**3GPP TSG RAN WG1 #114bis R1-** **231xxxx**

**Xiamen, China, October 9th – October 13th, 2023**

**Agenda item:** 7.1

**Source:** Moderator (Qualcomm)

**Title:** FL summary #1 of Clarify CSI feedback with SUL

**Document for:** Discussion/Decision

# Introduction

In R1-2310121, three ambiguities related to SUL were identified.

* For PUSCH with AP-CSI, how to interpret UL/SUL indicator and the numerology of reportSlotOffsetList, especially when UL-SCH Indicator = 0.
* UE behavior for PUSCH (and PUCCH) transmission with DCI 0\_0 when pucch-Config is **not** configured but PUCCH-ConfigCommon is configured.
* UE behavior for PUSCH (and PUCCH) transmission with DCI 0\_1/0\_2 when pucch-Config is **not** configured but PUCCH-ConfigCommon is configured.

The document is provided the discuss whether/how to clarify these ambiguities in RAN1 #114bis.

# CSI feedback with SUL

Consider a scenario where DCI formats 0\_1 or 0\_2 is received with AP-CSI request, the UL/SUL indicator indicates SUL, and UL-SCH Indicator = 0. In this scenario, although there is no UL-SCH, UE should still follow the UL/SUL indicator to transmit CSI in PUSCH on SUL. Regarding the reportSlotOffsetList, given that there is only one reportSlotOffsetList/reportSlotOffsetListDCI-0-1/reportSlotOffsetListDCI-0-2 configured for that cell, i.e., we don’t those RRC parameters configured for both SUL and UL, how to interpret the unit of Timing offset value associated with reportSlotOffsetList/reportSlotOffsetListDCI-0-1/reportSlotOffsetListDCI-0-2 needs to be clarified. Because CSI in PUSCH is transmitted on SUL, it is natural to interpret reportSlotOffsetList/reportSlotOffsetListDCI-0-1/reportSlotOffsetListDCI-0-2 in units of the SUL numerology.

In the above scenario, if UL/SUL indicator indicates UL, then UE should transmit CSI in PUSCH on UL, and interpret reportSlotOffsetList/reportSlotOffsetListDCI-0-1/reportSlotOffsetListDCI-0-2 in units of the UL numerology.

**Proposal 1: clarify the following as a conclusion in RAN1 Chair’s notes.**

* **When DCI formats 0\_1 or 0\_2 is received with AP-CSI request, regardless UL-SCH Indicator = 0 or 1, a UE transmits CSI in PUSCH on UL or SUL following the specification of UL/SUL indicator field in TS 38.212. The UE interprets reportSlotOffsetList/reportSlotOffsetListDCI-0-1/reportSlotOffsetListDCI-0-2 in units of the numerology of UL or SUL on which the AP-CSI in PUSCH is transmitted.**

Companies are welcome to provide comments to the above proposal in the table below.

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| Company Name | Comments |
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# Common PUCCH + PUSCH with SUL in DCI 0\_0

The follow is the current specification for UL/SUL indicator in DCI format 0\_0. The specification is quite comprehensive. But it still missed a few cases, where pucch-Config is not configured but PUCCH-ConfigCommon is configured.

In the case of the first sub-bullet, in case pucch-Config is not configured but PUCCH-ConfigCommon is configured, the specification is missing. We can further divide this case into two sub-cases as below.

- UL/SUL indicator - 1 bit for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell as defined in Table 7.3.1.1.1-1 and the number of bits for DCI format 1\_0 before padding is larger than the number of bits for DCI format 0\_0 before padding; 0 bit otherwise. The UL/SUL indicator, if present, locates in the last bit position of DCI format 0\_0, after the padding bit(s).

- If the UL/SUL indicator is present in DCI format 0\_0 and the higher layer parameter *pusch-Config* is not configured on both UL and SUL the UE ignores the UL/SUL indicator field in DCI format 0\_0, and the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured;

- If the UL/SUL indicator is not present in DCI format 0\_0 and *pucch-Config* is configured, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured.

- If the UL/SUL indicator is not present in DCI format 0\_0 and *pucch-Config* is not configured, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the uplink on which the latest PRACH is transmitted.

* Sub-case 1: PUCCH-ConfigCommon is only configured on one carrier, either on SUL or NUL.
* Sub-case 2: PUCCH-ConfigCommon is configured on both SUL and NUL.

For sub-case 1, UE should follow the principle of this sub-bullet specification to transmit PUSCH on the carrier for which PUCCH-ConfigCommon is configured. Naturally, UE should transmit PUCCH on the carrier for which PUCCH-ConfigCommon is configured.

For sub-case 2, UE should follow the principle of the third sub-bullet to transmit PUSCH on the carrier where the latest PRACH is transmitted. Furthermore, following the principle that PUCCH and PUSCH have to transmit on the same carrier when dynamic SUL/NUL switch does not apply, UE should transmit PUCCH on the carrier where the latest PRACH is transmitted as well.

In the case of the third sub-bullet, in case pucch-Config is not configured but PUCCH-ConfigCommon is configured, we can further divide this case into two sub-cases as below.

* Sub-case 1: PUCCH-ConfigCommon is only configured on one carrier, either on SUL or NUL.
* Sub-case 2: PUCCH-ConfigCommon is configured on both SUL and NUL.

For sub-case 1, there can be two solutions.

Solution 1 for sub-case 1 follows the current specification to transmit PUSCH on the carrier on which the last PRACH is transmitted. For PUCCH transmission, UE expect gNB should configure PUCCH-ConfigCommon on the same cell where the latest PRACH is transmitted, so that PUCCH and PUSCH are transmit on the same carrier in this sub-case. In other words, gNB has to configure rach-ConfigCommon and PUCCH-ConfigCommon on the same carrier.

Solution 2 for sub-case 1, which is arguably NBC, is transmitting both PUCCH and PUSCH on the carrier for which PUCCH-ConfigCommon is configured. But solution 2 is more aligned with the solution for sub-case 1 for the first bullet. Therefore, we prefer solution 2 slightly.

For sub-case 2, following current spec, UE transmit PUSCH on the carrier where the latest PRACH is transmitted. UE should transmit PUCCH on the carrier where the latest PRACH is transmitted as well.

With the above analysis, the following TP is proposed to clarify PUCCH/PUSCH transmission on SUL or NUL in case pucch-Config is not configured but PUCCH-ConfigCommon is configured.

**Proposal 2: Adopt the following TP in TS 38.212 (Rel-17) for DCI format 0\_0.**

- UL/SUL indicator - 1 bit for UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell as defined in Table 7.3.1.1.1-1 and the number of bits for DCI format 1\_0 before padding is larger than the number of bits for DCI format 0\_0 before padding; 0 bit otherwise. The UL/SUL indicator, if present, locates in the last bit position of DCI format 0\_0, after the padding bit(s).

- If the UL/SUL indicator is present in DCI format 0\_0 and the higher layer parameter *pusch-Config* is not configured on both UL and SUL the UE ignores the UL/SUL indicator field in DCI format 0\_0, and the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured;

- If the UL/SUL indicator is present in DCI format 0\_0, the higher layer parameter pusch-Config is not configured on both UL and SUL, and the high layer parameter pucch-Config is not configured while PUCCH-ConfigCommon is configured on both UL and SUL, the UE ignores the UL/SUL indicator field in DCI format 0\_0, and the corresponding PUSCH scheduled by the DCI format 0\_0 is for the uplink on which the latest PRACH is transmitted. The UE transmit PUCCH on the uplink on which the latest PRACH is transmitted.

- If the UL/SUL indicator is present in DCI format 0\_0, the higher layer parameter pusch-Config is not configured on both UL and SUL, and the high layer parameter pucch-Config is not configured while PUCCH-ConfigCommon is configured on either UL or SUL, the UE ignores the UL/SUL indicator field in DCI format 0\_0, and the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which PUCCH-ConfigCommon is configured. The UE transmit PUCCH on the UL or SUL for which PUCCH-ConfigCommon is configured.

- If the UL/SUL indicator is not present in DCI format 0\_0 and *pucch-Config* is configured, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which high layer parameter *pucch-Config* is configured.

- If the UL/SUL indicator is not present in DCI format 0\_0, and *pucch-Config* is not configured while PUCCH-ConfigCommon is configured on both UL and SUL, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the uplink on which the latest PRACH is transmitted. The UE transmit PUCCH on the uplink on which the latest PRACH is transmitted.

- If the UL/SUL indicator is not present in DCI format 0\_0, and *pucch-Config* is not configured while PUCCH-ConfigCommon is configured on either UL or SUL, the corresponding PUSCH scheduled by the DCI format 0\_0 is for the UL or SUL for which PUCCH-ConfigCommon is configured. The UE transmit PUCCH on the UL or SUL for which PUCCH-ConfigCommon is configured.

Companies are welcome to provide comments to the above proposal in the table below.

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# Common PUCCH + PUSCH with SUL in DCI 0\_1 or 0\_2

Similar issue of pucch-Config is not configured but PUCCH-ConfigCommon is configured can occurs for DCI 0\_1 and 0\_2 as well. The problematic scenario is the following.

* PUCCH-config is not configured on neither UL nor SUL, PUCCH-CommonConfig is configured on both UL and SUL, and PUSCH-Config is configured on either UL or SUL but not on both.

In this scenario, current specification is the following.

- UL/SUL indicator - 0 bit for UEs not configured with *supplementaryUplink* in *ServingCellConfig* in the cell or UEs configured with *supplementaryUplink* in *ServingCellConfig* in the cell but only one carrier in the cell is configured for PUSCH transmission; otherwise, 1 bit as defined in Table 7.3.1.1.1-1.

UL/SUL suppose to be 0 bit in this case. If pucch-Config is configured, pucch-Config should be configured on the carrier that *pusch-Config* is configured, following the principle that PUCCH and PUSCH have to transmit on the same carrier when dynamic SUL/NUL switch does not apply. However, in this case, PUCCH-config is not configured where PUCCH-CommonConfig is configured on both carrier, then UE could transmit PUCCH and PUSCH in different carriers, which violate the principle that PUCCH and PUSCH have to transmit on the same carrier when dynamic SUL/NUL switch does not apply.

The solution of the problem could be very simple. When NW configure dedicated PUSCH-Config, NW should configure it on the carrier where latest PRACH is transmit from the UE. In this way, unified specification is achieved between DCI 0\_0 and 0\_1/0\_2, and the UE follow the principle that PUCCH and PUSCH have to transmit on the same carrier when dynamic SUL/NUL switch does not apply.

**Proposal 3: When PUCCH-config is not configured on UL nor SUL, and PUSCH-Config is configured on either UL or SUL but not on both, the corresponding PUSCH scheduled by the DCI format 0\_1 and/or 0\_2 is for the UL or SUL for which the PUSCH-Config is configured, a UE expect that pusch-Config is configured on UL or SUL where UE transmit the latest PRACH. The UE transmit PUCCH on UL or SUL where UE transmit the latest PRACH.**

Companies are welcome to provide comments to the above proposal in the table below.

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# Conclusions

TBD…

# Reference

R1-2310121, Clarify CSI feedback with SUL, Qualcomm Inc.