**3GPP TSG RAN WG1 #117 R1-2405559**

**Fukuoka City, Fukuoka, Japan, May 20th – 24th, 2024**

**Agenda item:** 7

**Source:** Moderator (Samsung)

**Title:** Summary of discussion on intra-UE multiplexing and prioritization

**Document for:** Discussion and Decision

# Introduction

This contribution aims to collect and summarize company views on the remaining issue of intra-UE multiplexing and prioritization as discussed in [1] ~ [3]. The following two issues were also discussed in RAN1#116bis without consensus.

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| Whether MAC generates a MAC PDU for a CG PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority?  If MAC does not generate a MAC PDU for a CG PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority, whether the CG PUSCH is included in the “candidate PUSCHs” for UCI multiplexing? |

Please consider entering the contact information below for better coordination for this discussion.

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# Background

Regarding whether MAC generates a MAC PDU for a CG PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority, or whether a UE transmits a CU PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority, it seems the current spec is not clear. A follow up question is if MAC does not generate a MAC PDU for a CG PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority, whether the CG PUSCH is included in the “candidate PUSCHs” for UCI multiplexing? Companies are encouraged to provide views on these issues and potential spec impact.

# Discussion

## 1st round discussion

**Q1: Do you think the spec is clear on “Whether MAC generates a MAC PDU for a CG PUSCH overlapping with a PUSCH with SP-CSI reports without UL-SCH on a same serving cell?” or “whether a UE transmits a CG PUSCH overlapping with a PUSCH with SP-CSI reports on a same serving cell for a same priority” ? If YES, please clarify the details.**

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| **Company** | **View** |
| MTK | We are open to clarify this issue if companies think current spec is not clear.  For “PUSCH with semi-persistent CSI report overlapping with CG PUSCH”, 38.214 captures this prioritization requirement stating that the PUSCH with semi-persistent CSI report would be cancelled depending on whether a TB has been generated for the CG PUSCH.    In our view when UE does the DG vs CG PUSCH prioritization step, it would also perform CG PUSCH vs PUSCH semi-persistent CSI and would select PUSCH semi-persistent CSI regardless of whether there is data in the LCH queues. In other words, CG PUSCH is excluded from candidate PUSCH for UCI multiplexing if it overlaps with PUSCH with SP-CSI.  Note that the case of PUSCH with A-CSI is already handled as part of the DG vs CG PUSCH prioritization step.  For the proposal from the proponent, it seems generally fine to us, but it needs to delete the line regarding DG PUSCH:    But actually, it is more clear if we just say that the resolution of PUSCH overlap within the same CC whether this is DG vs CG, or as above PUSCH SP-CSI vs CG  PUSCH is done before selecting the PUSCH candidates. Please note that the above line cross out in red is important because DG is no always higher priority than CG for example in case of Release 17 URLLC FGI25-14 (priLowDG-HighCG). |
|  | Do NOT support. Spec is already clear that within a serving cell, when SP-CSI on PSUCH overlaps with a PUSCH with UL-SCH, SP-CSI PUSCH is dropped. And that PUSCH with UL-SCH can be CG-PUSCH or DG-PUSCH. Now regardless CG is associated with TB or not, it does not matter to the NW. NW shall assume SP-CSI PUSCH is dropped since NW does not know if overlapping CG is with or without UL-SCH. We can take a conclusion that SP-CSI is dropped when overlapping with a CG PUSCH. |
| Huawei, HiSilicon | Follow the logic of RAN2 spec, MAC layer will generate MAC PDU based on lower layer intended transmission. For example, if a PUSCH is notified to MAC, MAC layer will generate MAC PDU accordingly. Thus, rather than discuss whether MAC will generate a MAC PDU for CG PUSCH overlaps with SP CSI, it is better to clarify the collision handling principle in RAN1 if CG PUSCH and SP CSI is overlapping.  Based on the spec below, it describes the behavior that a PUSCH with UL-SCH overlapping with SP-CSI. However, it is not quite clear whether this PUSCH including UL-SCH can cover CG-PUSCH or not. Following the explanation from DCM, it seems Yes. We are open to clarify it and also tend to share the similar view slightly that CG PUSCH case is covered by the following spec.   |  | | --- | | If a UE would transmit a first PUSCH that includes semi-persistent CSI reports and a second PUSCH that includes an UL-SCH on the same carrier, 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. |   Therefore, RAN1 should focus on the principle in PHY, rather than discussing MAC PDU generation procedure. |
| ZTE | With the specification copied by MTK, we think it is clear that the CG PUSCH should be transmitted. |
| Moderator | I agree that the spec is clear in case there is a TB for the CG PUSCH. What I think is unclear is whether the MAC generates MAC PDU for this case.  In my understanding, the text copied by MTK does not mean the CG PUSCH always includes a TB, it only clarifies if the CG PUSCH includes a TB, SP-CSI is dropped.   |  | | --- | | If a UE would transmit a first PUSCH that includes semi-persistent CSI reports and a second PUSCH that includes an UL-SCH on the same carrier, 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. |   Companies are encouraged to further check where in the spec clarifies that MAC always generates a MAC PDU for this case. |
| Nokia | Logic should be clear here. The gNB cannot know if the CG-PUSCH is going to include a TB or not, and the UE behaviour should be the same regardless. The “that includes UL-SCH” is supposed to rule out L1-generated PUSCH transmission (A-CSI report), but not rule out L2-generated PUSCH transmission.  We are open to discuss a clarification even though our initial thinking was that the UE behaviour is clear and should be obvious what the UE should do. |
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**Q2: What is your view on the intended UE behaviour for the questions in Q1?**

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| **Company** | **View** |
| MTK | See our reply in Q1. |
| Apple | UE will drop SP-CSI on PUSCH, given that NW shall not expect SP-CSI anyway. Whether UE transmits or drops a CG without UL-SCH is up to UE implementation. |
| DCM | Same view with Apple |
| Huawei, HiSilicon | Open to discuss, Apple’s suggestion is a way for moving forward. |
| ZTE | The CG PUSCH is transmitted and SP CSI PUSCH is dropped. |
| Nokia | As said to Q1, the “…that includes UL SCH…” is supposed to rule out L1-triggered PUSCH transmission, e.g. A-CSI report on PUSCH without upper layer generated data. It is not supposed to rule out L2-triggered PUSCH transmission. |
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**Q3: Do you think the spec is clear on “whether a CG PUSCH is included in the “candidate PUSCHs” when the CG PUSCH overlaps with a PUSCH with SP-CSI reports without UL-SCH on a same serving cell” If YES, please clarify the details.**

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| **Company** | **View** |
| MTK | See our reply in Q1. |
| Apple | Yes, see comments above. |
| DCM | Yes |
| Huawei, HiSilicon | UE will clear PUSCH overlapping in advance, in that perspective, it is clear in the spec. |
| ZTE | The CG PUSCH is included in the ‘candidate PUSCH’ when it overlaps with a SP-CSI PUSCH in the time domain. It is in line with the current specification. |
| Nokia | Think the spec is clear, the UL SCH is whatever the L2 pushed down the processing chain. |
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**Q4: What is your view on “whether a CG PUSCH is included in the “candidate PUSCHs” when the CG PUSCH overlaps with a PUSCH with SP-CSI reports without UL-SCH on a same serving cell”?**

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| **Company** | **View** |
| MTK | See our reply in Q1. |
| Apple | See comments above. |
| Huawei, HiSilicon | See comments above. |
| ZTE | See comments above. |
| Nokia | See comments above |
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## 2nd round discussion

The following was proposed during the online discussion.

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| Possible Conclusion (Comeback on Thursday)  It is up to UE implementation to generate a MAC PDU for CG PUSCH overlapping with a PUSCH with SP-CSI on the same serving cell. The CG PUSCH does not overlap with the PUCCH with HARQ ACK. |

Some companies prefer to follow the current specification to generate a MAC PDU and always drop SP-CSI. The following is proposed.

**Proposed conclusion #1**

**A UE generates a MAC PDU for a CG PUSCH transmission occasion follows the current specifications when the CG PUSCH transmission occasion overlaps with a PUSCH with SP-CSI reports with a same priority on a same serving cell.**

Another issue I would like to check is about the understanding of the following highlighted yellow text.

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| If a UE would transmit a first PUSCH that includes semi-persistent CSI reports and a second PUSCH that includes an UL-SCH on the same carrier, 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. |

In my understanding, the text is only for CG PUSCH with a TB (implied by “includes an UL-SCH”), if MAC does not generate a MAC PDU for a CG PUSCH transmission occasion, there is no such restriction and the PUSCH with SP-CSI reports can be transmitted. Please check the following conclusion 2.

**Proposed conclusion #2**

**The transmission of a PUSCH with SP-CSI reports is not impacted by an overlapping CG PUSCH transmission occasion with a same priority on a same serving cell if MAC does not generate a MAC PDU for the CG PUSCH transmission occasion.**

HW made some offline comments and suggested that Conclusion #2 should be a sub-bullet of Conclusion #1.

**Proposed conclusion #1a**

**A UE generates a MAC PDU for a CG PUSCH transmission occasion follows the current specifications when the CG PUSCH transmission occasion overlaps with a PUSCH with SP-CSI reports with a same priority on a same serving cell.**

* **The transmission of a PUSCH with SP-CSI reports is not ~~impacted~~ canceled by an overlapping CG PUSCH transmission occasion with a same priority on a same serving cell if MAC does not generate a MAC PDU for the CG PUSCH transmission occasion.**

The following update is based on Nokia’s comment to avoid interpreting that UE always generates a MAC PDU in this case.

**Proposed conclusion #1b**

**Whether a ~~A~~ UE generates a MAC PDU for a CG PUSCH transmission occasion follows the current specifications when the CG PUSCH transmission occasion overlaps with a PUSCH with SP-CSI reports with a same priority on a same serving cell.**

* **The transmission of a PUSCH with SP-CSI reports is not ~~impacted~~ canceled by an overlapping CG PUSCH transmission occasion with a same priority on a same serving cell if MAC does not generate a MAC PDU for the CG PUSCH transmission occasion.**

**Q5: What is your view on the above proposals/conclusions**

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A note is proposed by QC for clarification which seems to be valid.

**Proposed conclusion #1c**

**Whether a ~~A~~ UE generates a MAC PDU for a CG PUSCH transmission occasion follows the current specifications when the CG PUSCH transmission occasion overlaps with a PUSCH with SP-CSI reports with a same priority on a same serving cell.**

* **The transmission of a PUSCH with SP-CSI reports is not ~~impacted~~ canceled by an overlapping CG PUSCH transmission occasion with a same priority on a same serving cell if MAC does not generate a MAC PDU for the CG PUSCH transmission occasion.**

**Note: the above conclusion is aligned with current RAN1 and RAN2 specifications. The conclusion has no specification impact.**

# Conclusion

The following is proposed based on the discussion.

**Proposed conclusion**

**Whether a ~~A~~ UE generates a MAC PDU for a CG PUSCH transmission occasion follows the current specifications when the CG PUSCH transmission occasion overlaps with a PUSCH with SP-CSI reports with a same priority on a same serving cell.**

* **The transmission of a PUSCH with SP-CSI reports is not ~~impacted~~ canceled by an overlapping CG PUSCH transmission occasion with a same priority on a same serving cell if MAC does not generate a MAC PDU for the CG PUSCH transmission occasion.**

**Note: the above conclusion is aligned with current RAN1 and RAN2 specifications. The conclusion has no specification impact.**

# Reference

1. R1-2404065 Discussion on intra-UE multiplexing and prioritization Samsung
2. R1-2404066 Correction on UCI multiplexing in a PUSCH transmission Samsung
3. R1-2404227 Discussion on the multiplexing prioritization for a PUSCH without a TB ZTE