**3GPP TSG-RAN WG1 Meeting #106-e R1-210xxxx**

**e-Meeting, August 16th – 27th, 2021**

**Agenda Item: 7.2.8**

**Source: Moderator (Huawei)**

**Title: Summary of [106-e-NR-Pos-02] DL PRS antenna ports and editorial corrections for SRS**

**Document for: Discussion and decision**

# Introduction

This document provides the summary for [106-e-NR-Pos-02] on the PRS antenna ports and some editorial changes.

[106-e-NR-Pos-02] Email discussion/approval on DL PRS antenna ports and editorial corrections for SRS (Aspect #2) until August 20 – Su (Huawei)

The related submission of contribution includes

1. R1-2106504 Draft CR on PRS antenna ports Huawei, HiSilicon

The email discussion is divided into two rounds, with the intermediate summary at 23:59 UTC, Aug. 18.

# General information

In [1], it is noticed that in TS 38.211, the antenna ports description lacks that for DL PRS, particularly for the cases when (slot-level) repetition is configured, whereas the DM-RS have the dedicated restriction for the same port “in the same slot”. Therefore, 1) the description for PRS antenna ports is added and 2) some editorial corrections to the SRS are provided as shown below:

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| 4.4.1 Antenna ports========================= Unchanged parts =========================For DM-RS associated with a PBCH, the channel over which a PBCH symbol on one antenna port is conveyed can be inferred from the channel over which a DM-RS symbol on the same antenna port is conveyed only if the two symbols are within a SS/PBCH block transmitted within the same slot, and with the same block index according to clause 7.4.3.1.For PRS, the channel over which a PRS symbol on one antenna port is conveyed can be inferred from the channel over which a PRS symbol on the same antenna port is conveyed only if the two symbols are within a DL PRS resource within the same slot.Two antenna ports are said to be quasi co-located if the large-scale properties of the channel over which a symbol on one antenna port is conveyed can be inferred from the channel over which a symbol on the other antenna port is conveyed. The large-scale properties include one or more of delay spread, Doppler spread, Doppler shift, average gain, average delay, and spatial Rx parameters. ========================= Unchanged parts =========================6.4.1.4.2 Sequence generation========================= Unchanged parts =========================The sequence group $u=\left(f\_{gh}\left(n\_{s,f}^{μ},l'\right)+n\_{ID}^{SRS}\right) mod 30$ and the sequence number  in clause 5.2.2 depends on the higher-layer parameter *groupOrSequenceHopping* in the *SRS-Resource* IE or the *SRS-PosResource* IE*.* The SRS sequence identity  is given by the higher layer parameter *sequenceId* in the *SRS-Resource* IE, in which case $n\_{ID}^{SRS}\in \left\{0, 1, …, 1023\right\}$, or the *SRS-PosResource* IE, in which case $n\_{ID}^{SRS}\in \left\{0, 1, …, 65535\right\}$. The quantity $l'\in \left\{0,1,…,N\_{symb}^{SRS}-1\right\}$ is the OFDM symbol number within the SRS resource.========================= Unchanged parts =========================6.4.1.4.4 Sounding reference signal slot configurationFor an SRS resource configured as periodic or semi-persistent by the higher-layer parameter *resourceType*, a periodicity  (in slots) and slot offset  are configured according to the higher-layer parameter *periodicityAndOffset-p* or *periodicityAndOffset-sp* in the *SRS-Resource* IE, or in the *SRS-PosResource* IE. Candidate slots in which the configured SRS resource may be used for SRS transmission are the slots satisfyingSRS is transmitted as described in clause 11.1 of [5, TS 38.213].========================= Unchanged parts ========================= |

# Discussion

## PRS antenna ports across slots

The reason for the change given by [1] is that in principle, the UE should not assume that the PRS of the same DL PRS resource repeated in different slots are from the same antenna port, which means that coherent combining for the same PRS resource across the repetition slots should not be expected.

### Proposal: Decide whether to adopt the following change.

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| For PRS, the channel over which a PRS symbol on one antenna port is conveyed can be inferred from the channel over which a PRS symbol on the same antenna port is conveyed only if the two symbols are within a DL PRS resource within the same slot. |

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| **Company** | **Yes/No** | **Comments** |
| OPPO | Has concern | If the restriction of “within the same slot” included, then the UE will not be allowed to combine the repetitions of one same DL PRS resource to improve the coverage performance of PRS and thus impair the NR positioning performance. The same channel shall be expected on repetitions of the same PRS resource within each transmission periodicity.  |
| Huawei, HiSilicon | Support. | To OPPO,We think coherent combining may not always be possible across repetitions. Unless explicitly indicated, we think UE should make such assumption.Note that for repetition, we may also repetition in non-adjacent slots. |
| vivo | No | Such restriction of “within the same slot” conflicts with the goal when we design DL PRS repetition in R16. It prevents UE to combine the same DL PRS resource which may cross slots.Whether combine or not across slots, it is up to UE implementation in that case. We don’t see the need for the specification to prevent that. |
| Intel | Comments | Although we share the motivation, we are not sure that proposed TP is the best way forward especially restriction within the same slot.In our view, there may be implementations where such combining is feasible. May be instead, we can say that “UE is not expected to combine channels on the same DL PRS resource across slots”. We can also consult with RAN4 on whether it is needed. |
| ZTE | Comments | Similar view with Intel. In addition, because of comb structure, the PRS may not be repeated in the same RE across multiple symbols. In this case, how can we understand the “inferred”. |
| Huawei, HiSilicon |  | Reply to above:To vivo: UE may “combine” the same PRS resource across slots, but it should be in a non-coherent way. It could be that the phase for the first path could vary across the slot boundary, e.g. phase of the first path is 0 for slot#0, and is pi for slot#1, even if other properties remain the same. We should not call it the same antenna port.To intel: So far as to our understanding, UE can do the combining, but combining PRS in multiple slots assuming there is no phase change at both TRP and UE side will be problematic. For PDSCH, we have the following fix:

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| For DM-RS associated with a PDSCH, the channel over which a PDSCH symbol on one antenna port is conveyed can be inferred from the channel over which a DM-RS symbol on the same antenna port is conveyed only if the two symbols are within the same resource as the scheduled PDSCH, in the same slot, and in the same PRG as described in clause 5.1.2.3 of [6, TS 38.214].  |

To ZTE: In general, the channel/CIR is symbol level defined. Then the CFR of the CIR could vary on different RE offsets, because we are doing frequency domain sampling at different sampling grid of the same CFR. “Inference” would mean that the channel on one symbol is predictable from the channel on another symbol; the prediction would take into account the RS pattern, as well as e.g. Doppler or CFO at the UE side. In other words, the same port means that UE could project the CFR on different REs on different symbols into a single symbol that has equivalent comb-1 structure. |
| CATT | Support with revision | We think the changes are needed as it can clarify the UE should not assume that the PRS of the same DL PRS resource repeated in different slots being coherently combined.We prefer the updated version as follows,

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| For PRS, the channel over which a PRS symbol on one antenna port is conveyed can be inferred from the channel over which another PRS symbol on the same antenna port is conveyed only if the two symbols are within a DL PRS resource within the same slot. |

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| Qualcomm | Not support | Starting from LTE, the assumption has been that PRS will be “coherent” within consecutive DL subframes as shown in the reference below (36.211):*-    Positioning reference signals are transmitted on antenna port. The channel over which a symbol on antenna port is conveyed can be inferred from the channel over which another symbol on the same antenna port is conveyed only within one positioning reference signal* ***occasion consisting of  consecutive downlink subframes****, where  is configured by higher layers.*Wherein the expression “consecutive downlink subframes” may even allow for gaps in between where UL or SF can be (snapshot from 36.133 on a test case for TDD)Having this as a background, it is a bit unclear to us why we should restrict it much more in NR compared to LTE.  |
| Apple | Comments | It’s true that under some scenarios coherent combining across slots is not always possible, but this text prohibits all possible scenarios for bundling… maybe we should leave spec as it is not to close doors for future improvements. But we are also fine with Intel’s suggestion. So we intend not to support |

## Editorial changes on SRS

The change removes the “-r16” suffix and the duplicated periodicity and offset for periodic and semi-persistent positioning SRS.

### Proposal: Decide whether to adopt the following change.

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| 6.4.1.4.2 Sequence generation========================= Unchanged parts =========================The sequence group $u=\left(f\_{gh}\left(n\_{s,f}^{μ},l'\right)+n\_{ID}^{SRS}\right) mod 30$ and the sequence number  in clause 5.2.2 depends on the higher-layer parameter *groupOrSequenceHopping* in the *SRS-Resource* IE or the *SRS-PosResource* IE*.* The SRS sequence identity  is given by the higher layer parameter *sequenceId* in the *SRS-Resource* IE, in which case $n\_{ID}^{SRS}\in \left\{0, 1, …, 1023\right\}$, or the *SRS-PosResource* IE, in which case $n\_{ID}^{SRS}\in \left\{0, 1, …, 65535\right\}$. The quantity $l'\in \left\{0,1,…,N\_{symb}^{SRS}-1\right\}$ is the OFDM symbol number within the SRS resource.========================= Unchanged parts =========================6.4.1.4.4 Sounding reference signal slot configurationFor an SRS resource configured as periodic or semi-persistent by the higher-layer parameter *resourceType*, a periodicity  (in slots) and slot offset  are configured according to the higher-layer parameter *periodicityAndOffset-p* or *periodicityAndOffset-sp* in the *SRS-Resource* IE, or in the *SRS-PosResource* IE. Candidate slots in which the configured SRS resource may be used for SRS transmission are the slots satisfyingSRS is transmitted as described in clause 11.1 of [5, TS 38.213]. |

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| **Company** | **Yes/No** | **Comments** |
| OPPO | NO | The current spec has no issue. |
| Huawei, HiSilicon | Yes | We do not need a standalone CR for the change, but can be the accompanying changes with other essential corrections, which I believe should be a normal procedure.From our side, we are fine to also leave the change to an editor alignment CR. |
| vivo | No | Our understanding is that “Only essential corrections” are allowed for AI 7.2.  |
| Intel | Yes | Editorial changes |
| ZTE | Yes | Okay with changes. |
| CATT | Yes | We are fine with the changes. |
| Apple | No | Same view as OPPO |

# Conclusion

TBD