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

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

**Agenda Item: 7.2.1**

**Source: Moderator (OPPO)**

**Title: Summary of the e-mail discussion [106-e-NR\_2step\_RACH-Core-01] on spatial filter for PUCCH before RRC connection in 2-step RACH**

**Document for: Discussion and Decision**

# Introduction

Corrections on 2-step RACH have been submitted at RAN1#106 e-meeting. A first summary asked for companies’ views on the necessary changes based on the proposed draft CRs during the preparation phase of August 9th – 13th, including whether discussion is needed for clarification before we can determine whether an issue is critical or essential.

After the preparation phase, one of the 2 issues is scheduled into the following email discussion:

[106-e-NR\_2step\_RACH-Core-01] Email discussion/approval the draft CR in [R1-2107261](file:///C%3A%5Cworking_document%5C3GPP_5G_standadization%5CRAN%5CTSGR1_106-e%5CInbox%5CDocs%5CR1-2107261.zip) (Spatial domain transmission filter for PUCCH before RRC connection) – Zhisong (OPPO)

* Discussion and decision by August 18, CR by August 20, final check by August 24

Section 2 extract the comments in the prapration phase. Section 3 provides further discussion points and the possible solutions.

# Preparation phase

Comments from preparation phase are cited below.

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| Company | Issue#2, need the CR? | Comments |
| CATT | Yes | Issue#1 is editorial issue and both issues can be discussed during this meeting. |
| Intel | No | Editorial change for issue#1. For issue#2, in Section 8.2A, spatial filter for PUCCH transmission during 2-step RACH procedure was clearly defined as follows. It is not clear to us the proposed change is needed. - the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission  |
| Nokia, Nokia Shanghai Bel | No | For issue #2 the needed text has already been captured in section 8.2A of 38.213.  |
| vivo | No | We share the same view as Intel that Spatial domain transmission filter for PUCCH has been already specified in the spec. |
| Samsung | No (but a new one could be discussed) | Agree with intel’s assessment on issue#2.In addition, we may find the cited text by [2] was also questionable, i.e., “The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in Clause 8.3.” Since Msg.3 could be scheduled by DCI as re-transmission, and the beam for msg3 initial and re-transmission is up to UE; so is it correct to always use RAR scheduled msg3 beam (i.e., initial msg3 transmission) for PUCCH? Or it is too late to change since R15 is specified like this.  |
| Ericsson | ? | For issue 1, it’s obviously an editorial issue, we propose to pass it to the editor with no need for discussion.For issue 2, maybe proponent company can clarify whether this CR* is only to determine the spatial domain transmission filter of the PUCCH for MsgB HARQ feedback,
* or is to determine the spatial domain transmission filter of all PUCCH transmissions before RRC connection.

We’re open to discuss this if it’s the latter case. |
| OPPO | Yes | The definition on spatial filter for PUCCH transmission in Section 8.2A, as copied in the following, is for PUCCH with HARQ-ACK information for RAR only. It is not applied for any PUCCH transmission, e.g. PUCCH with HARQ-ACK for PDSCH transmission without RAR.“transmission of a PUCCH with HARQ-ACK information having ACK value if the RAR message(s) is for successRAR, where - a PUCCH resource for the transmission of the PUCCH is indicated by PUCCH resource indicator field of 4 bits in the successRAR from a PUCCH resource set that is provided by *pucch-ResourceCommon* - a slot for the PUCCH transmission is indicated by a HARQ Feedback Timing Indicator field of 3 bits in the successRAR having a value $k$ from {1, 2, 3, 4, 5, 6, 7, 8} and, with reference to slots for PUCCH transmission having duration $T\_{slot}$, the slot is determined as $n+k+∆$, where $n$ is a slot of the PDSCH reception and $∆$ is as defined for PUSCH transmission in Table 6.1.2.1.1-5 of [6, TS 38.214]- the UE does not expect the first symbol of the PUCCH transmission to be after the last symbol of the PDSCH reception by a time smaller than $N\_{T,1}+0.5$ msec where $N\_{T,1}$ is the PDSCH processing time for UE processing capability 1 [6, TS 38.214]- for operation with shared spectrum channel access, a channel access type and CP extension [15, TS 37.213] for a PUCCH transmission is indicated by a ChannelAccess-CPext field in the successRAR as defined in Table 7.3.1.1.1-4 in TS 38.212 as defined in Table 7.3.1.1.1-4 in TS 38.212 or Table 7.3.1.1.1-4A in TS 38.212 if *ChannelAccessMode-r16* = "*semistatic*" is provided- the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmission”The CR covers any PUCCH transmission before PUCCH-SpatialRelationInfo is configured.With respect to question from Ericsson, our CR is the latter case. |
| Huawei, HiSilicon | Seems Ok |  |
| Qualcomm | OK to discuss it further | If the CR intends to address all PUCCH transmissions before RRC connection, it is beyond the scope of R16 2-step RACH maintenance. |

# Discussion phase

## Discussion on the issue and comments

4 companies, Intel, Nokia, vivo & Samsung, comment that the behavior has already been captured in section 8.2A of 38.213: the PUCCH will use a same spatial domain transmission filter of a last PUSCH transmission. The proponent (OPPO) then clarified that section 8.2A only cover the PUCCH in respond to the PDSCH by DCI scrambed with MsgB-RNTI. The draft CR is to specify the spatial filter for all the PUCCHs befor the RRC connection established.

It was additionally commented by Samsung that even for 4-step RACH, always assuming the same spatial filter of the 1st PUSCH may not be optimal in case some later re-transmission of PUSCH would use different spatial filter. It seems that issue could be a separated one.

2 companies, Ericsson and Qualcomm, are open for discussing the CR under the clarification that it is about the spatial filter for all the PUCCHs befor the RRC connection established.

3 companies, CATT, OPPO & Huawei, would like to accept the CR as it is consistent to behavior when only 4-step RACH configured and it ensure gNB receiving PUCCH.

ZTE also comment in email that it is feasible to allow free selection of spatial domnain transmission filter for any PUCCHs other than the PUCCH responding the MsgB. Then, no specification change would be needed.

## Proposals to move forward

After clarification, the issue can be focused on the general PUCCHs before RRC connection established. Then, the moderator suggests to put effort on this specific issue. 2 relavant options based on companies’ feedback are put in below.

Other options which help for the essinitial change or correction would also be proposed in the comment. Justification is apprciated.

**Proposal:**

Option1. Endorsing the draft CR R1-2107261 in principle, PUCCH will use the same spatial domain transmission filter as for a PUSCH in Type-2 random access procedure.

Option2. For any PUCCHs other than the PUCCH in responding a MsgB before the RRC connection, UE selection of spatial domnain transmission filter is unspecified.

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| Company | Preference | Comment |
| ZTE | Slightly prefer Option2 | Technically we think either option would be fine, because we believe normally the UE has no other choice but to apply the same Tx beam for UL transmissions before RRC connection, whether or not writtern in the specified. However, considering the late stage of Rel-16 maintenance, probably we can leave it as it is if there is no critical problem caused. |
| OPPO | Option1 | We see the need to clarify the behavior. The text only specify PUCCH for 4-step RACH would give message implying 2-step RACH will do different things. |
| CATT | Option 2 | We need clarify that we only agree with discussion about this issue in this meeting during preparation phase.For 2-step RACH, we only reached the related agreement in RAN1#99 as below and the agreement is already reflected in Section 8.2A of TS 38.213.Agreements:The UE transmits the PUCCH responding to msgB successRAR using the same spatial domain transmission filter in the same BWP as the last msgA PUSCH transmission/retransmission.In our understanding, above issue on is indeed out of scope on R16 2-step RACH maintenance if this CR addresses the spatial domain transmission filter of all PUCCH transmissions before RRC connection. |
| Qualcomm |  | OK to support Option 1 if it is the majority view.  |
| vivo |  | Although the issue is clarified as the general PUCCHs before RRC connection established, we are still reluctant to understand the motivation of this correction. To our understanding, before RRC connection established, UE needs only to feed back HARQ-ACK for PDSCH of Msg4 or MsgB. In these two cases, the spatial domain transmission filter for the corresponding PUCCH is already specified, as companies mentioned in the prepared phase. Could you clarify more what is case this CR is applied instead of the PUCCH transmission for HARQ-ACK for Msg4/MsgB? |
| Samsung  | Spirit of option 2 | We guess the option 2 intends to say there will be no “further” specification to define the new rules for PUCCH spatial filter determination. As already point by several companies.there is clear specification for PUCCH beam corresponding to msgB; for the comments by oppo during preparation phase, UE will only reply PUCCH after msgB as long as it’s a successful RAR, instead that, UE will PUCCH after msg4, which is not defined by 2step RACH.So we understand, this issue will be living with current implementation, without further specification.  |
| Apple | Option 2 | According to the discussion, if our unsertanding is correct, the draft CR is to cover the case that Msg3 PUSCH transmission is triggered by fallbackRAR or triggered by DCI, the PUCCH will use the same Tx beam. In some sense, the draft CR is to solve the Rel.15 issue. Without CR, we don’t see the critical issue, leaving it to UE implementation is enough.  |
| OPPO2 |  | To vivo: Before RRC connection established, there is delay for the RRC configuration parameter taken into effect. During that time, it still allows to have mssages other than MsgB/4. Then you need some assumption for PUCCH. That’s the reason why Rel-15 specification in 9.2.1 is in general for all PUCCH, otherwise it should specifically say for PUCCH of Msg4. To Samsung: I actually mean the behavior for general PUCCHs is unspecified in “2-step RACH” in regards of option2. Current text for 4-step in 9.2.1: “The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in Clause 8.3.”Hope this also clarify Apple’s questionWould be somehow strange to let 4-step cover all PUCCH, but 2-step RACH only cover the PUCCH of MsgB. But I do remember the specification text is the form we agreed in 2-step RACH session. 😊 incident. |
| Ericsson |  | According to the discussions so far, we can understand that the interntion of the CR is mainly to determine the beam of PUCCH before RRC connection setup complete, where the PUCCH is not for MsgB HARQ feedback when 2-step RA is selected by a UE.For 2-step RACH, in current spec. in 38.213:For MsgA PUSCH:A PUSCH transmission uses a same spatial filter as an associated PRACH transmission.For PUCCH corresponding to success RAR:- the PUCCH transmission is with a same spatial domain transmission filter and in a same active UL BWP as a last PUSCH transmissionSo, when 2-step RA is selected by UE, the uplink spatial domain transmission filter in uplink before RRC connection can only be the same spatial domain transmission filter as an associated PRACH transmission, although the actual filter applied may still be up to UE as this can hardly be tested by gNB.For 4-step RACH, although we have following text, but we don’t even know what is “the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant” in following text, meaning that the actual filter used in Rel-15 is not specified either, probably it could be also same as the beam used for corresponding PRACH transmission:The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in Clause 8.3.Given above, technically, maybe it could be fine to not specify further which uplink spatial domain transmission filter for PUCCH to use before RRC connection for 2-step RACH case, it is still up to UE. A smart UE will always select a potential best uplink TX beam corresponding to an RX beam of the best SSB before RRC connection. Similarly, gNB will also try to receive further uplink signals from UE based on the PRACH detection before RRC connection.However, maybe some update of the original CR could be necessary to solve the issue that in some cases UE may never transmits a PUSCH scheduled by RAR when 2-step RACH is used and without any fallback:

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| The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in Clause 8.3 when a Type-1 random access procedure is performed.~~or PUSCH for Type-2 random access procedure as described in Clause 8.1A~~ |

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| Nokia, Nokia Shanghai Bell | Option 2 | As already pointed out by other companies, the current agreement from RAN1#99 specifically addresses the PUCCH transmission filter as response for MsgB successRAR. According to our understanding, this has been captured just fine in existing specifications, and we are fine to not specific any UE specific behaviour for other cases (for the fallbackRAR or subsequent PUCCH transmissions prior to RRC connection being established). |

# Conclusion

It is to be updated.

# References

1. R1-2108214 FL summary on the maintenance of 2-step RACH ZTE
2. R1-2107261 Draft CR on spatial domain transmission filter for PUCCH OPPO

# Appendix

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| R1-2107261, OPPO | ***Reason for change:*** In current spec, regardless of random access scheme, spatial domain transmission filter for PUCCH is always the same as PUSCH transmission scheduled by a RAR UL grant.However, when 2-step RACH is applied, there is no PUSCH transmission scheduled by a RAR UL grant. The spatial domain transmission filter for PUCCH can be not be determined.In 2-step RACH procedure, PUSCH for Type-2 random access procedure has similar function and transmission parameter as PUSCH scheduled by a RAR UL grant in legacy random access procedure. So, it is straightforward to apply the same spatial domain transmission filter for PUCCH as PUSCH for Type-2 random access procedure when 2-step RACH is applied.***Summary of change:***PUCCH uses the same spatial domain transmission filter as for PUSCH for Type-2 random access procedure.***Consequences if not approved:*** Spatial domain transmission filter determination for PUCCH is missed when 2-step RACH is applied.========CR to TS38.213=======9.2.1 PUCCH Resource Sets<Unchanged part omitted>The UE transmits the PUCCH using the same spatial domain transmission filter as for a PUSCH transmission scheduled by a RAR UL grant as described in Clause 8.3 or PUSCH for Type-2 random access procedure as described in Clause 8.1A<Unchanged part omitted> |