**3GPP TSG RAN WG1 Meeting #104-e R1-210xxxx**

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

**Source: Moderator (ZTE)**

**Title: Summary on [104-e-NR-7.1CRs-07]**

**Agenda item: 7.1**

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

# Introduction

In RAN1#104-e, the potential ambiguous issue about closed-loop power control with an absolute TPC command was discussed and identified in [1-2]. During the preparation phase, companies agreed to discuss this issue in RAN1#104-e meeting.

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| [104-e-NR-7.1CRs-07] Draft CR on closed-loop power control with an absolute TPC command – Bo (ZTE) by Jan 29   * For Rel-16 only |

This summary is trying to collect/summarize companies’ input and draw a potential TP for **Rel-16 only**, according to companies’ input.

# Discussion

## Background introduction

In NR, there are two types of closed-loop power control (CL-PC): accumulated CL-PC and absolute CL-PC. In 38.213 as shown below, we have the following observation.

* It is clearly specified how to obtain TPC command(s)  for a given PUSCH transmission with accumulated CL-PC.
* However, for absolute CL-PC (as highlighted before), the UE behaviour of determining TPC command for a given PUSCH transmission with an absolute CL-PC is not specified and thus unclear.

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| - 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 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  ...  -  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  ...  -  is the PUSCH power control adjustment state for active UL BWP  of carrier  of serving cell  and PUSCH transmission occasion  if the UE is provided *tpc-Accumulation*, where  -  absolute values are given in Table 7.1.1-1  - If the UE receives a random access response message in response to a PRACH transmission on active UL BWP  of carrier  of serving cell  as described in Clause 8 |

According to our best knowledge and initial discussion during the preparation phase, the following unclear aspects were identified for further discussion.

* **Q1**: For DG (dynamic grant) PUSCH transmission, besides the DCI format scheduling the PUSCH, whether the TPC in DCI format 2\_2 can also be applied?
* **Q2:** For CG (configured grant) PUSCH transmission, what is the exact timeline for determining TPC command for CG PUSCH, e.g., latest DCI format **'KPUSCH,min' symbols** before transmission for CG PUSCH, or just latest DCI format before transmission for CG PUSCH?
* **Q3**: For CG PUSCH transmission, besides the DCI format 2\_2, whether the TPC in DCI format 0\_0/1/2 can also be applied (with the same closed loop index)?

## Companies’ input

Based on initial discussion, it seems that companies’ views about Q1 and Q2 have been converged.

* Regarding Q1, only DCI format scheduling the PUSCH can be applied for determining absolute TPC corresponding to DG PUSCH;
* Regarding Q2, absolute TPC in DCI format **'KPUSCH,min' symbols** before transmission is applied for determining absolute TPC corresponding to CG PUSCH.

Note that  is 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 . It has already been specified as for CG PUSCH transmission in an accumulative CL-PC.

But, the following two interpretations (or called as two solutions) are identified for Q3:

* Interpretation-1: Absolute TPC is **only** received from **group-common** DCI for CG PUSCH.
* Interpretation-2: Absolute TPC is received from **group-common** **or UE-specific** DCI for CG PUSCH.
  + Notice that the scheduling DCI and UE-specific DCI correspond to DCI format 0\_0/1/2, and group-common DCI corresponds to DCI format 2\_2.

In short, the main difference is that for CG PUSCH, whether absolute TPC in UE-specific DCI should be considered, besides group-common DCI.

Based on our best knowledge, the technical reasons for above two interpretations are summarized as follows, for the sake of cross reviews.

* Evidences/logics for interpretation-1：
  + For absolute TPC, we have the following description for closed loop value, and then the definition for is copied herein.

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| - 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 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 |

* + For CG PUSCH, there is NO DCI format that schedules the PUSCH transmission (as above highlighted in green), and consequently the absolute TPC in UE-specific DCI should NOT be considered.
* Evidences/logics for interpretation-2:
  + Close loop index is configured by RRC and associated with dynamic scheduled PUSCH and/or configured PUSCH, and so a close loop state indexed by *l* is updated by a TPC command associated to index *l*.
  + If precluding TPC in UE-specific DCI for CG PUSCH (as recommended in interpretation-1),
    - Not allowing network to indicate a UE the same close loop state for both dynamic grant and configured grant, so that the same close loop state is shared by both kinds of PUSCH.
    - Force a UE capable of FG 5-19/5-20 to support FG 8-4 tpc-PUSCH -RNTI
    - Require a UE capable of FG 5-19/5-20 to implement the third close loop state.

In first round, let’s collect views from companies and try to reach consensus about above three questions. After that, we can further consider how to draft the corresponding TP accordingly.

***Sub-issue #1(related to Q1 and Q2):***

***Proposal:*** *Absolute TPC is received from scheduling DCI for DG PUSCH, or latest DCI KPUSCH, min symbols before transmission for CG PUSCH.*

* *Note: the issue that absolute TPC in which type(s) of DCI format (e.g., group-common or UE-specific DCI formats) is applied to CG PUSCH will be discussed in Sub-issue #2.*

Please provide company’s view in the table below.

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| Company | Comment |
| Huawei, HiSilicon | Firstly, the proposal is unclear whether it is for an agreement or a conclusion. It should be a conclusion because it has no spec impact but reflects what the current spec is.  Secondly, the subbullet seems to make it as an open issue thus it is not good to be a part of any conclusion. If any necessary, this proposal can be discussed after the sub-issue #2 is resolved for the following reason,   * The framework of close-loop power control is as simple as that TPC command updates the close-loop state/register and PUSCH transmission takes the latest close-loop state/register into account when its preparation begins. * A close-loop state/register is shared by dynamic PUSCH and configured PUSCH if the same close-loop index is indicated by gNB to them which has been reflected by the current spec that the close-loop state/register of power control (i.e.  in TS 38.213 ) has not subscript to differentiate dynamic PUSCH from configured PUSCH. * Since the close-loop state/register can be updated by TPC command from DCI 0\_1/0\_2 (dynamic PUSCH), the TPC command also impacts on subsequent configured PUSCHs. So does DCI 2\_2.   Thirdly, the proposal seems to introduce a new UE behavior which is not necessary for the following reason,   * TPC command updates an indicated close-loop state/register of power control (i.e.  in TS 38.213 ) irrespective of absolute TPC command or accumulated TPC command, then PUSCH transmission must take the latest close-loop state/register into account if timing (as offset  in TS 38.213) is applicable. In short, the same UE behavior is also applied to absolute TPC. No need to make a new agreement specific to absolute TPC command. If it is deemed to be necessary, as least it should clearly reuse the same timing in current spec, i.e.   ***Proposal****: As a conclusion, the same timing offset  that has been specified in TS 38.213 for PUSCH power control is also applied to the case of an absolute TPC command.* |
| CATT | The spec is very clear for absolute power control. For absolute power control, there is no racing condition in TPC accumulation between different DCI. Thus, there is no ambiguity in the spec.  The DCI for TP commends are as follows  is a TPC command value included in a DCI format 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 |
| OPPO | We agree that if the same close loop index is configured for DG and CG based PUSCH, the same close loop adjustment state can be applied to both PUSCHs (though may be different). UE is not needed to maintain more than two close loop adjustment processes. Correction to the current specification is not needed. We are open to have a conclusion to make it clearer if needed. |
| Intel | In our understanding, according the configured close loop index for DG and CG PUSCH, the absolute TPC can be obtained from the latest available DCI format, no matter it is the DCI scheduling the DG PUSCH or DCI format 2\_2. |
| FUTUREWEI | We have same understanding as CATT, OPPO, and Intel. Do not see a need for CR or new conclusion. |

***Sub-issue #2(related to Q3):***

The following two candidate interpretations are identified for Q3:

* Interpretation-1: Absolute TPC is **only** received from **group-common** DCI for CG PUSCH.
* Interpretation-2: Absolute TPC is received from **group-common or UE-specific** DCI for CG PUSCH.
  + Note: UE-specific DCI corresponds to DCI format 0\_0/1/2, and group-common DCI corresponds to DCI format 2\_2, and the timeline for determining TPC for CG PUSCH (e.g., **'KPUSCH,min' symbols** before CG PUSCH transmission) is clarified in Sub-issue #1.
  + Note: as a basic assumption, the absolute TPC and the CG PUSCH as discussed above should be associated with same closed loop index.

Please provide company’s view (including suggestion about how to handle this sub-issue) in the table below.

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| Company | Comment |
| Huawei, HiSilicon | It cannot be interpretation-1.  Reiterate our comment above   * The framework of close-loop power control is as simple as that TPC command updates the close-loop state/register and PUSCH transmission takes the latest close-loop state/register into account when its preparation begins. * A close-loop state/register is shared by dynamic PUSCH and configured PUSCH if the same close-loop index is indicated by gNB to them which has been reflected by the current spec that the close-loop state/register of power control (i.e.  in TS 38.213 ) has not subscript to differentiate dynamic PUSCH from configured PUSCH. * Since the close-loop state/register can be updated by TPC command from DCI 0\_1/0\_2 (dynamic PUSCH), the TPC command also impacts on subsequent configured PUSCHs. So does DCI 2\_2.   In short, our understanding is the following  ***Observation****: if the same close-loop index l is indicated to a UE for dynamic PUSCH and configured PUSCH, the same close-loop state is shared by them. Any TPC command (absolute/accumulated) impacting the close-loop state has impact on both the dynamic PUSCH and the configured PUSCH.*  Please note that interpretation-1 changes the current Rel-15 UE behavior by   * Not allowing network to indicate a UE the same close loop state for both dynamic grant and configured grant, so that the same close loop state is shared by both kinds of PUSCH. * Force a UE capable of FG 5-19/5-20 to support FG 8-4 tpc-PUSCH-RNTI * Require a UE capable of FG 5-19/5-20 to implement the third close loop state. |
| CATT | Interpretation 2  TPC command in the DCI for both accumulated and absolute closed-loop power control is as follows,  is a TPC command value included in a DCI format 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 |
| OPPO | Interpretation 2  As mentioned, only one adjustment state will be maintained for the same close loop index, regardless of it is applied to DG or CG based PUSCH. |
| Intel | Interpretation 2  As commented by CATT, the spec captures the definition of  that includes both DCI formats. |
| FUTUREWEI | Same understanding as CATT, OPPO, and Intel. |

# Summary

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

**Draft TP**

# Reference

[1] R1-2100283, Discussion on closed-loop power control with an absolute TPC command, ZTE

[2] R1-2100284, Draft CR on closed-loop power control with an absolute TPC command, ZTE