**3GPP TSG-RAN WG1 #100b-eMeeting R1-200xxxx**

**April 20th –30th, 2020**

**Source: Moderator (Apple)**

**Title: Feature lead summary#2 of UL Power Control for NN-DC**

**Agenda item:** **7.2.10.1**

**Document for:** **Discussion and Decision**

# 1 Introduction

### Based on the outcome of the e-meeting preparation phase (See section 3 in [9]), the following email discussion has been kicked-off:

[100b-e-NR- LTE\_NR\_DC\_CA-ULPC-01] Email discussion/approval of issues 1/2/3/4/5 in [R1-2002346](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002346.zip) till 4/24, with potential TPs for approval till 4/29 (Apple, Hong)

# 2. Discussion

## Issue #1: Handling TPC Commands in DCI format 2-2 and 2-3.

In the latest 3GPP TS 38.213, the following was captured for the UE to compute the transmit power for the SCG staring from $T\_{0}$ with taking into account MCG

|  |
| --- |
| *The UE does not expect to have transmissions on the MCG that* *- are scheduled by DCI formats in PDCCH receptions with a last symbol that is earlier by less than or equal to* $T\_{offset}$ *from the first symbol of the transmission occasion on the SCG, and**- overlap with the transmission occasion on the SCG* |

However, as already brought up in last meeting and listed in feature leader summary, this text does not cover the case where a TPC command is transmitted by DCI format 2\_2 or 2-3 on MCG between $T\_{0}-T\_{offset}$ and $T\_{0}$. Figure 1 provides one example of CG-PUSCH to illustrate this problem, citing from [6]. This can happen for at least CG-PUSCH and periodic PUCCH (e.g. SR, P-/SP-CSI) and P-/SP-SRS and a common solution to solve all of cases should be targeted. This issue was discussed in [2][4][5][6][7]



Figure 1: Dynamic power sharing with PUSCH without dynamic UL grant on MCG

### On DCI format 2\_2

The following alternatives were proposed according to the contributions and email discussions in preparation phase:

* When UE has an SCG UL transmission and an overlapping MCG UL transmission, then for adjusting the power of the MCG UL transmission, the UE shall only consider TPC commands that are provided by DCI format 2-2 in PDCCH receptions with a last symbol that is earlier by less than or equal to $T$ from the first symbol of the transmission occasion on the SCG
	+ Alt.1: $T=T\_{offset}$
	+ Alt.2: $T=T\_{Proc,2}$
* Alt.3: When UE has an SCG UL transmission and an overlapping MCG UL transmission, then for adjusting the power of the MCG UL transmission, the UE does not expect to receive TPC commands that may impact on the transmission power of the MCG UL transmission that are provided by DCI format 2-2 in PDCCH receptions with a last symbol that is not earlier by less than or equal to $T\_{offset}$ from the first symbol of the transmission occasion on the SCG

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | Our first preference is Alt.2. Alt.1 is also ok if RAN2 confirms our working assumption in last meeting, otherwise we even don’t konw the specific value of Toffset.From our perspective, Alt.3 doesn’t make sense. If there are continuous UL transmissions in SCG and each UL transmission in SCG has a duration Toffset, this may end up with no transmission occasion for DCI 2\_2/2\_3 in MCG. Take the following figure as an example, if there are three continuous PUSCH transmissions in SCG, network is not possible to transmit any DCI 2\_2/2\_3 during the whole time duration overlapping with either Toffset, if the DCI 2\_2/2\_3 is not allowed to be transmitted after T0 – Toffset.  |
| Qualcomm | Support Alt.3. From the performance point of view, Alt.1 and Alt.3 are identical, while Alt.1 requires UE to expect receive a DCI format 2\_2, that is in the end ignored. It is also not clear how to handle the ignored TPC command in the DCI format 2\_2; whether it is still accumulated or not. The original intention of the agreement was to cut-down MCG UL transmission power impact at time T0 – T\_offset, so that the UE can determine SCG UL transmission power taking into account the information available until T0 – T\_offset. Alt.1 and Alt.2 may be against the principle. |
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### On DCI format 2\_3

In NR, the DCI format 2\_3 is used to trigger SRS carrier switching along with TPC commands for the SRS transmission. One point raised during email discussion of preparation phase is whether or not the DCI format 2\_3 has time restriction, instead of TPC command only.

The following options were therefore listed for discussion:

* When UE has an SCG UL transmission and an overlapping MCG UL transmission, then for adjusting the power of the MCG UL transmission, the UE shall only consider DCI format 2-3 in PDCCH receptions with a last symbol that is earlier by less than or equal to $T$ from the first symbol of the transmission occasion on the SCG
	+ Alt.1: $T=T\_{offset}$
	+ Alt.2: ???
* Alt.3: When UE has an SCG UL transmission and an overlapping MCG UL transmission, then for adjusting the power of the MCG UL transmission, the UE does not expect to receive DCI format 2-3 in PDCCH receptions with a last symbol that is not earlier by less than or equal to $T\_{offset}$ from the first symbol of the transmission occasion on the SCG
* Alt.4: ??

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | If I understand Alt.1 correctly, Alt.1 needs to be updated as below.* When UE has an SCG UL transmission and an overlapping MCG UL transmission, then for adjusting the power of the MCG UL transmission, the UE shall only consider DCI format 2-3 in PDCCH receptions with a last symbol that is earlier by ~~less~~ more than or equal to $T$ from the first symbol of the transmission occasion on the SCG

We support Alt.1 if RAN2 confirms our working assumption in last meeting, otherwise we even don’t konw the specific value of Toffset.Similar comments for DCI format 2\_3 as we provided in previous section. If there are continuous UL transmissions in SCG and each UL transmission in SCG has a duration Toffset, this may end up with no transmission occasion for DCI 2\_2/2\_3 in MCG.Regarding the case when DCI format 2\_3 is used to trigger SRS carrier switching along with TPC commands for the SRS transmission, we believe Alt.1 is also applicable to this case. |
| Qualcomm | Support Alt.3.Same reason as our answer to the question on DCI format 2\_2.  |
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## Issue #2: Handling UL Transmission Cancelation on MCG

Another issue with regard to dynamic power sharing (DPS) operation was identified in RAN1 100-e is how to handle Uplink transmission skip for MCG dynamic grant PUSCH/configured grant PUSCH due to 5.4.3.1.3 of TS38.321 or by DCI format 2\_4. This issue was further discussed in [6]

Although DCI format 2-4 does not schedule uplink transmissions, it would impact on the value of $\hat{P}\_{MCG}^{actual}$ due to UL cancelation. Similarly, for CG-PUSCH transmission, the UE may or may not transmit the PUSCH. For dynamic grant PUSCH, the UE may skip the transmission if some conditions are met which are specified in 5.4.3.1.3 of TS38.321.

Solutions proposed by companies can be categorized as follows:

* For power determination of UL transmission in SCG starting at $T\_{0}$, *UE is not required to take into account the skipped MCG UL transmission due to either DCI format 2\_0/ 2\_4 or according to section 5.4.3.1.3 of TS 38.321 received after* $T\_{0}-T$ for $\hat{P}\_{MCG}^{actual}$ determination for the UL transmission in MCG overlapping with the concerned SCG transmission
* Alt.1: $T=T\_{offset}$
* Alt.2: $T=T\_{Proc,2}$
* Alt.3: When UE has an SCG UL transmission and an overlapping MCG UL transmission,
* The UE does not expect to receive a SFI that may impact on the transmission power of the MCG UL transmission that are provided by DCI format 2-0 in PDCCH receptions with a last symbol that is not earlier by less than or equal to T\_offset from the first symbol of the transmission occasion on the SCG;
* The UE is not required to take into UL transmission cancellation that may impact on the transmission power of the MCG UL transmission that are provided by DCI format 2-4 in PDCCH receptions with a last symbol that is not earlier by less than or equal to T\_offset from the first symbol of the transmission occasion on the SCG;
* It is up to UE whether to take into account UL skipping for CG-PUSCH or DG-PUSCH according to section 5.4.3.1.3 of TS 38.321

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | Our first preference is Alt.2. Alt.1 is also ok if RAN2 confirms our working assumption in last meeting, otherwise we even don’t konw the specific value of Toffset.From our perspective, Alt.1/Alt.2 is only applicable to UL cancellation with corresponding DCI, i.e., if the correspoding DCI is received after T0-T, UE is not required to take into account the DCI.For CG-PUSCH, there is no corresponding scheduling DCI. Alt.1/Alt.2 doesn’t work for CG-PUSCH. Two potential approaches could be considered for CG-PUSCH.Approach#1: UE assumes that actual CG-PUSCH transmission exists in every transmission occasion.Approach#2: If the time instance {T1 – Tproc,2} is earlier than {T0 - Toffset}, this CG-PUSCH is considered into the power calculation (i.e., Example 1). Otherwise, if the time instance {T1 – Tproc,2} is later than {T0 - Toffset}, this CG-PUSCH is not considered into the power calculation (i.e., Example 2). |
| Qualcomm | Alt.3.First of all, higher-layer determination of UL skipping should be considered separately from physical layer indication of UL skipping. That is, it is not appropriate to define the timeline for UL skip according to section 5.4.3.1.3 of TS 38.321.Regarding DCI format 2\_4, detection of it after T0 – T\_offset just reduce the transmission power of the MCG. This has no harmful impact.Regarding DCI format 2\_0, the problem is that if the UE determines MCG configured UL transmission does not take place due to the conflict with semi-static “F“, but if the UE monitors DCI format 2\_0 after T0 – T\_offset but does not detect a DCI format 2\_0, then the UE may transmit MCG configured UL transmission according to the following agreements. Agreement:* Allow configured UL (CUL) transmissions in a set of symbols of a slot when the UE is configured with DCI 2\_0 format monitoring and does not detect a DCI 2\_0 format providing a slot format for the set of symbols. This is applicable when operating with LBE for the following cases.
	+ When the set of symbols are indicated as ‘F’ with a semi-static TDD pattern or
	+ When the UE is not configured with a semi-static TDD pattern
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## Issue #3: Power Determination for PUCCH and SRS Transmission

Another issue identified in last meeting is how to determine the power of periodic PUCCH (e.g. SR, P-/SP-CSI) and P-/SP-SRS. It was discussed in [2][4][5] and the following was proposed for power determination of UL transmission in SCG:

* Alt.1: UE assumes there is always UL transmission in the periodic PUCCH (e.g. SR, P-/SP-CSI) resource and P-/SP-SRS resource (Proposed in [2])
* Alt.2: CG-PUSCH, Periodic PUCCH, P/SP-SRS should be taken into account (Proposed in [4])
* Alt.3: Different look-ahead windows were defined depending on the UCI types (Proposed in [5])
	+ For PUCCH on MCG in response to a dynamic PDSCH or a SPS PDSCH, the last symbol of the PDSCH should be before time $t\_{0}-T\_{Offset}$, $T\_{Offset}$ should be equal to or larger than $T\_{proc,1}^{mux,i}.$
	+ For a PUCCH transmission on MCG for periodic CSI report, power allocation of SCG can always assume the presence of periodic CSI on MCG and no timeline checking.
	+ For a PUCCH transmission on MCG for SR, the period between time $t\_{0}-T\_{Offset}$ and the first symbol of SR resource is longer than SR preparation time.
	+ For a CG PUSCH transmission on MCG, the period between time $t\_{0}-T\_{Offset}$ and the first symbol of CG PUSCH resource is longer than $T\_{proc,2}$.
* Alt.4:
	+ Higher layer configured UL transmissions shall be taken into account for power determination in general
	+ If the higher layer configured UL transmission is triggered or cancelled due to the UE internal process (e.g., SR, CG-PUSCH, UL skip), it is up to UE whether to take it into account for power determination (this is correlated with the third sub-bullet of the above Issue #2)
	+ If the higher layer configured UL transmission is cancelled due to a DCI indication, the UE does not expect to receive such DCI in PDCCH receptions with a last symbol that is not earlier by less than or equal to $T\_{Offset}$ from the first symbol of the transmission occasion of the SCG (this is correlated with the first sub-bullet of the above Issue #2)

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | We support Alt.1.Alt.3 could be optimal, however we are not sure whether RAN1 has sufficient time to discuss these timelines case by case. Regarding the second bullet of Alt.4, we are open to further discuss this rule. However, seems it should be udpated as below. As the gNB doesn’t know wheter there is UL transmission or not, gNB always allocates power for the potential UL transmission. If UE has actual UL transmission, UE has to take the UL transmission into account for power determination instead of up to implementation.* + If the higher layer configured UL transmission is ~~triggered or~~ cancelled due to the UE internal process (e.g., SR, CG-PUSCH, UL skip), it is up to UE whether to take it into account for power determination (this is correlated with the third sub-bullet of the above Issue #2)

Regarding the third bullet of Alt.4, as we commented in previous sections, it doesn’t make sense in some scenarios. |
| Qualcomm | Alt.4, which is aligned with Alt.3 in the previous topic.  |
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## Issue #4: Handling UL Slot Aggregation on SCG

One issue raised in [7] with regard to dynamic power sharing is that current agreement causes severe constraint at gNB side due to lack of SCG scheduling information. As one consequence, MCG will have to assume worst case for SCG transmission length for scheduling MCG UL transmissions. Due to this, if SCG UL transmissions span multiple slots, the current specification text results in severe restrictions on MCG UL scheduling.

One example was provided in [7] as illustrated in FIG.2/FIG.3 below. For example, considering Figure 2 below, if the UE has an SCG UL transmission U1 spanning multiple slots, then MCG cannot schedule an uplink transmission U2m since $T\_{offset}$ is considered from “start of SCG UL transmission”. So, when the SCG transmission spans multiple slots, the $T\_{offset}$ restriction has to be effectively extended by the maximum number of slots allowed by slot aggregation. However, from UE perspective, it should be able to take U2m into account as long as P2m occurs $T\_{offset}$ ahead of start of second slot of U1. i.e., if there were two separate SCG UL transmissions U1 and U2 (as shown in Figure 3), the UE anyway has to support that case.



**Figure 2**



**Figure 3**

The following was proposed in [7]:

|  |
| --- |
| Proposal* $T\_{offset}$ is applied on per-SCG slot basis
 |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | According to the current spec, the Toffset is applied on per-SCG transmission occasion basis. Regarding to UL transmission with slot aggregation, each repetition is regarded as on transmission occasion. From this perspective, the current spec is clear to us. If we have to make a proposal for this issue, we propose the following one.Proposal:Toffset is applied on per-SCG UL transmission occasion basis. |
| Qualcomm | Need to check if we need to take into account the on-going discussion on TPC and UCI multiplexing for PUSCH repetition Type B.  |
|  |  |
|  |  |

## Issue #5: Maintenance or Editorial Issues

A number of TPs were proposed in [3][4][7] and listed below for discussions.

* **Issue 5-1:** TP to clarify the TDD UL/DL configuration for semi-static power sharing proposed in [3]

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | The current spec wording is in line with the wording in Section 11.1 (as shown below) of TS38.213. No spec update is needed.If a UE is not configured to monitor PDCCH for DCI format 2\_0, for a set of symbols of a slot that are indicated as flexible by *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated* if provided, or when *tdd-UL-DL-ConfigurationCommon* and *tdd*-*UL-DL-ConfigurationDedicated* are not provided to the UE |
| Qualcomm | Agree with ZTE. |
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* Issue 5-2: TP to clarify the definitions of $\hat{P}\_{MCG}^{actual}\left(i\_{1}\right)$ and $\hat{P}\_{SCG}^{actual}\left(i\_{2}\right)$ (i.e., linear values) proposed in [3]

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | Fine with the update. |
| Qualcomm | Support the TP. |
|  |  |
|  |  |

* Issue 5-3: TP to align RRC parameters between the endorsed MR-DC running CR of TS 38.331 and TS 38.213 proposed in [3] and [4]

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | Fine with the update. |
| Qualcomm | Fine in general, but it is still a running CR; it is sufficient to fix them after the parameters are actually fixed (unless there is any confusing aspect).  |
|  |  |
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* Issue 5-4: Removal of earlier text on dynamic power sharing proposed in [7]

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | We are open to this update. |
| Qualcomm | Support the TP. |
|  |  |
|  |  |

* Issue 5-5: Correction the timing of maximum transmission power determination proposed in [4]

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| ZTE | Fine with the update. |
| Qualcomm | The current spec is clear and no problem is found. Can proponent clarify the issue? |
|  |  |
|  |  |

# 3. Conclusion

# References

1. [R1-2001528](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001528.zip) UL power control for NR-NR dual connectivity Huawei, HiSilicon
2. [R1-2001618](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001618.zip) Remaining Issues of Dynamic Power Sharing for NR-DC ZTE
3. [R1-2001688](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001688.zip) Remaining issues on uplink power control for NR-NR DC vivo
4. [R1-2001736](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2001736.zip) Text proposals for UL Power Sharing for NR-DC OPPO
5. [R1-2002012](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002012.zip) Remaining issues on uplink power control for NN-DC Intel Corporation
6. [R1-2002345](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002345.zip) Remaining issues of UL Power Control for NN-DC Apple
7. [R1-2002418](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002418.zip) Remaining issues for NR-DC UL Power Control Ericsson
8. [R1-2002607](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_100b%5CDocs%5CR1-2002607.zip) Remaining details of Rel-16 DC uplink power control Nokia, Nokia Shanghai Bell
9. R1-2002743 Outcome of preparation discussion on UL Power Control for NN-DC Apple