**3GPP TSG-RAN WG2 Meeting #118 R2-220xxxx**

**e-Meeting, 9-20 May 2022**

**Source: Qualcomm Incorporated (Email discussion rapporteur)**

**Title: Summary for email discussion [AT118-e][045][NR17] DC Location Report (Qualcomm)**

**Document for: Decision**

**Agenda Item: 6.24.1**

# Introduction

This document summarizes the following email discussion.

* [AT118-e][045][NR17] DC Location Report (Qualcomm)

Scope: Treat R2-2204506, R2-2205266, R2-2205386, R2-2205387, R2-2205735, R2-2205517, R2-2205518,

Ph1 Determine agreeable parts, Ph2 agree CRs

Intended outcome: Report, Agreed CRs

Deadline: Schedule 1

* A **first round** with **Deadline for comments W1 Thursd May 12th 1200 UTC** to settle scope what is agreeable etc
* A Final round with **Final deadline W2 Wednesd May 18th 1200 UTC** to settle details / agree CRs etc.

Contact person for each participating company:

|  |  |  |
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# Discussion – Phase1

In this document, the following solution identifiers are used in the discussion.

* Solution 1: R2-2205266 (Qualcomm)
* Solution 2: R2-2205386, R2-2205387, R2-2205735 (Nokia)
* Solution 3: R2-2205517, R2-2205518 (Huawei)

RAN2 made the following agreements in RAN2#116bis meeting, based on the first RAN4 LS [1].

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| * For default DC location derivation, the UE signals:   1. the choice of frequency component, among {Activated CC, Configured CC, Activated BWP, Configured BWP}.  2. the choice of UL and/or DL for frequency component, among {UL, DL, Edge most frequencies among any DL and UL}   * The network specifies the radio resource configuration (including BWP / CC activation state) for which the UE is requested to report the offset to default DC location. FFS how the radio resource configuration is specified. * Introduce a new release-17 network request for the extended DC location reporting for more than 2 UL CCs. * Upon a new release-17 network request, the UE reports the extended DC location reporting for more than 2 UL CCs, i.e. the release-17 network request does not trigger the reporting of *reportUplinkTxDirectCurrent* and *reportUplinkTxDirectCurrentTwoCarrier-r16*. |

RAN2 then sent an LS to RAN4, asking questions for clarification in [2]. Reply LS was received from RAN4 in [3]. RAN4’s reply is reproduced below.

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| RAN4 would like to thank you RAN2 for their Reply LS on DC location for >2CC.  RAN4 has discussed the presented questions and conclude the following:  For the Question 1 there are different understanding on the meaning of “Per band per band combination” and “Per intra-band UL CA component per band combination” in RAN4. And it is RAN4 understanding as below:  For an intra-band UL CA configuration, a UE may have one or two default DC locations. For all the CCs within this band, there can be one or two CC groups where each CC group is associated with one default DC location. CC group can consist of multiple CCs. The default DC location framework applies to each CC group.  For Question 2, RAN4 has concluded that UE should declare if it has two default DC locations via *dualPA-Architecture* capability. Frequency component type is same for both default DC locations. For the calculation of the default DC locations, the component carriers associated with each default DC location must be known. UE may need a non-zero offset for each DC location.  Additionally, RAN4 has discussed and would like to clarify previous LS that in some cases for intra-band non-contiguous CA with one LO, the DC frequency may be outside the configured spectrum. The exact location of the carrier leakage must be known. |

* 1. DC location reporting granularity

The intention of RAN2 LS [2] was to clarify the granularity of DC location reporting. The solutions submitted to this RAN2 meeting propose the following.

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| # | Frequency component options (\*) | Offset to default |
| Solution 1 | Single PA: Per intra-band UL CA component per band combination.  Dual PA: Per CC group per intra-band UL CA component per band combination | Same as left. |
| Solution 2 | Per CC group per band entry per band combination | Per configured UL BWP per serving cell |
| Solution 3 | Per CC group per band combination | Same as left. |

(\*) RAN2 #116bis agreement:

1. the choice of frequency component, among {Activated CC, Configured CC, Activated BWP, Configured BWP}.
2. the choice of UL and/or DL for frequency component, among {UL, DL, Edge most frequencies among any DL and UL}

The reason why solution 1 differentiates between single PA and dual PA case is because in case of single PA, all CCs of intra-band UL CA component are of single CC group, hence no need of explicitly signalling CC group. Solution 3 took more generic approach where the lowest CC and the highest CC for each CC group is explicitly signalled. Solution 2 is functionally different and does not seem to allow CC grouping across band entries, i.e. intra-band non-contiguous.

For the offset of default DC location, solution 1 and solution 3 follow the principle that there is one offset per default DC location.

The rapporteur thinks the solution 3 is the simplest / straightforward approach, without the need of addressing “UL CA component” or “single / dual PA” at least from the RRC signalling structure perspective. RAN4 indicated the frequency component option is the same for the two CC groups in case of dual PA, which probably can be implemented as requirement text instead of implementing the restriction in the ASN.1 signalling structure.

**Proposal 1:** DC location (frequency component option and offset to default) is signalled per CC group. For determination of each CC group, the UE signals the lowest CC/serving cell and the highest CC/serving cell.

**Q1: Companies are requested to provide their input for proposal 1.**

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| **Company** | **Agree/Disagree** | **Comment** |
| Huawei, HiSilicon | Agree | We have the same understanding as the rapporteur that solution 1 and 3 follow the RAN4 principle and we could go with a generic way to simplify the changes. |
| OPPO | Agree |  |
| CATT | Agree |  |
| vivo | Agree |  |
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**Rapporteur’s proposal for phase 2:**

Proposal 1 is pursued.

* 1. Semi-static UE capability signalling vs Dynamic reporting

Different approaches are proposed for UE reporting, in particular on the reporting of frequency component option and CC group.

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| # | Description |
| Solution 1 | Frequency component option and CC group in UE capability signalling |
| Solution 2 | Frequency component option and CC group in UE capability signalling |
| Solution 3 | Frequency component option and CC group in RRC Reconfiguraion/Resume Complete |

The stated benefit of using UE capability signalling is that the network can know the CC group and frequency component option before it requests the extended DC location reporting, and can tailor the content of network request.

**Proposal 2:** Frequency component option and CC group are signalled per band combination as part of semi-static UE capability.

**Q2: Companies are requested to provide their input for proposal 2.**

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| **Company** | **Agree/Disagree** | **Comment** |
| Huawei, HiSilicon | Disagree | We understand there is a possibility that the network can know the CC group via UE capability reporting.  But on the other hand, before the network configures which band combination and CCs are used for the UE, it is unclear to us how the UE can justify which CCs should be grouped together. We understand the UE decides which CCs are grouped together according to the frequency range configured for each CC for a specific BC from the network.  So the basic question is whether CC group is semi-static or dynamic changed pending on network’s configuration, for example, if the reports involves CC1, CC2 and CC3, it is possible that CC3 is in the middle of CC1 and CC2, and the channel bandwidth could also be vary among CC1, CC2 and CC3 via network configuration. In this case, it would be difficult for the UE to group CC1/CC2 or CC1/CC3 together before getting the exact configuration.  Our view is that we could use a unified way to report all the relevant information together, so if CC groups and DC location offsets are need to be reported in MSG5, we think frequency component option could be sent in MSG5 as well, thus we can avoid fragmenting the information in different messages. |
| Qualcomm Incorporated (as Rapporteur) |  | See rapporteur comment#Q4-1 in Q4.  I believe it is still beneficial for the network to know the frequency component options, so that the network knows it does not have to provide this information when the frequency component is either configured CC or configured BWP? |
| OPPO | Disagree | If CC group(s) is reported via UE capability it basically means these CC group(s) is kind semi-static, while DC location and relevant offset is based on the configured/activated CC or BWP. Reporting not via UE capability could help to reduce the number of DC location n and relevant offset value.  On the other hand we think frequency component option is semi-static information, which could be provided via UE capability. |
| CATT | Disagree | The DC location is associated the configured/activated CC or BWP, which is changable, we prefer a flexible and common way to reporting the DC location for frequency component option and CC group. |
| vivo | Disagree | We also think dynamic reporting is better. |
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If proposal 2 is agreeable, it also makes sense to introduce UE capability filter for such UE capability signalling.

**Proposal 3:** Introduce UE capability filter for the new UE capability signalling.

**Q3: Companies are requested to provide their input for proposal 3.**

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| **Company** | **Agree/Disagree** | **Comment** |
| OPPO |  | If only frequency component option is reported through UE capability, then no additional filter is necessary. |
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**Rapporteur’s proposal for phase 2:**

* 1. Proposal 2 and 3 are not pursued. The UE capability only indicates the support for the extended DC location reporting mechanism. Frequency component option and CC group are signalled in *RRCReconfigurationComplete* and *RRCResumeComplete*. Network request for DC location reporting

RAN2 #116bis agreed:

* The network specifies the radio resource configuration (including BWP / CC activation state) for which the UE is requested to report the offset to default DC location. FFS how the radio resource configuration is specified.

The solutions submitted to this RAN2 meeting propose the following.

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| # | Description |
| Solution 1 | Combinations (max. 64) of the lowest and the highest activated CCs / BWPs for each CC group. |
| Solution 2 | One bit flag (ENUMERATED {true}) |
| Solution 3 | CC/BWP Combinations of UL and DL CC state (CC (de)activation state/active BWP) for the configured CA band combination.  (Rap NOTE: Not sure if I understood the intention of the proposed signalling) |

In [3], RAN4 indicated “*For all the CCs within this band, there can be one or two CC groups where* ***each CC group is associated with one default DC location***”. It seems only solution 1 addresses this requirement. Solution 2 does not cover the RAN2 agreement above.

**Proposal 4:** The network indicates combinations (max. number FFS) of the lowest and the highest activated CCs / BWPs for each CC group, for which the UE is requested to report DC location(s), when the frequency component is either ‘Activated CC’ or ‘Activated BWP’.

**Q4: Companies are requested to provide their input for proposal 4.**

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| **Company** | **Agree/Disagree** | **Comment** |
| Huawei, HiSilicon | Solution 3 | We understand the network would first configure the CCs, and then the UE uses these configured CCs to define the CC group and report the location offset for each CC group. After receiving the reporting from the UE, the network then know which CCs are grouped together with its associated DC location.  Another difference with Solution 1 is that solution 3 indicates also the deactivated state for the CC, because we are not sure if one CC is deactivated while this CC is in the middle of lowest and highest activated CCs, whether the DC location will be changed compared with the case when the CC is activated. |
| Qualcomm Incorporated (as Rapporteur) |  | Rap comment#Q4-1:  Thank you Huawei, for the clarification.  Indeed, with the clarified solution 3, there is no need of CC group awareness at the network side in providing this information. Therefore, this affects the discussion on proposal 2. |
| OPPO | Solution 3 with comment | We also think CC group is decided by UE itself but not network. The limited number of CC/BWP with their state combination would provide potential configurations that UE can deduce CC group and relevant DC location+ offset value. But we understand deactivated CC doesn’t impact the report hence could be removed from the signaling. |
| CATT | Solution 3 |  |
| Vivo | Solution 3 with comments | We agree with OPPO. |
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**Rapporteur’s proposal for phase 2:**

The network indicates the combinations of UL and DL CC state of each serving cell for the configured CA band combination. This is signalled in *CellGroupConfig.* “CC state” indicates CC activation state and the active BWP of the activated CC.

It was commented over email that the detailed structure of network request can be discussed in phase 2. In particular the possibility of requesting the extended DC location reporting per frequency band with the information of UL and DL CC state of each serving cell within the frequency band.

* 1. Others

This section covers aspects that seem to be aligned among the proposed solutions.

**Proposal 5:** Network request for the extended DC location reporting for more than 2 UL CCs is introduced in *CellGroupConfig*.

**Proposal 6:** UE reporting of offset to default DC location is introduced in *RRCReconfigurationComplete* and *RRCResumeComplete*

**Q5: Companies are requested to provide their input for proposal 5 and 6.**

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| **Company** | **Agree/Disagree** | **Comment** |
| Huawei, HiSililicon | Agree | In addition to the above P5 and P6, solution 3 also discussed the below one, the intention is to address the case that in an BC both 3CC and 2CC DC intra-band contiguous block are supported, and we prefer to use one mechanism to report the mixed case.  **Proposal 6: the Rel-17 DC location report mechanism should be used if a configured CA contains at least one UL intra-band CA block with more than 2 CCs, and in this case the report mechanism applies to all the intra-band CA blocks in the BC including 2 CCs UL intra-band CA blocks in this CA to avoid reporting Rel-16 DC location at the same time.** |
| OPPO | Agree | As for proposal 6 from Huawei, it is not clear what does CA blocks mean here. However we agree that only one report scheme is necessary for one specific connectivity. If network intends to configure more than 2 CCs during the whole connection, then network should choose Rel17 scheme. It means when the real configured/activated CC number is less than 3 CCs, UE will continue with Rel17 scheme. |
| CATT | Agree |  |
| vivo | Agree |  |
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**Rapporteur’s proposal for phase 2:**

Proposal 5 and proposal 6 are pursued. Continue the discussion on Huawei’s comment about the reporting mechanism for a band combination in which multiple UL intra-band CA components with >2CCs and with <=2CCs are included.

# Conclusion - Phase1 discussion

Based on the phase 1 discussion, the rapporteur proposes the following way forward.

**Proposal A:** DC location (frequency component option and offset to default) is signalled per CC group. For determination of each CC group, the UE signals the lowest CC/serving cell and the highest CC/serving cell. These parameters are signalled in *RRCReconfigurationComplete* and *RRCResumeComplete*.

**Proposal B:** Network request for the extended DC location reporting for more than 2 UL CCs is introduced in *CellGroupConfig*. The exact structure of the network request is discussed in phase 2.

**Proposal C:** As part of the network request, the network indicates the combinations of UL and DL CC state of each serving cell for the configured CA band combination.“CC state” indicates CC activation state and the active BWP of the activated CC.

**Proposal D:** UE capability indicates the support for the extended DC location reporting mechanism.

**Proposal E:** Continue the discussion on DC location reporting mechanism for a band combination in which multiple UL intra-band CA components with >2CCs and with <=2CCs are included, e.g. UL CA\_1C\_2A\_2C.

# Discussion – Phase2

* 1. Structure of network request for DC location reporting

One company suggested that the network request for the extended DC location reporting can be such that ***the network indicates the combinations of UL and DL CC state of each serving cell per UL intra-band CA component***. For example, in case of UL CA 1D\_2A\_2C, the network signals the CC state combinations for 1D component and 2A\_2C component separately. The stated benefit, as compared to signalling the CC state combinations for the entire band combination 1D\_2A\_2C. is that it reduces the number of combinations that have to be signalled.

**Q6: Companies are requested to provide their input for the *suggestion* above.**

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| **Company** | **Agree/Disagree** | **Comment** |
| Huawei, HiSilicon | Agree | This DC location reporting is for intra-band case and therefore we think the proposal by the rapporteur makes sense to reduce the unnecessary combinations. |
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* 1. Multiple UL intra-band CA components with >2CCs and with <=2CCs in band combination

In phase1 discussion, it was discussed which DC location reporting mechanism should be used for a band combination in which multiple UL intra-band CA components with >2CCs and with <=2CCs are included, e.g. UL CA\_1C\_2A\_2C. So far, RAN2 have defined the reporting mechanism for UL 1CC in release-15 and for UL intra-band CA with 2CCs in release-16.

There are a few possible options.

Option 1: Use the release-17 extended DC location reporting mechanism only.

Option 2: Use the release-17 extended DC location reporting mechanism for UL intra-band CA with >**=**2CCs and use the release-15 reporting mechanism for UL 1CC.

Option 3: Use the release-17 extended DC location reporting mechanism for UL intra-band CA with >2CCs, use the release-16 reporting mechanism for for UL intra-band CA with 2CCs and use the release-15 reporting mechanism for UL 1CC.

**Q6: Companies are requested to provide their input for the options above.**

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| **Company** | **Preferred option** | **Comment** |
| Huawei, HiSilicon | Option 2 | The main reason is due to the RAN4’s agreement below:  For a UL CA configuration in one band combination, there is only one mechanism will be used for DC location(s) reporting.  Both R16 and R17 DC location reporting are optional.   * + If UE supports both R16 and R17 capability, it is up to network to choose which one can be used in a band combination.   The above means for a BC containing 2 CCs UL intra-band CA blocks and more than 2 CCs UL intra-band CA blocks, if go for option 3, the network has to request twice on the same BC, we are not sure this is really an efficient way. |
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# Conclusion

# References

[1] R2-2200117 (R4-2119965) LS on DC location for >2CC RAN4 (To: RAN2)

[2] R2-2201978 Reply LS on DC location for >2CC RAN2 (To: RAN4)

[3] R2-2204506 (R4-2206602) Reply LS on DC location for >2CC RAN4 (To: RAN2)