwise stated. If a Msg3 PUSCH transmission overlaps in time with a second PUSCH transmission, including repetitions, on a same serving cell, or with a PUCCH transmission, after resolving the overlapping for PUCCH and PUSCH transmissions, the UE does not transmit the PUCCH or the second PUSCH, respectively. |
| Apple [3] | ***Proposal 1: MSG3 PUSCH scheduled by RAR UL grant is not considered as a candidate PUSCH for UCI multiplexing.***  ***Proposal 2: MSG3 PUSCH scheduled by a DCI with CRC scrambled by TC-RNTI is not considered as a candidate PUSCH for UCI multiplexing.***  ***Proposal 3: It is an error case that a MSG3 corresponding to CBRA is the only PUSCH overlapping with a PUCCH.***  ***Proposal 4: Adopt the following TP.***  UE does not expect the case where, ~~If~~ a Msg3 PUSCH scheduled by a RAR UL grant or a DCI with TC-RNTI overlaps with a PUCCH and the UCI is not multiplexed on any other PUSCH~~, the UCI is dropped and the UE does not transmit the PUCCH.~~The UE determines the PUSCH for UCI multiplexing by applying the following procedure on the candidate PUSCHs as described in this clause: |
| Qualcomm [4] | **Proposal 1:** No new timeline relaxations are necessary if a UE is required to drop a PUCCH that overlaps with a Msg3 transmission.  **Proposal 2**: Clarify that the new clause on UCI multiplexing on Msg3 does not apply to simultaneous transmission of PUSCH and PUCCH on two different carriers, i.e., PUCCH to be simultaneously transmitted on a different carrier need not be canceled if it overlaps with Msg3 PUSCH on a different carrier.  **Proposal 3:** Introduce a new R18 UE capability to indicate new UE behavior on UCI multiplexing in Msg3. |
| Nokia, Ericsson [5] | The proponents suggest adopting the changes as they were proposed in RAN1#116 [R1-2400950] in the updated Rel-18 CR in [6]. |
| Nokia, Nokia Shanghai Bell, CATT, Ericsson [6] | When a UE transmits multiple PUSCHs on respective serving cells in a slot with reference to slots for PUCCH transmissions and the multiple PUSCHs overlap with a PUCCH carrying UCI in the slot, the UE selects all the PUSCHs other than Msg3 PUSCH that overlap with the PUCCH as the candidate PUSCHs for UCI multiplexing within the slot.  If a UE would transmit a single PUSCH scheduled by a DCI format that includes a DAI field on a serving cell in a slot with reference to slots for PUCCH transmissions without any other PUSCH that would be transmitted on any serving cell in the slot and the UE does not determine any PUCCH carrying HARQ-ACK information in the slot, or if the UE indicates the corresponding capability *mux-HARQ-ACK-withoutPUCCH-onPUSCH* and the UE transmits multiple PUSCHs on respective serving cells in a slot with reference to slots for PUCCH transmissions and the UE does not determine any PUCCH carrying HARQ-ACK information in the slot and at least one of the multiple PUSCHs is scheduled by a DCI format that includes a DAI field, the UE selects the single PUSCH or all the multiple PUSCHs in the slot as the candidate PUSCHs for HARQ-ACK multiplexing within the slot except for any PUSCH among the multiple PUSCHs that is scheduled by a DCI format that includes a DAI field that is equal to 4 in case the UE is configured with *pdsch-HARQ-ACK-Codebook = dynamic* or with *pdsch-HARQ-ACK-Codebook-r16*, or is equal to 0 in case the UE is configured with *pdsch-HARQ-ACK-Codebook = semi-static*. A Msg3 PUSCH is not considered as a candidate PUSCH for HARQ-ACK multiplexing.  If a Msg3 PUSCH overlaps with a PUCCH and the UCI is not multiplexed on any other PUSCH, the UCI is dropped and the UE does not transmit the PUCCH. |

# References

1. R1-2402420 Discussion on remaining issues related to Msg3 PUSCH Samsung
2. R1-2402421 Draft CR for overlapping between msg3 PUSCH and other UL channels Samsung
3. R1-2402863 Views on multiplexing UCI on MSG3 PUSCH Apple
4. R1-2403168 Discussion On UCI multiplexing in Msg3 Qualcomm Incorporated
5. R1-2403316 On not multiplexing UCI on MSG3 PUSCH Nokia, Ericsson
6. R1-2403317 Clarification on not multiplexing UCI on MSG3 PUSCH Nokia, Nokia Shanghai Bell, CATT, Ericsson

# Discussion

Several directions have been suggested:

* Extend the base proposal of RAN1#116 to cover PUCCH and PUSCH repetitions
* Make the CBRA Msg3PUSCH overlap with PUCCH an error case by specification
* Introduce a new R18 UE capability indicating the UCI non-multiplexing to Msg3 PUSCH
* Agree the draft CR as it was submitted to RAN1#16

Please provide your comment on proposals raised on the UCI multiplexing on MSG3 PUSCH to the table below

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| Company | Comments |
| MTK | We support the proposals in x2863 from Apple (including “CBRA Msg3PUSCH overlap with PUCCH an error case”). We also support the proposal from x2420 about repetition (Samsung) and proposal in x3317 [6].  For the R18 UE capability part, we are open to discuss but also want to check what’s the default UE behavior if the new UE capability is not reported. |
| Nokia | As the proponent of 3316/3317 we’d obviously be OK with the draft CR in 3317. That said, the direction suggested by Samsung in 2420/2421 could be more complete and would take care of the issue we are most concerned of. We’d be willing to work on that approach as well.  Wrt. The Apple proposal of specifying that Msg3 PUSCH and PUCCH is an error case without in any way describing the UE behaviour that does not lead to everything failing is too loose. The specification should provide the reader with the understanding that what functionality works, while it is perfectly OK to us not to try and impose the behaviour on a specific timeline conditions under which the working behaviour must be enforced.  Wrt. a new UE capability, this would seem counter-productive when the common understanding should be that the non-multiplexing of UCI on Msg3 PUSCH is the only sensible implementation that all UEs should aim to do whenever they can. |
| QC | We are okay to consider both initial tx and retx for Msg3. From a timeline perspective, we prefer to retain the UCI multiplexing timeline even though this is technically a PUCCH cancelation.  Using Nokia CR as a starting point, we suggest the following edits to address some of the issues raised by Apple, and to also address the case where UEs are capable of transmitting PUSCH and PUCCH simultaneously, can we consider the following:  If a Msg3 PUSCH overlaps with a PUCCH and the UCI is not multiplexed on any other PUSCH, and higher layer parameter simultaneousPUCCH-PUSCH-SamePriority is not configured, and the timing conditions for overlapping PUCCHs and PUSCHs in clause 9.2.5 are fulfilled, the UCI is dropped and the UE does not transmit the PUCCH.  ----  We would like to further ask if we can live WITHOUT the following change:  “When a UE transmits multiple PUSCHs on respective serving cells in a slot with reference to slots for PUCCH transmissions and the multiple PUSCHs overlap with a PUCCH carrying UCI in the slot, the UE selects all the PUSCHs other than Msg3 PUSCH that overlap with the PUCCH as the candidate PUSCHs for UCI multiplexing within the slot.”  The above establishes a new UCI multiplexing behavior and it doesn’t seem critical to the issue at hand. A simple dropping rule irrespective of the number of PUSCHs involved seems the most straightforward approach. |
| Samsung | We support x2420/2421. For x2863, putting error case is quite restrictive in gNB implementation perspective because the main motivation of the proposal is that gNB doesn’t know which UE is transmitting Msg3 PUSCH. In addition, it has to be clarified that Msg 3 PUSCH should be excluded for the intra-UE multiplexing/prioritization even with Apple’s proposal. Therefore, Apple’s proposal is not a complete solution. Our proposal can resolve this issue as well as other general cases including PUSCH/PUCCH repetitions. We are fine to consider introducing UE capability.  For x2420/2421, it is noted that proposed texts includes initial transmission and retransmission for Msg3 PUSCH as well. Thus, we think that it is more complete wording to avoid potential ambiguities in future. |
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