**3GPP TSG-RAN WG1 #101 R1-200xxxx**

**e-Meeting, May 25th-June 5th, 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

Table 1 summaries the identified issues in accordance to the contributions submitted and more details for each issue were provided in the following sections.

**Table 1: Issues scoping based on contributions**



## 2.1 Issue-1: RAN2 LS reply on T\_offset determination WA

One working assumption was made in ran1 #100-eMeeting related to T\_offset determination and corresponding UE capability signaling. According to LS [12], MN is required to process the SCG configuration to identify the T\_offset used by the UE; Otherwise, possible largest value of T\_offset has to be assumed by MN for dynamic power sharing operation.

The LS reply from RAN2 [13] was received in this meeting and it states the following:

|  |
| --- |
| “*RAN2 would like to thank RAN1 for the LS on uplink power control for NR-NR Dual-Connectivity.* *RAN2 is still discussing the reply to RAN1 but has no consensus yet on introducing new inter-node signalling for T\_offset.**However, RAN2 would like to remind that it was agreed in Rel-15 that MN and SN are not required to comprehend each other’s UE configuration for MR-DC. Therefore, RAN1 making assumption that such comprehension is possible is not correct in RAN2 view.”* |

In addition, RAN2 is still discussing new functionality to improve the efficiency of DPS by introducing inter-gNB signal and hence avoid assuming the worst T\_offset value, even RAN1 did not ask for this.

Several companies [1][3][6][7][8][11] discussed the impact of RAN2 reply LS with following summarized proposal

* Opt.1: No impact and confirm the WA with removing $T\_{proc,CSI}$ from second capability (i.e. Alt.2 in [11]) for T\_offset determination [6][11].
* Opt.2: Revising the WA and defining the T\_offset values in RAN1 without the need of MN/SN interaction [1][7][10]:
	+ Option 2-1: <1, 0.5> ms [1]
		- Introducing one RRC parameter to configure the T\_offset value for UEs on a per FR basis [1].
	+ Option 2-2: <4, 1.5> ms [10]
	+ Reasoning:
* Opt.3: NOT support “look-ahead” with T\_offset [8]
* Opt.4: Wait from RAN2 further progress on email discussion [3]

The reasons for these options were summarized in the Table 2 below based on papers:

**Table 2:**

|  |  |  |  |
| --- | --- | --- | --- |
| Index | No. of companies | Companies | Reasoning |
| Opt.1 | 2 | Samsung [6], Qualcomm [11] | * No impact was seen on the RAN1 spec as the situation that “MN and SN do not comprehend each other’s UE configuration for MR-DC” was recognized already when making this agreement. [11]
* No impact was seen on the RAN1 spec. When the MN can comprehend the UE configurations of SCG, it helps MN to select a suitable and optimal value for T\_offset. If not, MN just set the T\_offset based on the possible largest value. [6]
* Current WA is better than specifying “absolute value” [11]
 |
| Opt.2 | 3 | Nokia [7], ZTE [1] (Opt.2-1), Ericsson [10] (Opt.2-2) | * Considering the late stage of the WI discussions (RAN4 is already waiting for RAN1 specs to stabilize to specify performance requirements), our preference is to fix this issue in RAN1 in this meeting rather than wait and rely on other WGs to find a solution. This removes the linking of T\_offset with RRC configurations of MCG and SCG and is fully aligned with RAN2 MR-DC framework and also current UE capability framework for dynamic power sharing [10].
 |
| Opt.3 | 1 | OPPO [8] | * The current framework for look-ahead operation doesn't work based on RAN2 LS [8]
 |
| Opt.4 | 1 | Huawei [3] | * RAN2 email thread discussion is still ongoing about how to accommodate the RAN1 WA and, then MN scheduler could be aware of the $T\_{proc,SCG }^{max}$and take the restriction introduced by the $T\_{offset}$ into consideration [3].
 |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | We are OK with Opt.4. Once RAN2 formally make a conclusion, we can further discuss this. |
| Samsung | OK to revisit the WA as needed after the LS from RAN2. |
| OPPO | Due to so many issues led by the look-head operation and the uncerntain solution of RAN2, we prefer not to support look-head operation. If majoirity companies still support look-head based mechanis, we can compromise to support Option 2 with the aim to finish the feature as soon as possbile.  |
|  |  |

## 2.2 Issue-2: TPC Commands in DCI format 2\_2 and 2\_3

**DCI format 2\_2**

NR supports different timeline of group-common TPC in DCI format 2\_2 for dynamic PUSCH (DG-PUSCH) and CG-PUSCH. More specifically, for DG-PUSCH, the k2 value in scheduling DCI format is used to limit the last applicable DCI 2\_2. While, for CG-PUSCH, minimum K2 value configured in PUSCH-ConfigCommon (i.e. cell-specific) is used to determine the last applicable DCI format 2\_2. It is FFS regarding how to handle the case when DCI format 2\_2 or 2\_3 is received after T0-T\_offset, as shown in FIG.1 copied from [11].



Figure 1: Group-TPC commands in DCI 2\_2 received after T0 – T\_offset.

This issue was extensively discussed in RAN1 #100 bis e-meeting, but no consensus was reached. Ten companies [1][2][3][4][5][6][8][9][10][11] shared views on this open issue and can be generally summarized as follows:

**Table 3:**

|  |  |  |
| --- | --- | --- |
|  | Description | Companies |
| Opt.1 | The NW ensures that the group TPC command in the DCI format 2\_2 received after T0 – T\_offset that is applied to the semi-static MCG UL transmission that overlaps with the SCG UL transmission starting at time T0 does not indicate transmission power increase for the MCG UL transmission. The UE can determine the sum power for the MCG UL transmission based on the information available at time T0 – T\_offset. | Qualcomm [11] |
| Opt.2 | 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 $T\_{offset}$ from the first symbol of the transmission occasion on the SCG
 | Ericsson [10]ZTE [1]Apple [9]Intel [5] |
| Opt.3 | Leave it to UE implementation | VIVO [2] |
| Opt.4 | *When UE has an SCG UL transmission and an overlapping MCG UL transmission, the UE is not expected to receive the PDCCH 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 for below cases:** *DCI format 2\_2 indicated transmission power adjustment for a PUSCH/PUCCH transmission on MCG, or*
 | HW [3]MTK [4] |
| Opt.5 | * When a UE is configured with NR-DC with dynamic power-sharing, for the semi-static MCG UL transmission starting at time T1, regardless of whether it overlaps with a SCG UL transmission, the UE does not apply TPC commands in DCI fomat 2\_2 received after T1 – {minimum *k2* value configured in *PUSCH-Config*}.
* NW ensures that minimum *k2* value configured in the *PUSCH-Config*  such that non-ignored DCI format 2\_2 is not present after T0 – T\_offset if there is an overlapping SCG transmission starting at time T0.
 |  |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | For Opt.2, the problem is that a UE cannot determine whether to ignore or apply a TPC command in DCI 2\_2 on a MCG serving cell. The behavior depends on whether or not the MCG transmission is overlapped with the SCG transmission starting at time T0. The overall principle of the NR-DC dynamic power-sharing is that the UE can determine the MCG sum power without being impacted by SCG power determination, and can determine SCG sum power by using the DCIs received in MCG before T0 – T\_offset. Opt.2 is against this principle. The only way of letting UE to ignore TPC commands in DCI format 2\_2s on a MCG serving cell is to let UE to determine whether to ignore or apply TPC commands according to the MCG configurations, such as Opt.5. However, this UE behavior (ignoring TPC commands in a certain condition) is quite new and would create more open issues. The benefit compared to Opt.1/4 is not much clear as well. Hence, it is not preferable to be introduced at this late stage of Rel.16. For Opt.3, a UE may not be able to resolve a transmission power problem that violates per-UE limit if we do not have any standard. Therefore, we think it cannot be said everything is up to UE implementation.Now, the remaining is Opt.1 vs Opt.4. According to the outcome of the discussion in the last meeting, we are proposing Opt.1. However, Opt.4 is acceptable as well. |
| Samsung | Our view is not captured. It is similar to Option 1 with the additional aspect that there is no need to assume that the network does not indicate power increase. In any case, this will probably not be visible in the specifications. |
| OPPO | In our understanding, the intention of Option 1 and Option 4 are similar, but with different wording. We can support Option 1 and Option 4For the case where a TPC command received after T-T\_offset but still have enough time to be applied to MCG transmission, Option 2 may lead to less powe transmission for MCG if the TPC command is to indicate power increase. MCG should always be prioritized for power sharing. Thus Option 2 is attractingOption 5 addresses the issue by introducing more restrictions on gNB configuration/scheduling. In order to make look-ahead based machanism workalbe, we introudce more and more restrictions on configuration /scheduling at gNB side, but we never evalue its impact on the system performance. Thus Option 5 is not a good choice |
|  |  |

**DCI 2\_3**

As discussed in RAN1 #101bis e-meeting, it should that 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 itself has time restriction, instead of TPC command only. In other words, since DCI format 2\_3 is also used to trigger SRS carrier switching, it should not be allowed to transmit after T\_offset, same as scheduling DCI format,

Companies views on this issue was summarized in the following Table 4:

**Table 4:**

|  |  |  |
| --- | --- | --- |
|  | Description | Companies |
| Opt.1 | 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 | HW [3]Intel [5]~~Samsung [6]~~ |
| Opt.2 | For SRS triggering, DCI format 2\_3 can be viewed as a DCI format scheduling PUSCH transmission. For SRS power control without triggering, DCI format 2\_3 can be viewed as for DCI format 2\_2. No impact due to DCI format 2\_3 | Samsung [6] |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | DCI format 2\_3 should be treated in the same manner as an UL grant if the SRS request is present in the DCI format 2\_3, and as a DCI format 2\_2 if the SRS request is not present. No special handling is necessary. |
| Samsung | Our view is misunderstood and is now included as “Opt. 2“. I think that is same as what Qualcomm mentions.  |
| OPPO | A common solution as Issue-2. Thus Option 1 is ok. |
|  |  |

## 2.3 Issue-3: Handling UL Transmission Cancelation on MCG

Another open issue discussed in last RAN1 meeting is how to handle UL transmission cancelation on MCG for MCG dynamic grant PUSCH/configured grant PUSCH due to 5.4.3.1.3 of TS38.321 or by DCI format 2\_4. Although DCI 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.

For different cancelation cases, companies’ views can be categorized using following table:

**Case 1: DCI format 2\_0/2\_4**

**Table 5:**

|  |  |  |
| --- | --- | --- |
|  | Description | Companies |
| Opt.1 | 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 the *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  | ZTE [1]HW [3]Samsung [6]Apple [9]Qualcomm [11] |
| Opt.2 | For power determination of UL transmission in SCG starting at $T\_{0}$, UE does not expect to receive DCI format 2\_0/2\_4 that is received in a PDCCH with last symbol that is earlier by less than T\_offset from a first symbol of a transmission occasion on the SCG  | MTK [4] |
| Opt.3: | left for UE implementation  | VIVO [2] |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| OPPO | Support Option.1 |
|  |  |
|  |  |
|  |  |

**Case 2: CG-PUSCH (different with Case 1 as the cancelation is not associated with DCI format)**

**Table 6**

|  |  |  |
| --- | --- | --- |
|  | Description | Companies |
| Opt.1 | UE assumes that actual CG-PUSCH transmission exists in every transmission occasion. | ZTE [1] |
| Opt.2 | If the time instance {T1 – Tproc,2} is earlier than {T0 – Toffset}, this CG-PUSCH is considered into the power calculation. Otherwise, if the time instance {T1 – Tproc,2} is later than {T0 – Toffset}, this CG-PUSCH is not considered into the power calculation | ZTE [1] |
| Opt.3: | left for UE implementation  | VIVO [2]MTK [4]Intel [5]Qualcomm [11]Samsung [6] |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | Opt.3 of Case 2 can be merged to Opt.1 of Case 1.  |
| OPPO | A common solution for case 1 and case 2 is prefered. |
|  |  |
|  |  |

## 2.4 Issue-4: Power Determination for PUCCH and SRS Transmission

Another issue is how to determine the power of periodic PUCCH (e.g. SR, P-/SP-CSI) and P/SP-SRS. Views on this issue was summarized as follows:

**Table 7:**

|  |  |  |
| --- | --- | --- |
|  | Description | Companies |
| Opt.1 | * UE assumes there is always UL transmission in the periodic PUCCH (e.g. P-/SP-CSI) resource and P-/SP-SRS resource for $\hat{P}\_{MCG}^{actual}$ determination.
 |  |
| Opt.2 | * UE is not required to take into account the cancellation of MCG UL transmissions for dynamic power sharing
	+ i.e. it is up to UE implementation whether to take into account for power determination
 |  |

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | Opt.2 is same as Opt.1 of Case 1 in Issue 3. |
| Samsung | Agree with Qualcomm |
| OPPO | Share the same view as QC and Support Option 2  |
|  |  |

## 2.5 Issue 5: Removal of earlier text on DPS

This issue was brought up in [11] to remove the following text in TS 38.213, taking into account the agreed WA context and lack of agreements made for supporting the following context:

“

*- if UE transmission(s) in slot* $i\_{1}$ *of the MCG overlap in time with UE transmission(s) in slot* $i\_{2}$ *of the SCG and if* $\hat{P}\_{MCG}^{actual}\left(i\_{1}\right)+\hat{P}\_{SCG}^{actual}\left(i\_{2}\right)>\hat{P}\_{Total}^{NR-DC}$ *in any portion of slot* $i\_{2}$ *of the SCG, the UE reduces transmission power in any portion of slot* $i\_{2}$ *of the SCG so that* $\hat{P}\_{MCG}^{actual}\left(i\_{1}\right)+\hat{P}\_{SCG}^{actual}\left(i\_{2}\right)\leq \hat{P}\_{Total}^{NR-DC}$ *in all portions of slot* $i\_{2}$*, where* $\hat{P}\_{MCG}^{actual}\left(i\_{1}\right)$ *and* $\hat{P}\_{SCG}^{actual}\left(i\_{2}\right)$ *are the UE transmission powers in slot* $i\_{1}$ *of the MCG and in slot* $i\_{2}$ *of the SCG, respectively, that the UE determines according to Clauses 7.1 through 7.5 using* $P\_{MCG}$ *and* $P\_{SCG}$*, respectively, as the maximum transmission powers on the MCG and the SCG and* $\hat{P}\_{Total}^{NR-DC}$ *is the linear value of a configured maximum transmission power for NR-DC operation in FR1 as defined in [8-3, TS 38.101-3]*

*- if UE transmission(s) in slot* $i\_{1}$ *of the MCG or in slot* $i\_{2}$ *of the SCG do not overlap in time with any UE transmission(s) on the SCG or the MCG, respectively, the UE determines a transmission power in slot* $i\_{1}$ *of the MCG or in slot* $i\_{2}$ *of the SCG as described in [8-3, TS 38.101-3] and in Clauses 7.1 through 7.5 without considering* $P\_{MCG}$ *or* $P\_{SCG}$*, respectively*

This issue was discussed in last RAN1 #100 bis e-meeting and no conclusion was made due to concern raised on the potential impact on PRACH transmission on MCG. More specifically, one company wants to clarify how to handle the PRACH transmission first and then to decide whether or not to remove this paragraph.

Companies views can be provided in the following Table:

|  |  |
| --- | --- |
| **Company** | **View/Position** |
| Qualcomm | This part is no longer aligned with the other part of the specs for NR-DC dynamic power-sharing. Proponent can clarify why this cannot be removed and how it should be resolved. |
| Samsung | Same opinion with Qualcomm. Can revisit after LS from RAN2. |
| OPPO | After futher thinking, we are ok to remove the above text from the current spec  |
|  |  |

# 3 Conclusion on the scope of the RAN1#101

To be completed

# References

1. [R1-2003324](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003324.zip) Remaining Issues of Dynamic Power Sharing for NR-DC ZTE
2. [R1-2003410](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003410.zip) Remaining issues on uplink power control for NR-NR DC vivo
3. [R1-2003501](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003501.zip) UL power control for NR-NR dual connectivity Huawei, HiSilicon
4. [R1-2003672](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003672.zip) Remaining issues on uplink power control for supporting NR-NR dual-connectivity MediaTek Inc.
5. [R1-2003749](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003749.zip) Remaining issues on uplink power control for NN-DC Intel Corporation
6. [R1-2003891](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003891.zip) Remaining Issues on UL Power Control for NR-DC Samsung
7. [R1-2003939](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2003939.zip) Remaining details of Rel-16 DC uplink power control Nokia, Nokia Shanghai Bell
8. [R1-2004057](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2004057.zip) Text proposals for UL Power Sharing for NR-DC OPPO
9. [R1-2004236](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2004236.zip) Remaining issues of UL Power Control for NN-DC Apple
10. [R1-2004361](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2004361.zip) Remaining issues for NR-DC UL Power Control Ericsson
11. [R1-2004473](file:///C%3A%5CUsers%5Cwanshic%5COneDrive%20-%20Qualcomm%5CDocuments%5CStandards%5C3GPP%20Standards%5CMeeting%20Documents%5CTSGR1_101%5CDocs%5CR1-2004473.zip) Remaining issues on NR-DC power-control Qualcomm Incorporated
12. R1-2001421, LS on uplink power control for NR-NR Dual-Connectivity, RAN1, RAN1#100-e
13. R1-2003262, LS reply on uplink power control for NR-NR Dual-Connectivity, RAN2, RAN1#101-e
14. R1-2004710 Outcome of preparation discussion on UL Power Control for NN-DC Moderator (Apple)