**3GPP TSG-RAN WG2 Meeting #119bis-e R2-22xxxxx**

**Online, 10 – 19 October 2022**

**Agenda item: 6.24.1**

**Source: Samsung**

**Title: Report of [AT119bis-e][008][NR17] Dual PA (Samsung)**

**Document for: Discussion**

# 1 Introduction

This document is the report of the following offline discussion:

* [AT119bis-e][008][NR17] Dual PA (Samsung)

 Scope: Treat R2-2209343, R2-2210134, R2-2209381, R2-2209382, R2-2210659. Determine agreeable parts, Based on agreeable parts, progress CRs

 Intended outcome: Report, Agreed-in-principle CRs

 Deadline: In time for CB W2 Mon (if CB is needed),

Note that the following discussion paper seems missing so it is included in this offline discussion:

[R2-2209383](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209383.zip) Discussion on R4 LS on dual-PA architecture clarification OPPO, Ericsson, Samsung discussion Rel-17 NR\_RF\_FR1\_enh

Deadline (for companies' feedback): Thursday 2202-10-13 1600 UTC

# 2 Contact information

|  |  |  |
| --- | --- | --- |
| Company | Name | Email address |
| Ericsson | Mattias Bergström | Mattias.a.bergstrom@ericsson.com |
| Qualcomm Incorporated | Masato Kitazoe | mkitazoe@qti.qualcomm.com |
| OPPO | Qianxi Lu | qianxi.lu@oppo.com |
| Huawei, HiSilicon | Yang Zhao | zhaoyang@huawei.com |
| Nokia, Nokia Shanghai Bell | Tero Henttonen | tero.henttonen@nokia.com |
| ZTE | Yu Liu | liu.yu3@zte.com.cn |
| MediaTek | Mutai Lin | morton.lin@mediatek.com |
| vivo | Xiaodong Yang | Yangxiaodong5g@vivo.com |
| CATT | Jie Shi | shijie@catt.cn |
| Intel | Candy Yiu | Candy.yiu@intel.com |
| Samsung | Sangyeob Jung | sy0123.jung@samsung.com |

# 3 Discussion

### 3.1 Discussion on the RAN4 reply LS

In [1], RAN4 replied to our questions as follows:

**Q1**: During RAN2#117, RAN2 had made the following agreement for the DC location report

* [032] It is left to UE implementation whether a UE supporting *dualPA-Architecture* for a BC always reports two DC locations for the BC.
* [032] A UE not supporting dualPA-Architecture for a BC always reports one DC location for the BC. Whether to change the specification can be discussed at next meeting.

Is the required change from RAN4 (i.e., the reporting of *dualPA-Architecture* also indicates the support of dual-LO) compatible with the RAN2 agreement above (i.e., the reporting of *dualPA-Architecture* does not mandate the UE to report two DC locations for the BC)?

**Q2**: In RAN2 specification, there are two *dualPA-Architecture* as follows: Where the former one is reported for the intra-band CA part of NR, while the latter one is for the intra-band BC part of (NG)EN-DC/NE-DC.

| ***dualPA-Architecture***For band combinations with single-band with UL CA, this field indicates the support of dual PA. If absent in such band combinations, the UE supports single PA for all the Uls. For other band combinations, this field is not applicable. | BC | No | N/A | N/A |
| --- | --- | --- | --- | --- |
| ***dualPA-Architecture***For an intra-band band combination, this field indicates the support of dual Pas. If absent in an intra-band band combination, the UE supports single PA for all the Uls in the intra-band band combination. For other band combinations, this field is not applicable.This capability applies to:- Intra-band (NG)EN-DC/NE-DC combination without additional inter-band NR and LTE CA component;- Intra-band (NG)EN-DC/NE-DC combination supporting both UL and DL intra-band (NG)EN-DC/NE-DC parts with additional inter-band NR/LTE CA component;- Inter-band (NG)EN-DC/NE-DC combination, where the frequency range of the E-UTRA band is a subset of the frequency range of the NR band (as specified in Table 5.5B.4.1-1 of TS 38.101-3 [4]).If this capability is included in an “Intra-band (NG)EN-DC/NE-DC combination supporting both UL and DL intra-band (NG)EN-DC/NE-DC parts with additional inter-band NR/LTE CA component”, this capability applies to the intra-band (NG)EN-DC/NE-DC BC part. | BC | No | N/A | N/A |

Is the required change also applicable to the latter one, or only applicable to the former one?

After discussion during RAN4#104-e, RAN4 would like to respectfully provide the following responses for RAN2 consideration.

***Response to Q1:*** Reporting DC location(s) is up to UE implementation which is independent with indicating *dualPA-Architecture* capability. The RAN4 required change on *dualPA-Architecture* capability was for the purpose of differentiating two sets of MPR requirements with different UE architectures for intra-band UL non-contiguous CA, it was not intended to use as an indicator for UE to report two DC locations as of now.

***Response to Q2*:** RAN4 required change applicable only to the former one is sufficient as of now.

The rapporteur thinks that [1] can be just noted and actual discussion can be done based on companies’ contributions [2 – 6] in the following section.

**Q1: Do companies agree to note the RAN4 reply LS [1]?**

|  |  |  |
| --- | --- | --- |
| Company | Yes / No | Comments (if any) |
| Ericsson | Yes |  |
| Qualcomm Incorporated | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | Yes but | We think the answer to Q1 means that indicaiting support of *dualPA-Architecture* is independent with whether to report two DC locations. We are not sure whether companies have same understanding here. |
| Nokia, Nokia Shanghai Bell | Yes (but CR needs discussion)  | The LS itself contains all the necessary information for RAN2 to progress. But we need to discuss how it’s captured in specs. |
| ZTE | Yes but | According to RAN4’s reply LS, reporting DC location(s) is independent with indicating *dualPA-Architecture* capability. But from RAN2 view, we think the UE supporting *dualPA-Architecture* for a BC can report two DC locations, in other words, the UE which does not support *dualPA-Architecture* for a BC can’t report the second DC location. So is RAN2’s understanding aligned with RAN4’s reply LS?  |
| Apple | Yes | We understand that dualPA-Architecture and DC location reporting are independent.  |
| MediaTek | Yes |  |
| vivo | Yes |  |
| CATT | Yes |  |
| Intel | Yes |  |
| Samsung | Yes |  |

*Summary: All companies that provided input agree to note the RAN4 reply LS; from those companies, it was commented that RAN4's answer to Q1 can be interpreted that the support of dualPA-Architecture is independent with whether to report two DC locations, which seems not to be aligned with RAN2's agreements in RAN2#117-e meeting. Though the rapporteur understands it seems not correct interpretation since RAN4 indicated the following statement in R2-2206503:*

*"dualPA-Architecture* capability was originally introduced in Rel-15 to indicate whether UE using one PA or two PAs to support the intra-band UL CA"

*how to interpret RAN4's answer to Q1 seems the main concern/issue to make progress on this topic. Hence, it is suggested to discuss*

**Proposal 1: RAN2 to discuss whether RAN4's answer to Q1 in the LS is aligned with RAN2's agreements made in RAN2#117-e meeting.**

### 3.2 Discussion on the response to Q1 in RAN4 reply LS

Based on RAN4’s response to Q1 in [1], the rapporteur understands that RAN4 confirmed RAN2’s understanding made in RAN2#117-e meeting. The CR in [2] suggests to capture this understanding in the specification explicitly (see below highlighted text).

|  |
| --- |
| *UplinkTxDirectCurrentTwoCarrier* field descriptions |
| ***carrierOneInfo***The serving cell ID and BWP ID of the first carrier of the uplink carrier aggregation for which the uplink Tx Direct Current location(s) are being reported.  |
| ***carrierTwoInfo***The serving cell ID and BWP ID of the second carrier of the uplink carrier aggregation for which the uplink Tx Direct Current location(s) are being reported. |
| ***singlePA-TxDirectCurrent***The uplink Tx Direct Current location for the UE which support single PA for this uplink carrier aggregation. For the UEs which support dual PA for this uplink carrier aggregation, this field is for reporting the uplink Tx Direct Current location of the first PA.  |
| ***secondPA-TxDirectCurrent***The uplink Tx Direct Current location used by the UE with the second PA for the Ues which support dual PA for this uplink carrier aggregation. This field shall be absent for the *UplinkTxDirectCurrentTwoCarrier* entity where *deactivatedCarrier* of *carrierOneInfo* or *carrierTwoInfo* is set to *deactivated*. In other situations, it is up to UE implementation when the UE includes the uplink Tx Direct Current location for the second PA. |

**Q2: Do companies agree with the CR [2]?**

|  |  |  |
| --- | --- | --- |
| Company | Yes / No | Comments (if any) |
| Ericsson | Yes | Added later:Agree with MediaTek. We thought this would be straightforward.Earlier it was proposed in the CR [R2-2205514](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_118-e/Docs/R2-2205514.zip) an alternative way of capturing that UE can include the second DC location based on implementation. That particular CR was “postponed” and RAN2 sent an LS to RAN4 to confirm that it indeed it was left for UE implementation. RAN4 replied that: Yes, it can be left for UE implementation. And now suddenly we should not capture anything? It makes us a bit puzzled.We think that the above proposed way is cleaner compared to R2-2205514 since the optionality of secondPA-TxDirectCurrent is better captured within that field itself, not in the single-PA field.We don’t have a strong view here, but we just wanted to highlight the line of thinking for the above change, which we thought would be rather straightforward to agree (or at least agree a modified version of it). But companies seem to have changed their minds? |
| Qualcomm Incorporated | No | We do not see a strong need to capture what is left to UE implementation. |
| OPPO | Yes | We are open on this though, since R2 agreement has clarified. |
| Huawei, HiSilicon | No | Without adding this sentence, nothing seems broken. |
| Nokia, Nokia Shanghai Bell | No | We don’t see the necessity of this: Since the field is optional, it is already clear that it is up to UE when to populate it. The current field description has the same meaning even without this sentence, and we don’t see any ambiguity in this. |
| ZTE | No | Please see our answer on Q1, and we wonder if it is common understanding that ‘the UE which does not support *dualPA-Architecture* for a BC can’t report the second DC location’. If this is a common understanding, the wording ‘In other situations’ of the CR may cause ambiguities. |
| Apple | No | Do not see the need. Also ZTE’s comments are valid. |
| MediaTek | Yes | We thought that was the reason why we sent LS to RAN4. Without capturing such a clarification, one could have the same question again in the future? |
| Vivo | Yes |  |
| CATT | Yes | Prefer to add the description to make it clear. |
| Intel | No | From RAN4 response, it seems like it is independent of dual PA capability. The sentence also needs to be added to singlaPA-TxDirectCurrent as well based on the RAN4 LS. |
| Samsung | Yes | Good to clarify to avoid IODT issues/discussions later.  |

*Summary: 6 companies agree with the intention of the CR; from those companies, it was commented that since RAN2 sent LS to RAN4 to confirm whether the following RAN2's understanding "it is left to UE implementation whether a UE supporting dualPA-Architecture for a BC always reports two DC locations for the BC" is correct or not, it is good to capture such understanding in specification to avoid further discussions. 6 companies disagree with the intention of the CR; from those companies, it was commented that the change is already clarified in the minutes; it was also commented that the specification is already clear that it is up to UE implementation due to optional field and current field description; it was also pointed out that RAN4 response needs to be clarified.*

*Considering companies' views are split in half-half and nothing is broken without the change, it is suggested not to pursue the CR.*

**Proposal 2: The CR R2-2210659 is not pursued.**

### 3.3 Discussion on the response to Q2 in RAN4 reply LS

According to RAN4’s response to Q2 in [1], three companies provided views [3 – 6] on how to implement the required change of intra-band CA part of NR for dualPA architecture. As the concerned capability bit exists from Rel-15, [3] suggests to extend the meaning of dualPA architecture from Rel-15 if there is no NBC i.e.

1. RAN2 confirm there is no NBC issue to extend the meaning of dualPA architecture capability in TS38.306, and agree on CR since Rel-15.

**Q3: Do companies agree that there is no NBC issue to extend the meaning of dualPA architecture capability in TS 38.306 from Rel-15? If not, please provide your detailed views/options on the required change in TS 38.306.**

|  |  |  |
| --- | --- | --- |
| Company | Yes / No | Comments (if any) |
| Ericsson | Yes | We understand from RAN4 LS R4-2206503 that dual PA architecture indeed means dual LO and the change proposed by RAN4 in that LS indeed is backwards compatible and is merely a clarification of what dual PA means, i.e. that it means also dual LO.RAN4 indicates in the LS that they suggest doing the change from Rel-16. But to have different meanings of a capability bit in different releases is not how we should do things. A capability bit must mean the same thing in all releases. The gNB should be able to inspect the capability bit an understand what the UE supports/not supports. The capability bits must be self-contained in that way.To change only from Rel-16 is therefore not appropriate.Since this is backwards compatible, RAN2 should change from Rel-15.If RAN2 ends up concluding that it is NOT backwards compatible, we would have to implement a new capability from Rel-16 onwards which in addition to dual PA indicates whether the UE has dual LO. But again, we understand that there is a one-to-one mapping between these and hence it is backwards compatible and the change should be done from Rel-15, not Rel-16. |
| Qualcomm Incorporated | Yes |  |
| OPPO | Yes |  |
| Huawei, HiSilicon | No | We understand RAN4 LS response in Q1 indicated that dualPA-Architecture capability setting is independent with reporting of two DC locations. In RAN4 terminology and context, dual LO means there will be dual DC locations, and therefore this change is inconsistent with RAN4’s interpretation. We think the above changes are not backward compatible, and not the same as what RAN4’s LS has indicated.  |
| Nokia, Nokia Shanghai Bell | Yes | As we also explained in our contribution [R2-2205380](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_119bis-e/Docs/R2-2205380.zip) already, there is no NBC issue since network has to anyway consider what UE reports, i.e. has to be prepared for one or two DC locations with the Rel-16/17 DC location reporting schemes.However, whether there is issue with FR1/FR2 is something to consider (see section 3.4) |
| ZTE | Yes |  |
| MediaTek | No strong view | We prefer to have consistent interpretation across Releases but we can follow the majority. |
| Vivo | Yes |  |
| CATT | Yes |  |
| Intel | No | We share the same view as HW. Our understanding of RAN4 reply LS is that dual PA architecture is independent with DC locations reporting.  |

*Summary: 7 companies agree that extending the meaning of existing dualPA-Architecture capability bit from Rel-15 does not cause NBC issue; 1 company has no strong view but prefers to have consistent interpretation across releases; while 2 companies disagree with others. As mentioned in section 3.1, the main concern seems how to interpret RAN4's response to Q1 in R2-2209343 i.e. whether dualPA-Architecture capability setting is independent with reporting of two DC locations. In any case, since it may touch legacy R15/16 releases, it seems appropriate to give more time for companies to check whether there is no NBC issue before confirming it. However, considering a clear majority view, the rapporteur thinks that it would be good to make at least RAN2's assumption in this meeting to avoid further discussion. Hence, the following proposal is suggested.*

**Proposal 3: RAN2 assumes that extending the meaning of dualPA-Architecture capability in TS 38.306 from Rel-15 as proposed in R4-2206503 is backward compatible (can be revisited if needed based on P1 or issues are found).**

**Q4: If companies agree with Q3, do you have any comments on the CRs [4 - 6]?**

|  |  |
| --- | --- |
| Company | Comments (if any) |
| Qualcomm Incorporated | Is the placement of "all the ULs" for single PA case in the final text appropriate?* the UE supports single PA and single LO frequency for all the ULs for FR1, or single LO frequency for FR2

Shouldn’t “all the ULs” be made applicable also to FR2? |
| Nokia, Nokia Shanghai Bell | Cover page: We have some suggestions to the cover page to make the change clearer:Reason for change could explain what RAN4 has requested to avoid cross-referencing the LS, e.g. for the first paragraph:*In the LS R4-2206503, RAN4 indicated that an update to the capability indication "dualPA-Architecture" is needed: The capability should indicate that UE supporting it supports dual LOs and therefore UE may have two DC locations (i.e. UE support dual PA also supports dual LO and may have two DC locations, and UE supporting single PA only supports single LO and has a single DC location).* The inter-operability analysis just says “no inter-operability issues” but could be elaborated: We do think there could be demodulation performance loss if network makes the wrong assumption, or NW might query for two DC locations but only receive one. There is still no inter-operability issues, but explaining those could be helpful, e.g. as shown below:*1. If the network is implemented according to the CR and the UE is not, UE may indicate support for dual PA but only support single DC location, which can lead to network not using Rel-16 DC location reporting and thus not being aware of a second DC location, which can lead to demodulation performance loss but no inter-operability issue.**2. If the UE is implemented according to the CR and the network is not, network doesn't know whether UE supports one or two DC locations based on the presence or absence of the dual PA capability, and has to always use Rel-16 DC location reporting to know this, which may incur some signalling overhead but no inter-operability issues.*Other comments has text that can be removed once the CR is updated to the latest version.CRsSee our answer to 3.4 – there may be ambiguity for FR1/FR2 band combinations.  |
|  |  |

*Summary: 1 company commented that all the ULs should be applicable to FR2 as well. 1 company suggested to improve the cover page to make the change clearer. The rapporteur suggests that proponents of the corresponding CRs R2-2210134, R2-2209381, R2-2209382 are requested to take these comments (if valid) into account for next meeting.* *Hence, no proposal is made for now.*

### 3.4 Others

For any other issues not covered above, please feel free to indicate them into the following table.

|  |  |  |
| --- | --- | --- |
| Company | Discussion points | Comments |
| Nokia, Nokia Shanghai Bell | FR1/FR2 ambiguity | The proposed CR says the capability means “dual LO for FR1 or FR2”, this opens up a potential ambiguity: the original capability was mostly meant for FR1. With the updated meaning, does this mean that UE can support dual LO for FR2 but not FR1, or vice versa? Network might use Rel-16 DC location mechanism for FR1 carriers even if UE never supports dual LO for FR1 (since the capability doesn’t make that clear), which can cause unnecessary signalling. That’s why it would be best to make it clear when UE can signal this, and what does it mean. We proposed to have separate FR1/FR2 capabilities split off from the main capability but are open to discuss also other ways to handle the FRX case in general.  |
|  |  |  |
|  |  |  |

*Summary: 1 company suggested to have separate FR1/FR2 capabilities split off from the main capability. The rapporteur suggests that proponents of the corresponding CRs R2-2210134, R2-2209381, R2-2209382 are requested to take these comment (if valid) into account for next meeting.* *Hence, no proposal is made for now.*

# 4 Conclusion

Based on the discussion in the previous sections we propose the following:

**Proposal 1: RAN2 to discuss whether RAN4's answer to Q1 in the LS is aligned with RAN2's agreements made in RAN2#117-e meeting.**

**Proposal 2: The CR R2-2210659 is not pursued.**

**Proposal 3: RAN2 assumes that extending the meaning of dualPA-Architecture capability in TS 38.306 from Rel-15 as proposed in R4-2206503 is backward compatible (can be revisited if needed based on P1 or issues are found).**

# 5 Reference

[1] [R2-2209343](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2209343.zip) Reply LS on clarification of dualPA-Architecture capability (R4-2214924; contact: Samsung) RAN4 LS in Rel-17 NR\_RF\_FR1\_enh To:RAN2

[2] [R2-2210659](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2210659.zip) Correction to description of secondPA-TxDirectCurrent field Ericsson, Samsung, OPPO CR Rel-17 38.331 17.2.0 3558 - F NR\_RF\_FR1\_enh

[3] [R2-2209383](https://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_119bis-e/Docs/R2-2209383.zip) Discussion on R4 LS on dual-PA architecture clarification OPPO, Ericsson, Samsung discussion Rel-17 NR\_RF\_FR1\_enh

[4] [R2-2210134](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2210134.zip) Correction to definition of dualPA-Architecture capability indication Ericsson, OPPO, Samsung CR Rel-15 38.306 15.18.0 0813 - F NR\_RF\_FR1\_enh

[5] [R2-2209381](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2209381.zip) Correction to definition of dualPA-Architecture capability indication Ericsson, OPPO, Samsung CR Rel-16 38.306 16.10.0 0812 - A NR\_RF\_FR1\_enh

[6] [R2-2209382](file:///C%3A%5CUsers%5Cmtk65284%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2_RL2%5CTSGR2_119bis-e%5CDocs%5CR2-2209382.zip) Correction to definition of dualPA-Architecture capability indication Ericsson, OPPO, Samsung CR Rel-17 38.306 17.2.0 0811 - A NR\_RF\_FR1\_enh