**3GPP TSG-RAN** **WG2 Meeting #109 electronic R2-xxxx**

**E-Meeting, 28th Feb– 6th Mar, 2020**

Source: vivo

Title: Power Control NR DC

Agenda Item: 6.10.2

Document for: Discussion and Decision

# Introduction

This document is summarized for the following email discussion:

* [AT109e][044][DCCA] Power Control NR DC (vivo)

 Scope: Treat Email discussion + additional issues from the other papers to this Agenda item

 Intended outcome: Agreed Issues resolutions

 Deadline: Mar 3 1200 CET

The document is organized as follows:

* Whether send an LS to RAN4 to inform the agreed new NR-DC power control parameters in RAN2 and the wording of LS if needed
* Discuss whether NR-DC power control mode should be indicated in *CG-ConfigInfo* message
* Discuss whether TDD pattern of MCG should be indicated in *CG-ConfigInfo* message

# Discussion

## 2.1 Send an LS to RAN4

In the email discussion [1], we have the following proposals for NR-DC power control:

***Proposal 2: The existing parameter p-UE-FR1 defined in TS 38.331 can be reused to configure the total maximum transmit power to be used by the UE across all cell groups for NR-DC on FR1.***

***Proposal 3: Introducing a new parameter p-UE-FR2 in the RRCReconfiguration message to configure the total maximum transmit power to be used by the UE across all cell groups for NR-DC on FR2.***

Proposal 2 and proposal 3 have been captured in the corresponding endorsed TP. From our understanding the ***p-UE-FR1*** and ***p-UE-FR2*** will impact maximum output power calculation in RAN4. Similar with EN-DC case according to TS 38.101-3, the total maximum transmit power to be used by the UE across all cell groups for EN-DC, is signaled by RRC within the parameter ***p-MaxUE-FR1*** defined in TS 36.331.

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| 6.2B.4.1.1 Intra-band contiguous EN-DCThe following requirements apply for one component carrier per CG configured for synchronous DC.…The configured maximum output power PCMAX\_ E-UTRA,*c* (*p*) in sub-frame *p* for the configured E-UTRA uplink carrier shall be set within the bounds:PCMAX\_L\_ E-UTRA,*c* (*p*) ≤ PCMAX\_ E-UTRA,*c* (*p*) ≤ PCMAX H \_ E-UTRA,*c* (*p*)where PCMAX\_L\_ E-UTRA,*c* and PCMAX H \_ E-UTRA,*c* are the limits for a serving cell *c* as specified in TS 36.101 [4] subclause 6.2.5 modified by PLTE as follows:PCMAX\_L\_ E-UTRA,*c* = MIN {MIN(PEMAX,*c* , PEMAX, EN-DC, PLTE) – tC\_ E-UTRA, *c*, (PPowerClass, EN-DC – ΔPPowerClass,EN-DC ), (PPowerClass – ΔPPowerClass) – MAX(MPR*c* + A-MPR*c* + ΔTIB,c + TC\_ E-UTRA, *c* + TProSe, P-MPR*c*)}PCMAX H \_ E-UTRA,*c* = MIN {PEMAX,*c*, PEMAX, EN-DC , PLTE, PPowerClass, EN-DC, PPowerClass – ΔPPowerClass}where- PEMAX,EN-DC is the value given by the field *p-maxUE-FR1* of the *RRCConnectionReconfiguration-v1530* IE as defined in TS 36.331 [8];- PLTE is the value given by the field *p-maxEUTRA-r15* of the *RRCConnectionReconfiguration-v1510* IE as defined in TS 36.331 [8] which is the same as PLTE in TS 38.213 [10];- ∆tC\_EUTRA, c = 1.5 dB when NOTE 2 in Table 6.2.2-1 of TS 36.101 [4] applies; ∆tC\_EUTRA, c = 0 dB otherwise; |

So, we suggest to send an LS to RAN4 to inform two new parameters introduced in RAN2. The drafted LS can be found in [3].

Now, companies are invited to provides their comments for the draft LS out [3].

**Q1: Do you agree to send an LS to RAN4 to inform two new parameters introduced in RAN2, and do you have any comments for the drafted LS out [3] if the LS is needed?**

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| **Company** | **Any comments** |
| Qualcomm | Agree to send LS to RAN4 on the new 2 max power parameters introduced in RAN2 |
| vivo | We assume that he ***p-UE-FR1*** and ***p-UE-FR2*** will impact maximum output power calculation in RAN4. We shall send the LS to RAN4 to inform two new parameters introduced in RAN2.  |
| Nokia | Agree to send LS to RAN4 to inform two new parameters introduced in RAN2 |
| Ericsson | Agree to send an LS to RAN4 |
| Huawei | Agree. |
| DOCOMO | Agree |
| OPPO | Agree  |
| Apple | Agree |

All the companies in this discussion agree to send an LS to RAN4.

**Proposal 1: Send the LS to RAN4 to inform two new parameters introduced in RAN2 for NR-DC power control.**

**A draft LS is provided in R2-2000294.**

## 2.2 NR-DC power control mode indication

Two semi-static power sharing and dynamic power sharing defined by RAN1 are as follows.

* Semi-static power sharing:

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| In RAN1#98, it was agreed to consider the following two alternatives for semi-static power sharing with :* Alt.1: For the UL transmission in MCG, the UE checks the semi-statically configured direction of the overlapping symbols of all serving cells of SCG, and vice versa.
	+ If such overlapping with UL transmission on the SCG is possible (i.e. collides with semi-static ‘UL’ and ‘flexible’ symbols on some CCs of SCG), UE limits its actual transmission power in MCG such that ;

* + Otherwise (i.e. collides with only semi-static ‘DL’ symbols on all CCs of SCG), can be up to and can be up to .
		- Alt.1-1: and are configured by RRC ehavior.
		- Alt.1-2: and are determined by RAN4 requirement.
* Alt.2: For the uplink transmission in MCG and in SCG, UE limits its actual transmission power to be up toand to be up to .
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* Dynamic power sharing:

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| * For NR-DC dynamic power sharing, to compute the transmit power for SCG UL transmission starting at time T0,
* UE checks for PDCCH(s) received before time T0-T\_offset that trigger an overlapping MCG UL transmission, and
	+ If such PDCCH(s) are detected, UE sets it’s transmit power in SCG (pwr\_SCG) such that pwr\_SCG <=min{PSCG, Ptotal– MCG tx power} where ‘MCG tx power’ is the actual transmission power of MCG
	+ Otherwise, pwr\_SCG <= Ptotal;
* UE does not expect to be scheduled by PDCCH(s) received on MCG after T0-[T\_offset] that trigger(s) MCG UL transmission(s) that overlaps with the SCG transmission.
	+ (working assumption) No new RRC signaling is introduced for T\_offset:
		- Alt.1: T\_offset <= T\_proc,2
		- Alt.2: T\_offset <= 2\*T\_proc,2
		- Alt.3: T\_offset ehaviory larger than Alt 1. & Alt 2 but <=4ms
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In RAN1#99 meeting, *NR-DC-PC-mode* is introduced in the IE *PhysicalCellGroupConfig* to indicated UE which mode is selected.

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| LTE\_NR\_DC\_CA\_enh-Core | NR-DC | PhysicalCellGroupConfig | NR-DC-PC-mode | New | Selects the uplink power control mode to use for NR-DC. |

According to the above agreements, UE behaviour is clear, i.e., UE adjusts its transmit power as the way defined for different power control modes. And in the email discussion [1], all companies agreed that it is MN to decide the power control mode.However, whether *NR-DC-PC-mode* needs to be indicated to the SN should be further discussed.

In this RAN2#109e meeting, 3 companies support that *NR-DC-PC-mode* is indicated to the SN [2][4][5], and 1 company does not support [6]. The main argument why the companies support is:

Since thatdifference from EN-DC power control, it is possible that when dynamic power control is set by MN in NR-DC power control. Thus, SN can’t distinguish whether MN sets dynamic or semi-static power sharing via *CG-ConfigInfo.* As a results, SN cannot determine whether SN is allowed to set the max SCG power such that the sum of MCG and SCG power exceeds the total UE max power.

**Q2: Do you think *NR-DC-PC-mode* is indicated to SN by MN?**

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| **Companies** | **Yes or No**  | **Comments** |
| **Qualcomm** | **Yes** | We think it is necessary.In EN-DC power control, whether the power control is dynamic or semi-static can be implicitly derived by SN via checking whether *p-maxEUTRA* + *p-maxNR-FR1* > *p-maxUE-FR1*. Specifically:* If *p-maxEUTRA* + *p-maxNR-FR1* > *p-maxUE-FR1*, it is dynamic power control.
* Otherwise (if *p-maxEUTRA* + *p-maxNR-FR1* ≤ *p-maxUE-FR1*), it is semi-static power control.

However, in NR-DC power control, the above implicit rule is not valid anymore. It is possible that *p-maxNR-FR1-MCG + p-maxNR-FR1 ≤ p-maxUE-FR1* when dynamic power control is set by MN. Then in this case, SN can’t distinguish whether MN sets dynamic or semi-static power sharing via *CG-ConfigInfo*. As a result, SN may not be able to know whether it can request more power via CG-Config, which will degrade the NR-DC power control performance. |
| **Vivo** | **No strong view** | From the UE aspects, the ehavior of UE is totally clear based on RRC parameter. From our understanding, there is no statement in RAN1 agreements to restrict must be satisfied for NR-DC dynamic power control. However, it is not clear for the benefit that MN configures when selecting dynamic power control mode.We should also ask RAN1 if is allowed in case of dynamic power control mode. |
| **Nokia** | **Yes** | Sharing of the mode would help at least SN to understand whether it can have any chance to schedule full power UL transmission or it should always schedule UL transmission with power limits. |
| **Ericsson** | **Yes** | Agree with Qualcomm. |
| **Huawei** |  | Agree with vivo. Even though we question the use case of when dynamic power control mode is configured by MN, but if it is allowed, then the *NR-DC-PC-mode* can be indicated to SN from MN, so that SN can know whether semi-static power control is configured, and furthermore which particular PC mode between Alt.1-2 and Alt.2.  |
| **DOCOMO** | **Yes** | Agree with Qualcomm, Nokia, especially for SN to decide its scheduling operation commented by Nokia.  |
| **OPPO** |  | We think the key point is that whether it is reasonable or feasible to configure *NR-DC-PC-mode* to dynamic power control mode and also configure This point need RAN1 to confirm. |
| **Apple** | **Yes** | Agree with Qualcomm. |

Majority of the companies in this discussion agree that *NR-DC-PC-mode* should be indicated to SN by MN.

**Proposal 2: For NR-DC power control,the *NR-DC-PC-mode* configured by MN is indicated to SN.**

## 2.3 TDD pattern indication

In this RAN2#109e meeting, whether semi-static TDD pattern of MCG should be included in *CG-ConfigInfo* message is discussed in [2]. The main argument is

If semi-static power control solution Alt 1-2 is selected, SCG UL performance can be improved if SN can also know the semi-static TDD pattern of MCG because SN scheduler can take into account when the UE can allocate larger power to SCG transmissions.

**Q3: Do you agree that the TDD pattern of MCG can be indicated to SN?**

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| **Companies** | **Yes or No**  | **Comments** |
| **Qualcomm**  | **Yes** | if semi-static power control solution Alt 1-2 is selected, basically it means that if all the symbols in MCG cells are DL, then SCG can get full power. So, in our understanding, if SN can also know the semi-static TDD pattern of MCG, then SN scheduler can take into account when the UE can allocate larger power to SCG transmissions. Therefore, it can improve SCG UL performance, compared with the case where SN considers TX power is simply split between MCG and SCG.Thus, we think that the semi-static TDD pattern of MCG can be optionally included in *CG-ConfigInfo* when semi-static power control Alt 1-2 is set by MN. ***With regards to Ericsson’s concerns:***According to latest 38.331, the semi-static TDD pattern of MCG is included in *sourceConfigSCG*, which is a container:CG-ConfigInfo-IEs ::= SEQUENCE {ue-CapabilityInfo OCTET STRING (CONTAINING UE-CapabilityRAT-ContainerList) OPTIONAL,-- Cond SN-AddMod...sourceConfigSCG OCTET STRING (CONTAINING RRCReconfiguration) OPTIONAL,scg-RB-Config OCTET STRING (CONTAINING RadioBearerConfig) OPTIONAL,...}Thus, although it is sent to SN as part of ServingCellConfigCommon in CG-ConfigInfo, the SN doesn’t decode it and thus can’t know it.***With regards to Huawei’s concerns:***1) When MN needs to inform SN: we think it at least can be sent together with *NR-DC-PC-mode (when Alt1-2 is selected).*Anyway, as along as we agree *NR-DC-PC-mode is* sent from MN to SN, we need to discuss the same issue. Therefore, we don’t think it will increase spec efforts2) Signalling overhead: only MCG’s semi-static TDD configuration is needed to be sent from MN to SN. Please note that such configuration is included in SIB1 and thereby it will change quite slowly. It is our assumption that MN can just send it once until EN-DC is released. Thus, we don’t think overhead is an issue3) Timing difference: first, we think UE can always know TDD pattern of both MN and SN. The only issue is whether SN can know semi-static TDD pattern of MN, right? Secondly, the timing offset between MN and SN can be obtained by SFTD. Therefore, we also don’t see any issue. |
| **Vivo**  | **FFS** | Based on the answer of Q2, If *NR-DC-PC-mode* is indicated to SN, the TDD pattern of MCG can also be indicated to SN.**Response to Ericsson/QC:**In our understanding, the TDD pattern in *CG-Config* is the TDD pattern of SCG, which will be sent to the UE for the case of SCG establishment or modification, or to the target SN in the case of SN triggered SN change. There is no parameter defined to send the TDD pattern of MCG to SN.

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| ***sourceConfigSCG***Includes all of the current SCG configurations used by the target SN to build delta configuration to be sent to UE, e.g. during SN change. The field contains the *RRCReconfiguration* message, i.e. including *secondaryCellGroup* and *measConfig*. The field is signalled upon change of SN, unless MN uses full configuration option. Otherwise, the field is absent. |

According to the above field description, the semi-static TDD pattern of MCG seems not to be included in sourceConfigSCG. In our understanding, there is no parameter defined to send the TDD pattern of MCG to SN.**Response to DCM:**I also double checked RAN3 specification, if my understanding is corrected, the existing TDD/TDM pattern is not suitable for NR-DC power control purpose. TDM pattern for harmonic interference is only for PCell not for all serving Cells in EN-DC case. TDM pattern for CLI is per node, is not per UE.It is simple to extend RRC inter-node message, the extension in RRC inter-node message will not impact RAN3. |
| **Nokia** | **Yes** |  |
| **Ericsson** | **Yes with comment** | Our understanding is that the semi-static TDD patter is already exchanged in the inter-node message. From 11.2.3 we have:For a field that conveys the UE configuration in *CG-Config* (SN initiated change of SN configuration, or SCG configuration query) and in *CG-ConfigInfo* upon change of SN (i.e. *mcg-RB-Config*, *scg-RB-Config* and *sourceConfigSCG*):- The source node shall include all fields necessary to reflect the AS configuration of the UE, unless stated otherwise in the field description or in this sub-clause. For RRCReconfiguration included in the field scg-CellGroupConfig in CG-Config, ReconfigurationWithSync is included with only the mandatory subfields (e.g. newUE-Identity and t304) and ServingCellConfigCommon; |
| **Huawei** | **No** | We understand that in case of semi-static PC mode alt1-2, if SN can determine the UL subframes without overlapping, it can try to use more power. However, one thing is currently the MCG serving cell configuration including TDD pattern is not exchanged on X2/Xn interface, if we want to support this for power control we also need to decide when the MN needs to inform such configuration to SN, e.g. SCell addition/release or even SCell activation/deactivation or switching between dormancy and non-dormancy. In our view, this information exchange can only be useful if the information is accurate and timely which also means a lot of signalling overhead. The other thing is according to RAN1 agreement “it is up to UE to determine whether the overlapping with UL transmission on the SCG is possible, if/when factors other than the TDD UL-DL configurations of the serving cells in the SCG (e.g, timing difference, drift) need to be taken into account.”, there are several uncertain factors other than the TDD UL-DL configurations to determine whether overlapping is possible. Therefore we are not sure the exchange of TDD pattern can bring how much benefit in this case comparing with the signalling overhead.   |
| **NTT DOCOMO** | **Yes with comment** | Whilst we see a point to utilise TDD pattern in SN, even today, SN could parse the sourceConfigSCG and look into the TDD pattern by implementation. In addition, resource coordination information is defined for MR-DC, over Xn/X2 IF. So, we’re wondering if the existing IE over Xn can be reused or extended for NR-DC. RAN3 feedback would be required. |
| **OPPO** | **Yes with comments** | One question first for Alt 1-2. It applies to TDD case, not FDD?We agree with QC, the SCG can know when to apply full power with the TDD pattern decided by MN. For Huawei concern, we also think it is valid. So we think if the DD pattern can be not so frequent. E.g. MN update the TDD pattern ony after SCell addition? |
| **Apple** | **Yes** |  |

Majority of the companies in this discussion agree that TDD pattern of MCG is indicated to SN. More specifically, the semi-static TDD pattern of MCG can be optionally included in *CG-ConfigInfo* when semi-static power control Alt 1-2 is set by MN. In our understanding, there is no parameter defined to send the TDD pattern of MCG to SN.

**Proposal 3: For NR-DC power control, introduce an optional IE in *CG-ConfigInfo* message to indicate thesemi-static TDD pattern of MCG to SN when semi-static power control Alt 1-2 is set by MN, the TP can be found [7].**

# Summary

**Proposal 1: Send the LS to RAN4 to inform two new parameters introduced in RAN2 for NR-DC power control.**

**Proposal 2: For NR-DC power control,the *NR-DC-PC-mode* configured by MN is indicated to SN.**

**Proposal 3: For NR-DC power control, introduce an optional IE in *CG-ConfigInfo* message to indicate thesemi-static TDD pattern of MCG to SN when semi-static power control Alt 1-2 is set by MN, the TP can be found [7].**

1. Reference
2. R2-2000293, Report of email discussion power control for NR-DC, vivo, discussion
3. R2-2000137, Remaining issues of power control in NR-DC, Qualcomm Incorporated, discussion
4. R2-2000294, Draft LS on NR-DC power control, vivo, LS out, To:RAN4, Cc:RAN1
5. R2-2000674, NR DC power control Nokia, Nokia Shanghai Bell, discussion
6. R2-2000872, Remaining issues for NR-DC power control, Ericsson, discussion
7. R2-2001391, NR-DC power control Huawei, HiSilicon, discussion

[7] R2-20xxxxx, Text proposal of power control NR-DC, vivo, discussion