3GPP TSG-RAN WG1 Meeting #110bis R1-220xxxx

e-Meeting, October 10th – 14th, 2022

**Agenda item:** 7.1

**Source:** Moderator (Qualcomm Incorporated)

**Title:** [110bis-e-NR-R15-08] - Discussion on timeline for group power control command

**Document for:** Discussion and Decision

# Background

This email discussion is to treat the following contribution (CR for Rel-16):

R1-2209934 Draft CR on Clarification on timelines for group power control command Qualcomm Incorporated

The contribution above proposes to define the timelines for group power control as . According to the proponents, based on the current specifications the UE has zero or negative time to decode a DCI and apply the TPC command. For completeness, the “reasons for change”, “summary of change” and actual CR change are shown below:

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| ***Reason for change:*** | Current specification does not clarify what is the required timeline for application of TPC commands carried over group DCIs (DCI format 2\_2 scrambled by TPC-PUCCH-RNTI or TPC-PUSCH-RNTI, or DCI format 2\_3 scrambled by TPC-SRS-RNTI).  For instance, if we conside the case of using 2\_2 for power control of CG-PUSCH, where the CG-PUSCH reads as follows (TS 38.213, 7.1.1):  - 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  *k2* is defined in TS 38.331 as follows:  PUSCH-TimeDomainResourceAllocation ::=  SEQUENCE {     k2                                      INTEGER(0..32)                                  OPTIONAL,   -- Need S     mappingType                             ENUMERATED {typeA, typeB},     startSymbolAndLength                    INTEGER (0..127) }  The minimum value for *k2* is zero, therefore can be zero. This leads to the UE having to apply the TPC command non-causally, which is non-implementable.  A similar issue is present in subclause 7.2.1 for PUCCH and 7.3.1 for SRS. |
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| ***Summary of change:*** | Clarify that the timeline between the reception of a TPC command and its application to a PUSCH is . This timeline is the same as the one defined in 11.1.1. |

11.3 Group TPC commands for PUCCH/PUSCH

**<Unchanged parts are omitted>**

The UE does not expect to apply a TPC command on a PUSCH or PUCCH transmission if the first symbol of the PUCCH or the PUSCH occurs within relative to a last symbol of a CORESET where the UE detects the DCI format 2\_2 carrying the TPC command. is the PUSCH preparation time for the corresponding UE processing capability [6, TS 38.214] assuming , and corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_2 and the SCS configuration of the PUCCH or PUSCH.

11.4 SRS switching

**<Unchanged parts are omitted>**

The UE does not expect to apply a TPC command on an SRS transmission if the first symbol of the SRS occurs within relative to a last symbol of a CORESET where the UE detects the DCI format 2\_3 carrying the TPC command. is the PUSCH preparation time for the corresponding UE processing capability [6, TS 38.214] assuming , and corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_3 and the SCS configuration of the SRS.

1. Discussion – Round 1

Please provide input by Tuesday 11th 23:59pm CET

**Q1: Do you agree that the current timelines for power control are not defined (potentially leading to unimplementable UEs) and, therefore, a CR is needed?**

* **If the answer is negative, please provide your understanding on the minimum time between end of the PDCCH carrying a DCI 2\_2 or 2\_3 and the first channel/signal the UE has to apply the power control to (in actual time).**

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| Company | Comment |
| Huawei, HiSilicon | No.  Because the concerned timelines were explicitly discussed and the following agreements were achieved in RAN1#93, along with TPs achieved in RAN1#94. It is not true to claim “not defined”.  The only issue is that for a special case with minimum configured k2=0, whether the Tproc,2 specified in TS 38.214 should be taken into account for the timeline of applying TPC to a configured PUSCH. Since the k2 is always subject to Tproc,2, zero k2 does not mean that a UE can response with zero symbol gap but a gap larger than Tproc,2. With this common understanding, for the issue above, Tproc,2 should be taken into account. A CR could be OK to clarify it only for the specific case with minimum k2=0. For the other cases, it is unclear for us why new UE behaviours causing NBC issues are needed.  **RAN1#93**  **Agreement:**  K value for non-scheduled UL transmission is the minimum of the common configured K2 values of the associated BWP.   * Applies for both PUSCH and SRS   **Working Assumption**  For PUCCH, K value for non-scheduled UL transmission is the minimum of the common configured K2 values  **Working Assumption**  For group common TPC   * If group TPC commands for PUSCH are received the K symbols before PUSCH transmission period i, the accumulation is updated according to all the group common TPC commands; * If group TPC commands for PUCCH are received the K symbols before PUCCH transmission period i, the accumulation is updated according to all the group common TPC commands; * If group TPC commands for SRS not tied with PUSCH are received the K symbols before SRS transmission period i, the accumulation is updated according to all the group common TPC commands;   Notes: How to capture the above is up to editor, especially for the time unit of i and K.  **RAN1#94**  **Agreement**  Following working assumption is confirmed  For PUCCH, K value for non-scheduled UL transmission is the minimum of the common configured K2 values  **Agreement**  The text in the paragraph on the PUSCH power control in {38.213: 7.1.1 UE behaviour}.   |  | | --- | | - If the PUSCH transmission is configured by higher layer parameter *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 higher layer parameter *k2* in *PUSCH-ConfigCommon* and for UL BWP  of carrier  of serving cell |   **Agreement**  The text in the paragraph on the PUCCH power control in {38.213:7.2.1 UE behaviour}.   |  | | --- | | - 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 higher layer parameter *k2* in *PUSCH-ConfigCommon* and for UL BWP  of carrier  of serving cell |   **Agreement**  The text in the paragraph on the SRS power control in {38.213: 7.3.1 UE behaviour}.   |  | | --- | | - 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 higher layer parameter *k2* in *PUSCH-ConfigCommon* and for UL BWP  of carrier  of serving cell | |
| CATT | We don’t see the need of this CR. The timeline of applying TPC command had been discussed in Rel-15 was based on the processing time between receiving TPC command and PUSCH/SRS transmission. There was no consensus during Rel-15 discussion to capture this timeline explicitly in the specification. Thus, we don’t need to re-open the discussion. |
| Qualcomm | Yes.  Regarding the comment from Huawei, we would like to highlight that *k2* is cell-specific, so there may be cases where the *k2* contains delays that a given UE may not support (e.g. if we have a mix of Cap1 and Cap2 devices).  Regarding the comment from CATT, is the understanding that the timeline is not explicitly captured, and the UE can decide when to apply the TPC command? |
| Samsung | No.  First, unlike what is stated in the cover sheet, the CR is not a “clarification”. It is an NBC change and against agreements for CG-PUSCH as cited by Huawei (not repeated here).  Second, there is no issue with the timelines – they are perfectly clear and the minimum timeline is already defined based on the minimum *k2*. The specifications capture that a UE has received the TPC command – there is no other processing required (e.g. unlike almost all other cases, the specifications do not say “the UE received the PDCCH” - DCI has already been processed). A Rel-15 UE is capable of adjusting a transmission power on a per symbol basis. |
| Apple | Yes.  Although we think the design intention should be as what HW commented below:   * “Since the k2 is always subject to Tproc,2, zero k2 does not mean that a UE can response with zero symbol gap but a gap larger than Tproc,2.”   The implementation always follows the exact spec text. With the current text, as quoted by Qualcomm, the ‘’ does result in ‘zero’ application time for group common TPC command.  Can opponent companies clarify how the current spec can be interpreted as the TPC command is applied at least coming earlier than when ‘’? |
| Qualcomm | Regarding Samsung’s comment:  *The specifications capture that a UE has received the TPC command – there is no other processing required (e.g. unlike almost all other cases, the specifications do not say “the UE received the PDCCH” - DCI has already been processed).*  If we apply this interpretation to both CG and DG, and based on the text on 213, we would conclude that the TPC command in an uplink grant does not affect the scheduled PUSCH, which I think is not the intention:  -  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,  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  For the case of DG (here), is exactly the delay between the end of PDCCH and start of PUSCH. If we take the interpretation of “TPC command values […] received” (here) being counted from the moment the DCI is processed, then the DCI processing ends after symbols, and therefore the TPC command in the uplink grant would not be applied. Our understanding is that, for dynamic grant, you would apply all the TPC commands carried in PDCCHs before the PDCCH carrying the uplink grant.  Note that the same text describes DG and CG, so we cannot interpret the same sentence in two different ways for CG and DG. |
| Samsung2 | @QC: RAN1 took the approach of not changing any PUSCH parameter after the UL grant – there is no such thing for CG-PUSCH. Whether some parameters could have had a shorter timeline for DG-PUSCH was not worth bothering about and RAN1 adopted the same rule for everything. That does not mean that (a) there is any issue with the Rel-15 specifications, or (b) there is any ambiguity of the Rel-15 specifications, or (c) the change would not be NBC, or (d) the UE is not capable of adjusting PUSCH transmission power per symbol. |
| Qualcomm | *RAN1 took the approach of not changing any PUSCH parameter after the UL grant – there is no such thing for CG-PUSCH*  This was not our point. In the previous response, you stated the following:  *The specifications capture that a UE has received the TPC command – there is no other processing required (e.g. unlike almost all other cases, the specifications do not say “the UE received the PDCCH” - DCI has already been processed).*  If we apply that interpretation to the case of DG, then the TPC command carried in the uplink grant that schedules a PUSCH does not affect that PUSCH, which is obviously wrong. So, the only possible interpretation of the text is that the time refers to the PDCCH reception.  Of course, we agree that for DG any TPC command received after the scheduling DCI does not affect the PUSCH. |
| Spreadtrum | We support the intention and also aware of the problem may cause to the zero application time when k2=0. |
| OPPO | Yes.  We agree with the analysis from QC above. K2=0 leaves no time for UE to process the TPC command. If we cannot agree on the CR, then in case of K2=0, the group TPC command with latency smaller than cannot be treated by UE. That is, the UE behaviour in the CR would be applied anyway regardless of the CR agreed or not. |
| Intel | Yes, the k2 values should be subject to the minimum PUSCH processing time for a UE. |
| MTK | We see no harm to support the CR to make current spec more clear. |
| vivo | We are flexible to have a CR or conclusion.  From a UE implementation perspective, for the timeline of group common TPC application, the minimum time between the reception of a group common TPC and its application to a PUSCH/PUCCH/SRS should be larger than . |
| Samsung | @QC: We agree that based on the text for DG-PUSCH, the statement “TPC values the UE receives” is with reference to the end of the PDCCH reception – not of the DCI processing. Although that would in principle prohibit a CG-PUSCH transmission with TPC adjustment to occur at the immediate next symbol after the last symbol of a PDCCH reception with DCI format 2\_2, requiring is excessive and does not correspond to a time needed for a UE to decode a DCI format – an addition of a TPC command for the CLPC state is then practically instantaneous and, once determined, a corresponding power adjustment can be per symbol.  For the above reasons, and for the reasons mentioned in the previous response, we continue to not be supportive of the CR. Rel-15 UEs have been in the field for years, no problem has been identified in network deployments, and there is no reason to introduce an NBC change. |

**Q2: If the questions to Q1 is “YES”, do you have any comments on the CR? (e.g. value of processing time, how to capture the restriction, etc.)**

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| Company | Comment |
| Apple | No, we support this CR in general. |
| OPPO | We are fine with the CR. |
| Intel | Fine with the CR. |
| MTK | Fine with the CR |

## Summary of Round 1

10 companies provided feedback to the following question:

**Q1: Do you agree that the current timelines for power control are not defined (potentially leading to unimplementable UEs) and, therefore, a CR is needed?**

Yes (7): Vivo, MTK, Intel, Oppo, Spreadtrum, Qualcomm, Apple

Maybe OK for minimum k2=0 (1): Huawei/HiSi

No (2): CATT, Samsung

Five companies (Apple, Oppo, Intel, MTK, Qualcomm) are OK with approving the proposed CR.

The companies that mentioned that a CR is not needed highlighted the following points:

* There is no issue observed in the field.
* The change is NBC.
* The UE is capable of changing PUSCH power per symbol.

Based on the input so far, the moderator proposes to continue the discussion and try to converge on a potential CR.

1. Discussion – Round 2

From the Feature Lead perspective, and based on the discussion in the 1st round, there seems to be consensus that the UE cannot adjust the power if there is a zero gap between the PDCCH carrying the TPC command and the PUSCH (or SRS/PUCCH). However, the following questions were raised:

* There is no issue observed in the field.
* The change is NBC.
* The UE is capable of changing PUSCH power per symbol.

Companies are encouraged to provide feedback on these three issues.

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| Company | Comment |
| CATT | Even if TPC is not updated in time, there is barely any difference in performance. However, the change is NBC and not essential. |
| Huawei, HiSilicon | The gap  between TPC reception and its effective time has been specified in TS 38.213 for dynamic grant and configured grant, respectively, as excerpt copied below. For dynamic grant, the gap is never zero symbol. For configured grant (optional UE capability), the gap can be zero only when the minimum configured k2 is zero. Therefore, the 3rd question is definitely not true for UEs capable of dynamic grant only. It can only be discussed for UEs capable of configured grant.  *TS 38.213*  *- If a PUSCH transmission is scheduled by a DCI format,  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*  Technically, zero gap between the PDCCH carrying the TPC command and the PUSCH (or SRS/PUCCH) for the configured grant case is basically not implementable from UE perspective.  Since it is common sense from UE perspective that zero gap is not implementable (based on the Round-1 discussion and also as summarized by FL), at least correcting this zero gap case in specification is not an NBC issue. |
| ZTE | First of all, we do not observe this issue in this field. By default, additional requirement for Tproc,2 should be taken into account, and we do not think that this requirement should be specified for group-common timeline again. No companies can follow zero-gap case. Based on that, we also do not think that this issue is an NBC issue. Then, PUSCH power update is based on transmission occasion, i.e., a same Tx power applied to PUSCH transmission occasion. |
| Qualcomm | *There is no issue observed in the field*  It is unclear if this issue is due to these optional features not being widely supported (CG is an optional feature, 2\_2 and 2\_3 are separate optional features) or due to the fact that if the UE skips the application of a power control command the system does not fall apart (the system should be robust to missed DCIs). Either way, it is apparent that the current specification requirements cannot be met by the UE.  *The change is NBC.*  To determine that the change would be NBC, we should first clarify what is the current UE behavior. For companies saying that the change is NBC:  What is the current UE behavior if the gap between 2\_2 and CG PUSCH is negative (in actual time)?  What is the current UE behavior if the gap between 2\_2 and CG PUSCH is zero?  What is the current UE behavior if the gap between 2\_2 and CG PUSCH is 1 symbol? (etc.)  In our understanding, although the timeline is not defined, current UEs implementing these features (if any) would need a gap of , so they will not apply the TPC commands. Therefore, the change just captures what a current UE would be likely doing.  *The UE is capable of changing PUSCH power per symbol.*  Although this is true in some cases (e.g. power scaling), it is not really relevant for the discussion. The key thing is how long time the UE has between reception of a PDCCH and application of the power change. |
| Samsung | @QC:  Not to repeat all previous comments, suffices to say that the change is NBC when nothing is “broken”. is an excessive timeline for processing a DCI format. There are UEs in the field that can do so (and apply the updated power) in much less time than . The proposed CR will make those UEs spec-noncompliant (there may also be an impact on current system operation). |
| Huawei, HiSilicon | We agree with Qualcomm’ explanation that is quite clearly addressing the above three points asked by FL in this round.  In addition, we want to stress again that the time needed for UE applying the TPC command not only includes DCI processing time but also the PUSCH transmission preparation time. |
| MTK | In general, we share similar view with QC, while Samsung’s argument also sounds reasonable, although as UE vendor we may always prefer a more safe timing constraint.   * There is no issue observed in the field.   + This may due to the reason the power adjustment misalignment does not make the system fall apart instantaneously, but it may damage system performance * The change is NBC.   + If there are UEs in the field that can do so (and apply the updated power) in much less time than T\_(proc,2), they can continue to do so and gain a better performance. I guess Samsung is referring NBC change to NW side, if NW expects UE to apply the updated power in much less time than T\_(proc,2). * The UE is capable of changing PUSCH power per symbol.   + Yes, while for DCI 2\_2, 2\_3, UE needs to decode DCI and change power later, which would need more time than symbol level processing. |
| Qualcomm | @Samsung:  On this: “There are UEs in the field that can do so”, what is the processing time for those UEs, and where is it specified?  In general, the situation is quite clear to us: The current specifications give zero processing time (or negative, in some cases) to process a TPC command, which is non-implementable. |
| Samsung | @MTK: The change is NBC as it creates two UE behaviors. An existing UE will process the TPC command and will not assume it is an error. A UE implementing the proposed CR will treat it as an error (if the PDCCH is not received before ) and will not process it. A network will not know the UE power status. That will result to incorrect scheduling, reduced throughout, and frequent retransmissions and PHR. Further, the condition of the proposed CR itself may not be possible for a NW to fulfil in general or, at least, unless the NW makes changes to existing deployments in order to ensure that a time between the reception of the PDCCH providing DCI 2\_2 does not conflict (with respect to being earlier by at least ) with any of the CG PUSCHs for the group of UEs that the DCI 2\_2 addresses.  @Qualcomm: Yes, as already discussed, it is fact that a DCI format decoding time is not accommodated in the Rel-15 specs. However, it is also a fact that Rel-15 UEs exist in operation for several years now without any associated problem. Making an NBC change to address a problem that does not exist when there are current deployments cannot be agreeable. |
| Qualcomm | @Samsung  OK, now I think I understood your concern on the UE side.  When you mention that there are UEs in the field that can process the command faster, our understanding is that those UEs can keep processing it that way. To clarify the behavior, maybe we can modify the text as follows:  The UE is not required to apply a TPC command on a PUSCH or PUCCH transmission if the first symbol of the PUCCH or the PUSCH occurs within relative to a last symbol of a CORESET where the UE detects the DCI format 2\_2 carrying the TPC command. is the PUSCH preparation time for the corresponding UE processing capability [6, TS 38.214] assuming , and corresponds to the smallest SCS configuration between the SCS configuration of the PDCCH carrying the DCI format 2\_2 and the SCS configuration of the PUCCH or PUSCH.  Regarding this part:  *the condition of the proposed CR itself may not be possible for a NW to fulfil in general or, at least, unless the NW makes changes to existing deployments in order to ensure that a time between the reception of the PDCCH providing DCI 2\_2 does not conflict (with respect to being earlier by at least ) with any of the CG PUSCHs for the group of UEs that the DCI 2\_2 addresses.*  It is not clear to us what is the current assumption at the network side, could you clarify it? The network has to leave some nonzero gap between the DCI 2\_2 and the CG\_PUSCH, but it is anyway taking a gamble since there is no specification text describing how large this gap should be. It may work with some subset of UEs (e.g. based on some agreed upon value bilaterally between two companies or two divisions of the same company during IODT), but there is no guarantee that this same value will work when interoperating with other UEs. Several UE vendors in this thread mentioned that they need , so I would be very surprised if issues do not appear sooner or later. |
| Samsung | The “UE is not required” is certainly better than the “UE does not expect”.  It may not be possible to tell what all NWs are currently doing, but it is relatively typical that PDCCH is provided at the beginning of a slot and CG-PUSCH is either in a next slot (TDD/FDD) or has already started by the time of the PDCCH reception (FDD) – hence, no issue with the Rel-15 specs/deployments.  We’re still reluctant to agree to the CR as a Rel-15 CR due to existing deployments and possible unforeseen issues. We also think that is excessive for DCI decoding (there are no other meaningful delays involved – summation of a TPC command is “instantaneous” and the power adjustment is supported per symbol) but it may be the timeline to use in the end as it is the simpler one, fits with the rest of the UL timelines, and nothing new needs to be defined.  Our suggestion would be to re-consider the “UE is not required” version of the CR for Rel-16 at RAN1#111 in ~1 month (there is no particular urgency). |
| Qualcomm | The CR as submitted to the meeting is proposed for Rel-16, not Rel-15. Is the CR with the modified text something Samsung could accept?  As FL: I’ll report the situation to Mr Chair and suggest to extend the discussion during next week or to postpone it to R1#111. |
| Samsung | There seems to be some confusion – the AI is 7.1 (Rel-15 CRs) and the email discussion is under R15-08 (but, yes, the CR was submitted for Rel-16 and that was missed).  Although we cannot confirm at this moment whether an updated CR would be agreeable, if it uses “is not required” instead of “does not expect” and does not result in TPC commands being thrown away (only not processed if the timeline is not met), it would certainly be more acceptable (and, in the previous discussions, we were assuming the CR was for Rel-15). |

## Summary of Round 2

During this round of discussion, companies provided their assessed impact on current UEs and networks, and a couple of key points were raised:

1. The timeline of should not impact UEs that are able to process the DCIs and apply the power control faster. In this sense, it is proposed to reword the wording from “UE does not expect” to “UE is not required”.
2. The CR is for Rel-16, not Rel-15.
3. There was also a mention that the UE not meeting the timeline will not process the power control command. We think this can be clarified by stating that the power control will be applied to the first transmission meeting the timeline.
4. Discussion – Round 3

Given the input in the previous round, the moderator proposes to try to agree first on a proposal before discussing the details of the TP.

**Proposal 4.1: Clarify, for Rel-16, the behavior for power control of PUSCH / PUCCH / SRS without a corresponding DCI:**

* **A UE is not required to apply a TPC command if the PDCCH carrying the TPC command is received later than before the start of the PUSCH / PUCCH / SRS.**
* **A UE that does not apply a TPC command for a corresponding PUSCH / PUCCH / SRS shall apply the TPC command for a later PUSCH / PUCCH / SRS that meets the timeline requirements.**

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| Company | Comment |
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1. Conclusions

TBD