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

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

**Source: Moderator (ZTE)**

**Title: Email Discussion Summary of [106-e-NR-7.1CRs-03]**

**Agenda item: 7.1**

**Document for:** **Discussion/Decision**

# Introduction

During RAN1#106-e, three contributions were submitted to discuss and clarify the ambiguity issue for accumulated closed loop power control for BWP switching [1-3]. During the preparation phase, companies agreed to discuss this issue in RAN1#106-e meeting.

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| [106-e-NR-7.1CRs-03] Issue#5: Draft CR on accumulated closed loop power control for BWP switching by August 20 – Bo (ZTE)[R1-2106536](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106536.zip) Discussion on accumulated closed loop power control for BWP switching ZTE[R1-2106537](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2106537.zip) Draft CR on accumulated closed loop power control for BWP switching ZTE[R1-2107503](file:///D%3A%5CDocuments%5C3GPP%20documents%5CRAN1%5CTSGR1_106-e%5CDocs%5CR1-2107503.zip) Draft 38.213 CR on PUSCH/PUCCH power control adjustment state during UL BWP change MediaTek Inc. |

This summary is trying to collect/summarize companies’ input and draw potential TP based on companies’ input.

# Discussion

## Background introduction

In current NR spec [4], power control parameters, such as parameters for open loop power control (e.g. P0, alpha), for closed loop power control (e.g. number of closed loop power control loops), and for path loss (e.g. PL-RS, i.e. DL RS for path-loss measurement), are configured per BWP *b* per carrier *f* per cell *c*. However, it is not clear for the UE behavior on how to handle accumulated closed loop value in the new active BWP in the case of UL BWP change.

***Observation****: From spec perspective, there is no clear UE behavior on handling accumulated closed loop value in the case of UL BWP change.*

Furthermore, when reviewing the already RAN1 agreement, it can be observed that in RAN1 #90-bis, it is agreed that up to 2 closed-loop power control processes is maintained for PUSCH:

Agreement: For N closed-loop power control processes, i.e., fc(i,l), for NR PUSCH power control for serving cell c, the following working assumption is confirmed:

* **N is up to 2**

In RAN1 #90-bis, it is also agreed as a working assumption that up to 2 closed-loop power control processes is maintained for PUCCH:

Working Assumption:

* Support *P*cmax,c(*i*), *P*0\_PUCCH(*F*), *PL*c(*k*), g(*i*) for NR PUCCH power control in slot *i* for serving cell *c*.
* **Support up to 2 closed-loop power control processes, i.e., *l***

It means that configuring each UL BWP with up to two independent power control adjustment states is NOT aligned with the agreements in RAN1#90-bis (i.e., up to 2 for PUSCH, and up to 2 for PUCCH, per serving cell).

For sake of presentation, in both [1] and [3], some examples are raised for clarifying the difference between “per BWP power state control” and “per cell power state control”. One example in [3] is copied as follows. It can be observed that “per cell power state control” offers benefits for Tx power continuity over “per BWP power state control” when UL BWP changes. Some more details can be found in companion contributions [1], [2] and [3].



**Figure 1** Illustrative example of “per BWP power state control” v.s. “per cell power state control”

## Companies’ input

According to the input from contributions [1-3], clarifying the UE behavior on how to handle accumulated closed loop power control value in the new active BWP when active BWP changes becomes essential and necessary. In such case, the ‘per cell power state control’ is aligned with already agreement, and is beneficial for transmit power continuity.

* Specifically, for each closed loop *l*, when BWP changes, the accumulated closed loop value for the new BWP should be reset or re-determined according to the accumulated closed loop value from the previous BWP.

For moving forward this issue, we will try to reach consensus/agreement between companies firstly; after that, the draft TP based on the consensus/agreement will be discussed accordingly.

Based on above, the following proposal is provided.

***Proposal:*** *For each accumulated closed loop l in a serving cell/uplink, UE shall use the same PUSCH/PUCCH/SRS power control adjustment state (i.e.,*//*) before and after UL BWP changes.*

* *Note that the UE is not expected to maintain more than two PUSCH/PUCCH power control adjustment states and more than one independent SRS power control adjustment state (i.e., not tied to PUSCH closed loop) per serving cell/uplink.*

Please provide company’s view in the table below.

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| Company | Comment |
| Futurewei | We do not support this. Our view is that the power control state should be reset to zero after BWP switch since other power control parameters and PL-RS can be all different now. Note that by resetting to zero, the UE only maintains up to 2 close loop power control states for the active BWP. |
| Apple | Support the proposal. There was no agreement that BWP switching would have any impact on CL-PC state. So UE should still maintain the CL-PC state.  |
| MTK | We support the moderator proposal. It resolves the spec ambiguity and avoid misunderstanding between NW/UE on the behavior of power state control. Also, the **moderator proposal provides benefits for transmit power continuity** compared to “per BWP power state control” or “reset to zero after BWP switch”. |
| OPPO | Support the proposal. Reply to Futurewei’s comment: In Rel-15, there were proposals and discussions to reset the value when BWP is switching, but it was not agreed. Thus, the value should be maintained after BWP switching.  |
| CATT | We are OK with the proposal as the conclusion without any change of specification. The power control is per cell. The footnote of BWP at the power control formula is to indicate the current active BWP. There is no need to specify any power control behavior for BWP change.  |
| vivo | We agree with the intend of the moderator proposal, as it is consistent with the RAN1#90bis agreement. And we are fine with either making an RAN1 conclusion, or a spec change.  |
| Samsung | Okay with the proposal. Although there is no explicit agreement/conclusion in case of BWP change, it is more natural to maintain closed loop regardless of BWP instead of resetting.  |
| CMCC | Ok with the proposal, we are fine to clarify the CL-PC behavior. |
| DOCOMO | Ok with the proposal. We are fine to clarify the CL-PC behavior in case of BWP switching.  |
| Intel | We are fine with the proposal. In case of BWP switching, the power control adjustment state needs to be maintained. |
| Futurewei2 | Thanks for the discussion. As a number of companies mentioned, there was no conclusion in RAN1 on this issue before. Some companies argued that we need to maintain the transmit power continuity and hence keep the value of the closed loop power control state unchanged after BWP switching. However, power control parameters are configured per BWP including the open loop parameters, closed loop parameters, and PL RS. When open loop parameters and PL RS all changed due to BWP switching, we fail to see the reason and benefit to only keep the close loop state value. No transmit power continuity can be secured. Furthermore, for each UL BWP, the interference situation and the network power control, resource allocation, scheduling consideration can be quite different in addition to that of open loop parameters and PL RS. Therefore, resetting the closed loop state value should be the proper technical solution instead of keep it unchanged after BWP switching. And we cannot agree with the current proposal. |
| Huawei, HiSilicon | Considering independent closed-loop states between PUSCH and PUCCH, as well as between PUSCH and SRS in some configuration, suggest a small clarification to the proposal (in green).“ … *UE shall use the same PUSCH/PUCCH/SRS power control adjustment state (i.e.,*//*), respectively, before and after UL BWP change**“s* |
| QC | We are fine with the proposal as a clarification/consensus. In most cases, if not always, it is beneficial to keep the PC accumulation at BWP switching. When NR PC was designed, power control per cell was assumed. And, if necessary, network could configure different loops for two BWPs that will not share the PC accumulation. Or alternatively, network can reconfigure the open-loop parameter of the target BWP after BWP switching. |

If supporting the above proposal, please provide company’s views on two candidate CRs in [2] (R1-2106537) and [3] (R1-2107503) as in the appendix (e.g., which one is preferred, or suggestions on drafting CR); otherwise, please provide the recommended spec change.

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| Company | Comment |
| Futurewei | This can be discussed later after the first issue is concluded.  |
| Apple | Support R1-2106537 |
| MTK | We support both the two candidate CRs in [2] (R1-2106537) and [3] (R1-2107503), based on the moderator proposal. For our CR proposal in [3], **the text “per serving cell” should be modified to be “per serving cell/uplink”** as used in the moderator proposal. |
| OPPO  | We are open to either TP. Another possible TP is just to add similar sentence as below to the spec TS 38.213:*UE maintains up to two power control adjustment states for PUSCH and PUCCH per serving cell/uplink.*Since the spec describes the cases where the accumulated value is reset. BWP switching is not included in these cases. Thus, the above description seems sufficient to address the issue. |
| CATT | We don’t see the need of CR since it is very clear that the closed-loop power control is not subject to change during BWP switching.  |
| Vivo | The CR text, if necessary, can be discussed in the next phase.  |
| Samsung | Okay in principle. However, current proposed TP may not work in the case where two BWPs have different *tpc-Accumulation* configurations: one is accumulate mode and the other one is absolute mode.* For example, for PUSCH, it is likely that  can be accumulated value or absolute value according to configuration. So, it is unclear how a UE maintains value when 1) BWP 1 (configured with accumulated mode) is changed to BWP 2 (configured with absolute mode) or 2) BWP 2 (configured with absolute mode) is changed to BWP 1 (configured with accumulated mode). Therefore, to avoid such ambiguous situation in future, we would like to suggest to have a same configuration for all BWPs in a serving cell because it has no UE impact as follows.

“*the UE expects to be provided a same configuration of tpc-Accumulation for each of BWPs of carrier f of serving cell c*”* Between two TPs, we slightly prefer TP#2 with some modification as follows. For SRS and PUCCH, text in below can be applied similarly

*“For each, the UE ~~uses~~ assumes the ~~same~~ common PUSCH power control adjustment state  ~~before and after UL BWP change~~ to each configured BWP of carrier f of serving cell c.”** We don’t think that it is necessary to add something like *“A UE is not expected to maintain more than xxx PUSCH/PUCCH/SRS power control adjustment states per serving cell”* because the proposed sentence of keeping “same/common power control adjustment itself” includes the meaning. Regarding the maximum number of closed loop states, it is already clearly specified in RRC.
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| CMCC | We are fine to either TP. |
| DOCOMO | Generally fine with either TP. On Samsung’s first point, we are not sure why a same configuration would be required among BWPs as we understand that the TPs are talking about the accumulation in the same BWP but after BWP switching.  |
| Intel | We slightly prefer R1-2106537.  |
| Huawei, HiSilicon | We prefer R1-2107503 with the updates from MediaTek in this thread.The TP in R1-2106537 is not well aligned with the FL proposal because the text can incorrectly assign the value of closed loop state#1 to closed loop state#0 in the following case,* BWP switching from BWP#1 to BWP#2
* The last PUSCH transmission in BWP#1 is associated with closed loop state#1, but the succeeding PUSCH transmission in BWP#2 is associated with closed loop state#0.
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| Samsung2 | On top of our previous comment, we prefer following TP based on MediaTek’s version for simplicity as follows. Still, we don’t think that second sentence is necessary because this can be seen as gNB misconfiguration.  *- A PUSCH/PUCCH power control adjustment state for a UE is unaffected by an UL BWP change.*  |

# Summary

The following potential TP is updated based on the companies’ input.

**Draft TP**

# Reference

[1] R1-2106536, Discussion on accumulated closed loop power control for BWP switching, ZTE

[2] R1-2106537, Draft CR on accumulated closed loop power control for BWP switching, ZTE

[3] R1-2107503, Draft 38.213 CR on PUSCH/PUCCH power control adjustment state during UL BWP change, MediaTek Inc.

[4] 3GPP TS 38.213-fe0, NR Physical layer procedures for control

# Appendix

## Candidate TP#1 in R1-2106537

In [2] (R1-2106537), the following candidate TP is provided for PUSCH/PUCCH/SRS:

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| 7.1.1 UE behaviour<Unchanged part omitted>-  is the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is not provided *tpc-Accumulation*, where - The  values are given in Table 7.1.1-1-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUSCH transmission occasion  and  symbols before PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  for PUSCH power control adjustment state , where  is the smallest integer for which  symbols before PUSCH transmission occasion  is earlier than  symbols before PUSCH transmission occasion - If a PUSCH transmission is scheduled by a DCI format 0\_0 or DCI format 0\_1,  is a number of symbols for active UL BWP  of carrier  of serving cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUSCH transmission - If a PUSCH transmission is configured by *ConfiguredGrantConfig*,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of serving cell  - If the UE has reached maximum power for active UL BWP of carrier  of serving cell  at PUSCH transmission occasion  and , then - If UE has reached minimum power for active UL BWP of carrier  of serving cell  at PUSCH transmission occasion  and , then - For the first PUSCH transmission occasion after an active UL BWP changes, a power control adjustment state is determined by a latest PUSCH power control adjustment state from the previous BWP.- A UE resets accumulation of a PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  to - If a configuration for a corresponding  value is provided by higher layers- If a configuration for a corresponding  value is provided by higher layerswhere  is determined from the value of  as - If  and the UE is provided higher *SRI-PUSCH-PowerControl*,  is the *sri-PUSCH-ClosedLoopIndex* value(s) configured in any *SRI-PUSCH-PowerControl* with the *sri-P0-PUSCH-AlphaSetId* value corresponding to  - If  and the UE is not provided *SRI-PUSCH-PowerControl* or , - If ,  is provided by the value of *powerControlLoopToUse*<Unchanged part omitted>7.2.1 UE behaviour<Unchanged part omitted>-  is the current PUCCH power control adjustment state  for active UL BWP  of carrier  of serving cell  and PUCCH transmission occasion , where - The  values are given in Table 7.1.2-1-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before PUCCH transmission occasion  and  symbols before PUCCH transmission occasion  on active UL BWP  of carrier  of serving cell  for PUCCH power control adjustment state, where  is the smallest integer for which  symbols before PUCCH transmission occasion  is earlier than  symbols before PUCCH transmission occasion - If the PUCCH transmission is in response to a detection by the UE of a DCI format 1\_0 or DCI format 1\_1,  is a number of symbols for active UL BWP  of carrier  of serving cell  after a last symbol of a corresponding PDCCH reception and before a first symbol of the PUCCH transmission- If the PUCCH transmission is not in response to a detection by the UE of a DCI format 1\_0 or DCI format 1\_1,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of serving cell - If the UE has reached maximum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then - If UE has reached minimum power for active UL BWP  of carrier  of primary cell  at PUCCH transmission occasion  and , then  - For the first PUCCH transmission occasion after an active UL BWP changes, a power control adjustment state is determined by a latest PUCCH power control adjustment state from the previous BWP.- If a configuration of a  value for a corresponding PUCCH power control adjustment state  for active UL BWP  of carrier  of serving cell  is provided by higher layers, -  If the UE is provided *PUCCH-SpatialRelationInfo*, the UE determines the value of  from the value of  based on a *pucch-SpatialRelationInfoId* value associated with the *p0-PUCCH-Id* value corresponding to  and with the *closedLoopIndex* value corresponding to ; otherwise, - Else, - , where , and  is the TPC command value indicated in a random access response grant corresponding to a PRACH transmission or is the TPC command value in a DCI format with CRC scrambled by C-RNTI or MCS-C-RNTI that the UE detects in a first PDCCH reception in a search space set provided by *recoverySearchSpaceId* if the PUCCH transmission is a first PUCCH transmission after 28 symbols from a last symbol of the first PDCCH reception, and, if the UE transmits PUCCH on active UL BWP  of carrier  of serving cell , ; otherwise,  where  is provided by higher layers and corresponds to the total power ramp-up requested by higher layers from the first to the last preamble for active UL BWP  of carrier  of primary cell , and  corresponds to PUCCH format 0 or PUCCH format 1<Unchanged part omitted>7.3.1 UE behaviour<Unchanged part omitted>-  if the UE is not configured for PUSCH transmissions on active UL BWP  of carrier  of serving cell , or if *srs-PowerControlAdjustmentStates* indicates separate power control adjustment states between SRS transmissions and PUSCH transmissions, and if *tpc-Accumulation* is not provided, where - The  values are given in Table 7.1.1-1-  is jointly coded with other TPC commands in a PDCCH with DCI format 2\_3, as described in Clause 11.4-  is a sum of TPC command values in a set  of TPC command values with cardinality  that the UE receives between  symbols before SRS transmission occasion  and  symbols before SRS transmission occasion  on active UL BWP  of carrier  of serving cell  for SRS power control adjustment state, where  is the smallest integer for which  symbols before SRS transmission occasion  is earlier than  symbols before SRS transmission occasion - if the SRS transmission is aperiodic,  is a number of symbols for active UL BWP  of carrier  of serving cell  after a last symbol of a corresponding PDCCH triggering the SRS transmission and before a first symbol of the SRS transmission - if the SRS transmission is semi-persistent or periodic,  is a number of  symbols equal to the product of a number of symbols per slot, , and the minimum of the values provided by *k2* in *PUSCH-ConfigCommon* for active UL BWP  of carrier  of serving cell  - If the UE has reached maximum power for active UL BWP  of carrier  of serving cell  at SRS transmission occasion  and , then - If UE has reached minimum power for active UL BWP  of carrier  of serving cell  at SRS transmission occasion  and , then - For the first SRS transmission occasion after an active UL BWP changes, a power control adjustment state is determined by a latest SRS power control adjustment state from the previous BWP.- If a configuration for a  value or for a  value for a corresponding SRS power control adjustment state  for active UL BWP  of carrier  of serving cell  is provided by higher layers-  - Else-  where is the TPC command value indicated in the random access response grant corresponding to the random access preamble that the UE transmitted on active UL BWP  of carrier  of the serving cell , and ; where  is provided by higher layers and corresponds to the total power ramp-up requested by higher layers from the first to the last preamble for active UL BWP  of carrier  of serving cell .<Unchanged part omitted> |

## Candidate TP#2 in R1-2107503

In [3] (R1-2107503), the following candidate TP is provided for PUSCH/PUCCH:

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| 7.1.1 UE behaviour<Unchanged parts are omitted>For the PUSCH power control adjustment state  for active UL BWP  of carrier  of serving cell  in PUSCH transmission occasion -  is a TPC command value included in a DCI format 0\_0 or DCI format 0\_1 that schedules the PUSCH transmission occasion  on active UL BWP  of carrier  of serving cell  or jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUSCH-RNTI, as described in Clause 11.3-  if the UE is configured with *twoPUSCH-PC-AdjustmentStates* and  if the UE is not configured with *twoPUSCH-PC-AdjustmentStates* or if the PUSCH transmission is scheduled by a RAR UL grant as described in Clause 8.3- For each, UE uses the same PUSCH power control adjustment state  before and after UL BWP change. A UE is not expected to maintain more than two PUSCH power control adjustment states per serving cell<Unchanged parts are omitted>7.2.1 UE behaviour<Unchanged parts are omitted>For the PUCCH power control adjustment state  for active UL BWP  of carrier  of primary cell  and PUCCH transmission occasion -  is a TPC command value and is included in a DCI format 1\_0 or DCI format 1\_1 for active UL BWP  of carrier  of the primary cell  that the UE detects for PUCCH transmission occasion  or is jointly coded with other TPC commands in a DCI format 2\_2 with CRC scrambled by TPC-PUCCH-RNTI [5, TS 38.212], as described in Clause 11.3-  if the UE is provided *twoPUCCH-PC-AdjustmentStates* and *PUCCH-SpatialRelationInfo* and  if the UE is not provided *twoPUCCH-PC-AdjustmentStates* or *PUCCH-SpatialRelationInfo*- For each, UE uses the same PUCCH power control adjustment state  before and after UL BWP change. A UE is not expected to maintain more than two PUCCH power control adjustment states per serving cell<Unchanged parts are omitted> |