3GPP TSG RAN WG1 #104-e R1-21xxxxx

**e-Meeting, January 25th – February 5th, 2021**

Agenda Item: 7.1

Source: Moderator (vivo)

Title: Summary for [104-e-NR-7.1CRs-16] Draft CR for Msg3 retransmission power control

Document for: Discussion and Decision

# Introduction

This document is a summary for the email discussion thread [104-e-NR-7.1CRs-16] Draft CR for Msg3 PUSCH retransmission power control, focusing on the potential ambiguity on the RS used for pathloss estimation for Msg3 PUSCH retransmission corresponding to a RAR UL grant in connected mode.

This summary is to collect companies’ inputs and decide whether a TP is needed.

[104-e-NR-7.1CRs-16] Draft CR for Msg3 retransmission power control – Siqi (vivo) by Jan 29

**Note that the deadline for the email and the potential TP is set on Jan 29**, **please provide your first-round feedback by UTC 23:59 pm, Jan 26.**

# Phase-1: Discussion and clarification

Based on the discussions till January 22th, it has been observed that companies have different interpretations of the RS used for pathloss estimation for Msg3 PUSCH retransmission (CBRA) in connected mode since there is no specific agreement/description for this case. It would be good to clarify first the common understanding so that companies could be on the same page before discussing whether TPs are needed. The relevant description in the Rel-15 NR specification is cited below:

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| - is a downlink pathloss estimate in dB calculated by the UE using reference signal (RS) index  for the active DL BWP, as described in Clause 12, of carrier  of serving cell  =omitted=  - If the PUSCH transmission is scheduled by a RAR UL grant as described in Clause 8.3, the UE uses the same RS resource index  as for a corresponding PRACH transmission  - If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in DCI format 0\_1 and a set of *PUSCH-PathlossReferenceRS-Id* values. If the PUSCH transmission is scheduled by a DCI format 0\_1 that includes a SRI field, the UE determines the RS resource index  from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*  - If the PUSCH transmission is scheduled by a DCI format 0\_0, and if the UE is provided a spatial setting by PUCCH-SpatialRelationInfo for a PUCCH resource with a lowest index for active UL BWP  of each carrier  and serving cell , as described in Clause 9.2.2, the UE uses the same RS resource index  as for a PUCCH transmission in the PUCCH resource with the lowest index  - If the PUSCH transmission is scheduled by a DCI format 0\_0 and if the UE is not provided a spatial setting for a PUCCH transmission, or by a DCI format 0\_1 that does not include a SRI field, or if *SRI-PUSCH-PowerControl* is not provided to the UE, the UE determines a RS resource index  with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking* |

## 2.1 Msg3 PUSCH retransmission corresponding to a RAR UL grant in connected mode

Msg3 PUSCH initial transmission in connected mode is triggered by a **CBRA** preamble, then the corresponding PUSCH retransmission must be scheduled by DCI format 0\_0 with CRC scrambled by TC-RNTI. In this case, gNB will treat the Msg3 PUSCH retransmission from the connected UE as an idle UE. However, the green highlighted text can be interpreted as that the pathloss RS used for PUCCH transmission using a PUCCH resource with a lowest index or the RS with zero PUSCH-PathlossReferenceRS-Id value should be used for the Msg3 PUSCH retransmission power control.

***Q1. For pathloss RS for Msg3 PUSCH reTX (in contention-based RACH) for connected mode UE, which is your interpretation?***

* **Interpretation1**. Msg3 PUSCH reTX use the same RS as the corresponding Msg3 PUSCH initial TX for pathloss estimation
* **Interpretation2.** Msg3 PUSCH reTX use the same RS as a PUCCH transmission using PUCCH resource with a lowest index or the RS corresponding to PUSCH-PathlossReferenceRS-Id value being equal to zero as specified by the green highlighted text

***Please provide company’s view in the table below.***

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| Company | Interpretation | Comments |
| vivo | Interpretation1 | As gNB cannot recognize the connected UE during the CBRA procedure, it will expect UE to use the same RS for the msg3 initial TX and msg3 reTX. If a different RS is used, the msg3 reTX power can be wrongly set, thus leading to additional retransmission and potential access failure. |
| ZTE | Interpretation 1 |  |
| Docomo | Interpretation 1 | Since gNB cannot identify which UE is transmitting Msg. 3 before contention resolution of CBRA, it is not feasible to use UE dedicated RRC parameter for the Msg. 3 and Msg. 3 re-transmission. |
| Samsung | Interpretation 2 | We did not make any agreement for interpretation1 and current spec supports interpretation 2. |
| CATT | Interpretation 2 | This is the RACH procedure triggered for CONNECTED mode UE, such as PDCCH order and BFR. The lowest RS index for PUCCH or PUSCH usually is the anchor DL RS resource used for the reference signals for the transport of all DL and UL control information. The anchor DL RS (or the associated beam) is mostly used for DL DCI to trigger RACH procedure and associated UL power control. Thus, that is what is captured in the spec.  [vivo-reply]  Thanks for your comment. You mentioned DL DCI triggering RACH, so I guess you are referring to the CFRA case where it may be possible for gNB to indicate a RS the same as the anchor DL RS in the PDCCH order triggering RACH TX. However, this email focuses on the CBRA case where gNB can neither identify the UE during access nor update the anchor RS in advance to accommodate the SSB selected for PRACH TX. |
| Apple | Interpretation 2 | For msg3 retransmission for Idle UE, the pathloss is estimated according to RS from SSB. For Connected UE, msg3 retransmission PL estimation is determined according to higher layer configured parameters. |
| Huawei, HiSilicon | More complicate | Firstly, the proposal should cover both the cases of Msg3 retransmission (CBRA) and PUSCH retransmission scheduled by DCI 0\_0 (CFRA) because the same UE behavior should be ensured since both retransmissions are scheduled by DCI 0\_0 which a subsequent retransmission to a PUSCH scheduled by RAR UL grant. In this case, with respect to the above question, our understanding is that the same RS as the corresponding initial transmission scheduled by RAR UL grant is applied to the retransmission scheduled by DCI 0\_0, irrespective of CFRA and CBRA.  Secondly, the proposal should cover the other case where the retransmission is scheduled by DCI 0\_1 which is only allowed in CFRA.  In current spec, the following text is applied to DCI 0\_1 scheduling a PUSCH  If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in DCI format 0\_1 and a set of *PUSCH-PathlossReferenceRS-Id* values. If the PUSCH transmission is scheduled by a DCI format 0\_1 that includes a SRI field, the UE determines the RS resource index  from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*  With respect to the text above, this PUSCH can be a retransmission of a PUSCH scheduled by RAR UL grant only when the RAR UL grant is a response to contention free random access triggered by a PDCCH order.  The UE behavior should not be changed by the final CR.  Therefore, our proposal is  ***Proposal:***   * *if a PUSCH is scheduled by DCI 0\_0 as a retransmission for an initial PUSCH transmission scheduled by RAR UL grant, the same RS for PL calculation as the initial transmission is applied to the retransmission, irrespective of CFRA and CBRA.* * *If a PUSCH is scheduled by DCI 0\_1 as a retransmission for an initial PUSCH transmission scheduled by RAR UL grant in case of CFRA, the RS determination for PL calculation is the same as any PUSCH transmission scheduled by DCI 0\_1*   [vivo-reply]  Thank you for your comment. Regarding the first bullet, it looks fine to me but it seems CATT has different views on CFRA case, I would like to hear more views.  Regarding the second bullet, my understanding is that the CFRA access procedure completes when the RAR arrives, the PUSCH retransmission corresponding to RAR UL grant scheduled by DCI format 0\_1in this case is a normal PUSCH and it is natural to handle it in the same way as other PUSCH transmission scheduled by DCI format 0\_1. |
| MediaTek | Interpretation 1 | We share the same understanding as vivo. |
| FUTUREWEI | Interpretation 1 |  |
| Intel | Current: Interpretation 2  Intended:  Interpretation 1 | For CBRA, the intended behavior should be interpretation 1. However, we agree with Samsung that the current specification behavior does seem to state interpretation 2.  Similar to Huawei, we also think for the CFRA triggered by PDCCH order, existing behavior should be retained (interpretation 2). However unlike what Huawei mentioned, for this, we think the behavior should be retained for both DCI 0-0 and DCI 0-1. It would be more complicated and quite drastically change legacy Rel-15 behavior if we introduce different mechanics depending on DCI format. |

***Q2. Do you think a TP is necessary? If necessary, for Rel-15 or Rel-16?***

***(Note:*** ***TP of Rel-15 and Rel-16 are provided in the appendix for reference, please have a check. If you have any comments or suggestions about the TPs, please provide your views in this table.)***

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| Company | Necessary or not | Rel-15 or Rel-16 | Comments |
| vivo | Necessary | Either Rel-15 or Rel-16 |  |
| ZTE | Necessary | Rel-16 only is slightly preferred | Considering that Rel-15 spec has been stable for a long period, we slightly prefer to update Rel-16 only. |
| Docomo | Necessary | Either Rel-15 or Rel-16 | In our view, this CR is to clarify the common understanding between companies. If all companies have the same understanding, we prefer to modify it in Rel.15. If there is a company who have different understanding, we are fine to agree it as Rel.16. |
| Samsung | Not necessary |  | The interpretation 1 for Q1 is to align the RS setting between initial and retransmission of msg3.  However, even though the same RS is configured between initial and retransmission of msg3, PL measurement result can be changed since channel is changed.  In this aspect, this issue is different with the same PO\_UE\_PUSCH configuration between initial and retransmission of msg3.  In our understanding, this is an optimization issue.  [vivo-reply]  Thank you for your comment.  If the same RS is used, the difference in estimated pathloss between the initial TX and reTx should be small even if the channel conditions change over time. This is because the estimation of the pathloss is based on the high-level filter RSRP, which is obtained by applying a filter to multiple L1 instances over a long period of time (usually containing several RS transmission cycles or hundreds of milliseconds). The time gap between the msg3 initial TX and reTx is likely to be much smaller compared to the time for high-layer measurements and evaluations, a small number of L1 measurement instances within the time gap has minor impact on the L3 RSRP results after applying the adaptive filter.  However, if different RSs are used, in some cases the difference in RSRP for different RSs can be very large. The RSRP measurement is performed on a per-RS basis and is highly dependent on the relative position of the UE and the beam center of the RS. If the UE is close to the center of the beam of one of the RSs and far from the other, the higher-level filter RSRP for the two RS can be very different, so that the estimated pathloss can be very different. I don't see why this issue is different from the misaligned PO\_UE\_PUSCH configuration discussed in previous meeting, they both introduce an unexpected power gap between the initial TX and reTX, making it impossible for the UE to maintain power continuity across (re)transmission, and can even lead to frequent random access procedures. |
| CATT | Not necessary |  | This question is based on the misinterpretation of question 1 and misunderstanding of UL power control principle. We don’t see the need for any further correction for RACH Msg3 power control. |
| Apple | Not necessary |  | Our understanding is if msg3 is retransmitted, the PL is derived from RS the same as PUCCH transmission, if configured. the msg3 re-transmission will use the same beam as the PUCCH transmission, according to following spec.  38.214 section 6.1  *For PUSCH scheduled by DCI format 0\_0 on a cell, the UE shall transmit PUSCH according to the spatial relation, if applicable, corresponding to the dedicated PUCCH resource with the lowest ID within the active UL BWP of the cell,*  *as described in Subclause 9.2.1 of [6, TS 38.213].* |
| Huawei, HiSilicon | Necessary |  | As commented to Q1, the TP should cover both cases with DCI 0\_0 scheduling, ensuring the same UE behavior. Additionally, the current UE behavior for DCI 0\_1 scheduling should be kept for the retransmission scheduled by DCI 0\_1. |
| MediaTek | Necessary |  |  |
| FUTUREWEI | Necessary | Slightly prefer Rel-16 |  |
| Intel | Might be necessary, but need further discussion | Depends (see comments) | We think it would be clarify what the goal of the CR should be.  If the goal is fix the specification and clarify the UE behavior according to what is being implemented by vendors, then fixing the specification should be applied to both rel-15 and 16 as it should not impact Rel-15 UE that may have been deployed already.  If that is not the case, and we are trying to fix a wrongfully implemented behavior, we think it should be only for Rel-16, as changing Rel-15 behavior at this time has severe consequences.  As for whether the CR is needed. We generally think the CR could be useful (and possibly necessary) but would like see what the CR is changing. As mentioned above if this change is also changing the CFRA by PDCCH order behaviors, that may not be ok. |

## 2.2 Others

***If you have comments on other cases, please provide your views in the table below.***

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| Company | Comments |
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# Summary of Phase-1 discussion

According to the first-round inputs, the majority view(eight companies) is that interpreation1 should be the expected UE behavior for Msg3 PUSCH reTX (**CBRA**) in connected mode to determine pathloss RS, it also seems that the majority prefer to have a TP, three companies prefer to have a TP in Rel-16 to avoid the risk of changing the Rel-15 behavior.

Three companies support interperation2 and stated that the current specification can be understood as that Msg3 PUSCH reTX is performed based on the interpretation2.

One company commented that interpretation1 should also be considered for the case of PUSCH scheduled by DCI 0\_0 as retransmission for an initial PUSCH transmission scheduled by RAR UL grant in case of **CFRA**, however, the views are diverging on this case.

Regarding the case of PUSCH scheduled by DCI 0\_1 as retransmission for an initial PUSCH transmission scheduled by RAR UL grant in case of CFRA, there seems to be a common understanding among companies that the UE behavior as defined in the current specification for PUSCH scheduled by DCI format 0-1 should be retained, so no further clarification is needed.

# Phase-2: Conclusion and TP

Moderator suggests **focusing on the CBRA case only**. It is identified that interpration2 can lead to different power settings for Msg3 PUSCH reTX and initial transmission. However, the most controversial part of the discussion is that some companies believe that the difference in pathloss estimates between the initial TX and reTX with interpretation2 could be significant in some cases, causing retransmission failure and may even hurt gNB operation, while others think that it will not and can be properly handled by gNB. Given this situation, moderator suggests three directions to move forward.

**Regarding the pathloss RS for Msg3 PUSCH reTX (in contention-based RACH) for connected mode UE**

* Alt1. Agree that intepretation1 is correct, make a RAN1 conclusion or TP for Rel-16
* Alt2. Agree that intepretation2 is correct, make a RAN1 conclusion and no spec change is expected
* Alt3. Conclude that UE can implement in either interpretation and it is up to gNB to ensure that UE with different interpretations can work properly.

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| Company | Comments |
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# Appendix

## < TP for Msg3 reTX (CBRA) for Rel-16 fore reference>

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| - If the PUSCH transmission is scheduled by a RAR UL grant as described in Clause 8.3, or for a Msg3 PUSCH retransmission, or for a PUSCH transmission for Type-2 random access procedure as described in Clause 8.1A, the UE uses the same RS resource index as for a corresponding PRACH transmission  - If the UE is provided *SRI-PUSCH-PowerControl* and more than one values of *PUSCH-PathlossReferenceRS-Id*, the UE obtains a mapping from *sri-PUSCH-PowerControlId* in *SRI-PUSCH-PowerControl* between a set of values for the SRI field in a DCI format scheduling the PUSCH transmission and a set of *PUSCH-PathlossReferenceRS-Id* values and determines the RS resource index from the value of *PUSCH-PathlossReferenceRS-Id* that is mapped to the SRI field value where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*  - Except for Msg3 PUSCH retransmission, if the PUSCH transmission is scheduled by DCI format 0\_0, and if the UE is provided a spatial setting by PUCCH-SpatialRelationInfo for a PUCCH resource with a lowest index for active UL BWP of each carrier and serving cell , as described in Clause 9.2.2, the UE uses the same RS resource index as for a PUCCH transmission in the PUCCH resource with the lowest index  - If the PUSCH transmission is not scheduled by DCI format 0\_0, and if the UE is provided *enableDefaultBeamPL-ForSRS* and is not provided *PUSCH-PathlossReferenceRS* and *PUSCH-PathlossReferenceRS-r16,* the UE uses the same RS resource index as for an SRS resource set with an SRS resource associated with the PUSCH transmission  - If  - the PUSCH transmission except for Msg3 PUSCH retransmission is scheduled by DCI format 0\_0 and the UE is not provided a spatial setting for a PUCCH transmission, or  - the PUSCH transmission is scheduled by DCI format 0\_1 or DCI format 0\_2 that does not include an SRI field, or  - *SRI-PUSCH-PowerControl* is not provided to the UE,  the UE determines a RS resource index with a respective *PUSCH-PathlossReferenceRS-Id* value being equal to zero where the RS resource is either on serving cell or, if provided, on a serving cell indicated by a value of *pathlossReferenceLinking*  - If  - the PUSCH transmission except for Msg3 PUSCH retransmission is scheduled by DCI format 0\_0 on serving cell ,  - the UE is not provided PUCCH resources for the active UL BWP of serving cell , and  - the UE is provided *enableDefaultBeamPL-ForPUSCH0-0*  the UE determines a RS resource index providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the serving cell  - If  - the PUSCH transmission except for Msg3 PUSCH retransmission is scheduled by DCI format 0\_0 on serving cell ,  - the UE is not provided a spatial setting for PUCCH resources on the active UL BWP of the primary cell [11, TS 38.321], and  - the UE is provided *enableDefaultBeamPL-ForPUSCH0-0*  the UE determines a RS resource index providing a periodic RS resource configured with *qcl-Type* set to 'typeD' in the TCI state or the QCL assumption of a CORESET with the lowest index in the active DL BWP of the serving cell |

# Reference

1. R1-2100406 Draft CR for Msg3 retransmission power control, vivo, e-Meeting, January 25th – February 5th, 2021