**3GPP TSG RAN WG1 Meeting #110 R1-220xxxx**

**Toulouse, France, August 22-26, 2022**

**Agenda Item: 7.2.5**

**Source: Moderator (Huawei, HiSilicon)**

**Title: Summary of Intra-UE prioritization related to SP-CSI**

**Document for: Discussion and Decision**

# Introduction

This summary is dedicated to discuss the remaining issues on UL prioritization cases related to SP-CSI. For this meeting, this issue has been raised in [1], [2], [3], and it was also discussed during RAN1#109-e for which it is summarized in [4].

**Intra-UE prioritization related to SP-CSI (to be moderated by Thorsten- Huawei)**

**Background**

In Rel-16, for handling collision between a high priority UL channel and a low priority UL channel, the low priority UL channel will be canceled. According to the current specification some cases related to SP-CSI are missing and consequently, the UE behavior for these cases is not clear and may cause misunderstanding between gNB and UE. How to handle these remaining cases has been discussed during the last meeting and companies could achieve a good understanding about each other’s views.

The goal for the discussion in this meeting is to decide the UE behavior for the 5 remaining cases and to agree on a corresponding text proposal.

# Discussion

## Input papers to the meeting

**Initial moderator remark:**

The remaining cases 1-5 for overlapping related to SP-CSI have been discussed during last meeting.

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|  | HP PUCCH with DCI | HP PUCCH with SPS AN without DCI | HP PUCCH with SR | HP PUSCH with DCI | HP CG PUSCH | HP PUSCH with SP-CSI without DCI |
| LP PUCCH with DCI | HP | Error case | HP | HP | HP | Error case |
| LP PUCCH with SPS AN without DCI | HP | HP | HP | HP | HP | HP |
| LP PUCCH with SR | HP | HP | HP | HP | HP | HP |
| LP PUCCH with CSI | HP | HP | HP | HP | HP | HP |
| LP PUSCH with DCI | HP | Error case | HP | Error case | DG | Case 2 |
| LP CG PUSCH | HP | HP | HP | DG | HP | Case 3 |
| LP PUSCH with SP-CSI without DCI | HP | HP | HP | Case 1 | Case 5 | Case 4 |

For this meeting, 2 Companies, Huawei/HiSilicon and Nokia/Nokia Shanghai Bell raise this topic in their papers and both provide a TP.

Huawei, HiSilicon discusses this issue in R1-2205781 [1] and R1-2207533 [3]. Where in the first paper the different cases are analysed and proposals are given, and in the latter paper the corresponding TP is provided. The proposals are based on the majority views that have been obtained during last meeting and are copied into the Appendix of this summary.

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| From R1-2205781 [1] (HW/HiSi)  ***Case 1: HP PUSCH with DCI and LP PUSCH with SP-CSI without DCI***  In Rel-15, PUSCH with data cancels the entire PUSCH with SP-CSI if they overlap. For case 1, HP DG PUSCH can override LP PUSCH with SP-CSI if the timeline requirement satisfied. The timeline is the same as in Rel-15, which means the LP PUSCH is cancelled entirely and no partial cancellation is applied.  ***Proposal 1: For Case 1, i.e. an overlap between HP PUSCH with DCI and LP PUSCH with SP-CSI without DCI***   * ***The entire LP channel is cancelled. The time-line requirement is the same as in Rel-15 for DG PUSCH overriding LP PUSCH with SP-CSI.***   ***Case 2: HP PUSCH with SP-CSI without DCI and LP PUSCH with D*C*I***  Case 2 should be treated as error case, since the gNB would not schedule a LP PUSCH which anyway cannot be transmitted because of the overlapping HP PUSCH.  ***Proposal 2: For Case 2, i.e. an overlap between HP PUSCH with SP-CSI without DCI and LP PUSCH with DCI***   * ***UE treats it as error case.***   For Cases 3~5, both HP and LP channels are semi-statically configured by the gNB. All these configured UL channels are periodical. According to the discussion during the RAN1#109-e meeting, some companies are concerned that it would be too restrictive to avoid the overlapping by gNB’s configuration. Therefore, these cases can instead follow CG-CG handling, which would imply that the HP channel cancels the LP channel. Similar to R15, the cancellation should start from the first symbol of the LP channel, which means no partial cancellation will be performed for the PUSCH-PUSCH collision case.  ***Proposal 3: For the*** ***overlap between LP PUSCH and HP PUSCH of the following cases,***   * ***Case 3: HP PUSCH with SP-CSI without DCI and LP CG PUSCH*** * ***Case 4: HP PUSCH with SP-CSI without DCI and LP PUSCH with SP-CSI without DCI*** * ***Case 5: LP PUSCH with SP-CSI without DCI and HP CG PUSCH*** * ***UE follows CG-CG handling, that is HP channel cancels the entire LP channel.*** |

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| From R1-2207533 [3] (HW/HiSi)  **TP for 38.213, section 9:**  < Unchanged parts are omitted >  If a UE would transmit the following channels, including repetitions if any, that would overlap in time  - a first PUCCH of larger priority index with SR and a second PUCCH or PUSCH of smaller priority index, or  - a configured grant PUSCH of larger priority index and a PUCCH of smaller priority index, or  - a first PUCCH of larger priority index with HARQ-ACK information only in response to PDSCH(s) reception without corresponding PDCCH(s) and a second PUCCH of smaller priority index with HARQ-ACK information only in response to PDSCH(s) reception without corresponding PDCCH(s), or a second PUCCH of smaller priority index with SR and/or CSI, or a configured grant PUSCH with smaller priority index, or a PUSCH of smaller priority index with SP-CSI report(s) without a corresponding PDCCH, or  - a PUSCH of larger priority index with SP-CSI reports(s) without a corresponding PDCCH and a PUCCH of smaller priority index with SR, or CSI, or HARQ-ACK information only in response to PDSCH(s) reception without corresponding PDCCH(s), or  - a configured grant PUSCH of larger priority index and a configured PUSCH of smaller priority index on a same serving cell  the UE is expected to cancel a repetition of the PUCCH/PUSCH transmissions of smaller priority index before the first symbol overlapping with the PUCCH/PUSCH transmission of larger priority index if the repetition of the PUCCH/PUSCH transmissions of smaller priority index overlaps in time with the PUCCH/PUSCH transmissions of larger priority index.  If a UE would transmit the following channels, including repetitions if any, that would overlap in time  - a first PUCSCH of larger priority index with SP-CSI report(s) without a corresponding PDCCH, and a second configured grant PUSCH of smaller priority index or a PUSCH of smaller priority index with SP-CSI reports(s) without a corresponding PDCCH, or  - a configured grant PUSCH of larger priority index and a PUSCH of smaller priority index with SP-CSI reports(s) without a corresponding PDCCH  the UE is expected to cancel a repetition of the PUSCH transmissions of smaller priority index from the starting symbol of the repetition if the repetition of the PUSCH transmissions of smaller priority index overlaps in time with the PUSCH transmissions of larger priority index.  If a PUSCH of smaller priority index with SP-CSI reports(s) without a corresponding PDCCH overlaps in time with a PUSCH scheduled by a DCI format of larger priority index in one or more symbols on the same carrier, and if the earliest symbol of these PUSCH channels starts no earlier than N2+d2,1 symbols after the last symbol of the DCI scheduling the PUSCH where d2,1 is the maximum of the d2,1 associated with the PUSCH carrying semi-persistent CSI report and the PUSCH with data transmission, the CSI report shall not be transmitted by the UE. Otherwise, if the timeline requirement is not satisfied this is an error case.  When a UE determines overlapping for PUCCH transmissions with SL HARQ-ACK reports and PUSCH of smaller priority index, including repetitions if any, after resolving the overlapping PUCCH other than PUCCH transmissions with SL HARQ-ACK reports and/or PUSCH transmissions, if the PUSCH includes no UCI, the UE resolves the overlapping for PUCCH transmissions with SL HARQ-ACK reports and PUSCH of smaller priority index as described in clauses 9.2.5 and 9.2.6.  When a UE determines overlapping for PUCCH transmissions with SL HARQ-ACK reports and PUSCH of larger priority index only, including repetitions if any, after resolving the overlapping PUCCH other than PUCCH transmissions with SL HARQ-ACK reports and/or PUSCH transmissions, the UE does not transmit the PUCCH with SL HARQ-ACK reports  where  - the UE expects that the transmission of the PUSCH would not start before after a last symbol of the corresponding PDCCH reception;  - is the PUSCH preparation time for a corresponding UE processing capability assuming [6, TS 38.214], based on and as subsequently defined in this clause, and is determined by a reported UE capability.  The UE expects the PUCCH and PUSCH transmissions fulfill the conditions in clause 9 and clause 9.2.5 for UCI multiplexing replacing the reference time of "end of PDSCH" with "end of the last symbol of a last PSFCH reception occasion" as described in 16.5 and *Tproc,*1 with *Tprep*.  A UE does not expect that a PUCCH carrying SL HARQ-ACK reports overlaps with PUSCH with aperiodic or semi-persistent CSI reports.  A UE does not expect to be scheduled to transmit a PUCCH or a PUSCH with smaller priority index that would overlap in time with a PUCCH of larger priority index with HARQ-ACK information only in response to a PDSCH reception without a corresponding PDCCH. A UE does not expect to be scheduled to transmit a PUSCH of small priority index scheduled by a DCI format or a PUCCH of smaller priority index that would overlap in time with a PUSCH of larger priority index with SP-CSI report(s) without a corresponding PDCCH.  < Unchanged parts are omitted > |

Nokia provides their views in R1-2206144 [2]. It is suggested to define all 5 cases remaining cases as error cases and a corresponding TP is provided.

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| From R1-2206144 [2] (Nokia/Nokia Shanghai Bell)  In RAN1#109-e discussions on Rel-17 intra-UE multiplexing/prioritization, the scenarios where a HP/LP PUSCH overlaps with a LP/HP PUSCH with SP-CSI without a corresponding PDCCH have been discussed without reaching a consensus. This is because the handling for these scenarios is currently not defined in the specifications.  **TP for 38.213, section 9:**  < Unchanged parts are omitted >  The UE expects the PUCCH and PUSCH transmissions fulfill the conditions in clause 9 and clause 9.2.5 for UCI multiplexing replacing the reference time of "end of PDSCH" with "end of the last symbol of a last PSFCH reception occasion" as described in 16.5 and *Tproc,*1 with *Tprep*.  A UE does not expect that a PUCCH carrying SL HARQ-ACK reports overlaps with PUSCH with aperiodic or semi-persistent CSI reports.  A UE does not expect to be scheduled to transmit a PUCCH or a PUSCH with smaller priority index that would overlap in time with a PUCCH of larger priority index with HARQ-ACK information only in response to a PDSCH reception without a corresponding PDCCH. A UE does not expect to be scheduled to transmit a PUCCH of smaller priority index that would overlap in time with a PUSCH of larger priority index with SP-CSI report(s) without a corresponding PDCCH.  A UE does not expect to be scheduled to transmit a PUSCH of a first priority index that would overlap with a second PUSCH of a second priority index with SP-CSI report(s) without a corresponding PDCCH, where the first priority index and the second priority index are different.  In the remaining of this clause, a UE multiplexes UCIs with same priority index in a PUCCH or a PUSCH before considering limitations for UE transmission as described in clause 11.1 and clause 11.1.1. A PUCCH or a PUSCH is assumed to have a same priority index as a priority index of UCIs a UE multiplexes in the PUCCH or the PUSCH.  < Unchanged parts are omitted > |

## Round 1

Since different views have been provided by companies how to handle the different cases, it seems better to firstly agree on the behaviour before going to the text proposal.

Last meeting, it was pointed out by companies that defining all 5 overlapping cases as error will be complicated for the gNB implementation, since the overlap is hard to avoid some times. Especially, for two configured PUSCHs.

Companies are therefore encouraged to give their feedback on the following 3 questions:

Question 1: For Case 1 – overlap between HP PUSCH with DCI and LP PUSCH with SP-CSI without DCI, which is your preferred option?

* Option A: The entire LP channel is cancelled. The time-line requirement is the same as in Rel-15 for DG PUSCH overriding LP PUSCH with SP-CSI.
* Option B: Error case

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| **Company** | **View** |
| Apple | Option A |
| ZTE | Option A. But no spec. impact. For Case 1,3,4,5, generally, the solutions could be treated as HP PUSCH cancelling LP PUSCH, no need to consider whether the PUSCH is CG PUSCH or the PUSCH is with SP-CSI without DCI. |
| CATT | We prefer Option A as we commented in the last meeting.  One minor comment is that the timeline in Rel-15 is for PUSCH with SP-CSI to be overridden by PUSCH with UL-SCH. Maybe we can say the timeline requirement is the same as defined in TS 38.214 Clause 5.2.5. |
| Qualcomm | Although not exactly, but this case is similar to DG vs. DG. Hence, we prefer Option B. |
| Spreadtrum | Option A |
| vivo | We prefer Option B |
| Samsung | Option A  We share similar view as ZTE. For all the 5 cases, SP-CSI can be treated as CG PUSCH.  If companies would like to clarify in the spec, we suggest to change ‘configured grant PUSCH’ to ‘configured PUSCH’ in TS 38.213. |

Question 2: For Case 2 – overlap between HP PUSCH with SP-CSI without DCI and LP PUSCH with DCI, do you agree to treat this situation as an error case?

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| **Company** | **View** |
| ZTE | Can be considered as the collision between the HP PUSCH without DCI and scheduled LP PUSCH. The general case has been discussed in prior release, but the solution was left to implementation and not captured in specification. So for Case 2 here, it can also be left to implementation. |
| CATT | As we commented in the last meeting, for this case, we are fine to define it as an error case or define the UE behaviour to prioritize HP PUSCH and drop the LP PUSCH entirely. |
| Qualcomm | Same as above, we prefer Option B. |
| Spreadtrum | Option B |
| vivo | Agree to treat as error case |
| Samsung | NO, same comment as in Q1. |

Question 3: For Case 3, 4, 5 – overlap between HP PUSCH with SP-CSI without DCI and LP PUSCH with DCI, which is your preferred option?

* Option A: UE follows CG-CG handling, that is HP channel cancels the entire LP channel
* Option B: Error case

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| **Company** | **View** |
| Apple | Option A |
| ZTE | Option A. But no spec. impact as explained in Question 1. |
| CATT | For Case 3/4/5 – overlap between HP PUSCH with SP-CSI without DCI and LP PUSCH without DCI, we agree that HP PUSCH cancels the LP PUSCH entirely. |
| Qualcomm | Option B for case 4 since we do not see a use case. For URLLC, network is more likely to trigger A-CSI. For Case 3 and 5, we are open to Option A. |
| Spreadtrum | Option A |
| vivo | Option B |
| Samsung | Option A, same comment as in Q1. |

# Outcome

TBD.

# References

[1] [R1-2205781](file:///C:\Users\younsun\Documents\3GPP%20documents\RAN1%20tdocs\TSGR1_110\Docs\R1-2205781.zip), “Remaining issues on UL prioritization cases related to SP-CSI”, Huawei, HiSilicon

[2] [R1-2206144](file:///C:\Users\younsun\Documents\3GPP%20documents\RAN1%20tdocs\TSGR1_110\Docs\R1-2206144.zip), “[Draft CR] Clarification on intra-UE prioritization for PUSCH with SP-CSI”, Nokia, Nokia Shanghai Bell

[3] [R1-2207533](file:///C:\Users\younsun\Documents\3GPP%20documents\RAN1%20tdocs\TSGR1_110\Docs\R1-2207533.zip), “Correction on UL prioritization cases related to SP-CSI”, Huawei, HiSilicon

[4] [R1-2205440](file:///D:\old_drive_E\work\先进算法研究组\标准\03%20提案\RAN1\Docs\R1-2205440.zip), “Summary of [109-e-R16-URLLC-07] Issue#8: Remaining issues on UL prioritization cases related to SP-CSI, Moderator (Huawei), RAN1 #109-e

# Appendix – Companies’ views from RAN1#109-e on the 5 cases and how to capture them in the specification

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| Case 1 | HP PUSCH with DCI and LP PUSCH with SP-CSI without DCI | | | | |
| Already supported in Rel-16 | | Currently missing in Rel-16 | | Comments |
| Company | Yes/No | Behaviour | Yes/No | How to define behaviour |
| HW/HiSi | No | n.a. | Yes | Error case |  |
| vivo | No | n.a. | Yes | Error case |  |
| Intel | No | n/a | Not “missing”, juts not spelled out | Error case |  |
| DOCOMO | No | n.a. | Yes | Error case |  |
| CATT | No | n.a. | Yes | HP cancel LP with Rel-15 timeline requirement | See below |
| Samsung | No | n.a. | Yes | Error case | See below |
| Qualcomm | No | n.a. | Yes | HP cancels LP with the same timeline as in R15 DGCG collision handling |  |

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| Case 2 | HP PUSCH with SP-CSI without DCI and LP PUSCH with DCI | | | | |
| Already supported in Rel-16 | | Currently missing in Rel-16 | | Comments |
| Company | Yes/No | Behaviour | Yes/No | How to define behaviour |
| HW/HiSi | No | n.a. | Yes | Error case |  |
| vivo | No | n.a. | Yes | Error case | See below |
| Intel | No | n/a | Not “missing”, just not spelled out | Error case |  |
| DOCOMO | No | n.a. | Yes | Error case |  |
| CATT | No | n.a. | Yes | Same as Case 1 or error case | See below |
| Samsung | No | n.a. | Yes | Error case | See below |
| Qualcomm | No | n.a. | Yes | Error event |  |

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| Case 3 | HP PUSCH with SP-CSI without DCI and LP CG PUSCH | | | | |
| Already supported in Rel-16 | | Currently missing in Rel-16 | | Comments |
| Company | Yes/No | Behaviour | Yes/No | How to define behaviour |
| HW/HiSi | No | n.a. | Yes | Error case |  |
| vivo | No | n.a. | Yes | Fine to support |  |
| Intel | No | n/a | Not “missing” but not spelled out explicitly | Follow CG-CG handling. |  |
| DOCOMO | No | n.a. | Yes | Follow CG-CG handling. |  |
| CATT | No | n.a. | Yes | HP cancel LP |  |
| Samsung | YES | Transmit HP |  |  |  |
| Qualcomm | No | n.a. | Yes | The same as CGCG collision handling |  |

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| Case 4 | HP PUSCH with SP-CSI without DCI and LP PUSCH with SP-CSI without DCI | | | | |
| Already supported in Rel-16 | | Currently missing in Rel-16 | | Comments |
| Company | Yes/No | Behaviour | Yes/No | How to define behaviour |
| HW/HiSi | No | n.a. | Yes | Error case |  |
| vivo | No | n.a. | Yes | Fine to support |  |
| Intel | No | n/a | Not “missing” but not spelled out explicitly | Follow CG-CG handling. |  |
| DOCOMO | No | n.a. | Yes | Follow CG-CG handling. |  |
| CATT | No | n.a. | Yes | HP cancel LP |  |
| Samsung | YES | Transmit HP |  |  |  |
| Qualcomm | No | n.a. | Yes | The same as CGCG collision handling |  |

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| Case 5 | LP PUSCH with SP-CSI without DCI and HP CG PUSCH | | | | |
| Already supported in Rel-16 | | Currently missing in Rel-16 | | Comments |
| Company | Yes/No | Behaviour | Yes/No | How to define behaviour |
| HW/HiSi | No | n.a. | Yes | Error case |  |
| vivo | No | n.a. | Yes | Fine to support |  |
| Intel | No | n/a | Not “missing” but not spelled out explicitly | Follow CG-CG handling. |  |
| DOCOMO | No | n.a. | Yes | Follow CG-CG handling. |  |
| CATT | No | n.a. | Yes | HP cancel LP |  |
| Samsung | YES | Transmit HP |  |  |  |
| Qualcomm | No | n.a. | Yes | Follow CGCG handling |  |