**3GPP TSG RAN WG1 #116-bis R1-24xxxxx**

**Changsha, Hunan Province, China, April 15th – 19th, 2024**

**Title : Summary of discussion on RAN2 LS on parallel Tx Capability**

**Source : Moderator (ZTE)**

**Agenda item : 5**

**Document for** **: Discussion/Decision**

# Introduction

This is to discuss the following LS

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| **Rel-17 UE capability**R1-2401943 LS on Parallel Tx Capability RAN2, ZTERAN1 response necessary. To be discussed under agenda item 5. To be moderated by Xianghui (ZTE). Comeback on Thursday. |

The content of the LS (R1-2401943) is copied below [1].

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| For the capability of “Simultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells”, there is a Note2 as below in the RAN1 LS (R1-2312456)

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|  AgreementSimultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells is supported. * Note 1: Above applies since Rel-17.
* Note 2: Above applies only for inter-band CA
* Note 3: Above is subject to one new RRC parameter and one new UE capability (per BC). When the new RRC parameter is provided, simultaneous PUSCH and PUCCH transmission of same priority is always applied on different cells belonging to different bands.
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During RAN2 discussion, there are 2 different understanding on this Note:* Understanding #1: This capability can also be applied to the NR-DC band combination with the inter-band CA operation on the MCG/SCG
* Understanding #2: This capability can only be applied to the inter-band CA band combination

Thus RAN2 would like to confirm which understanding is aligned with RAN1’s intention.**Q1: For the application of “Simultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells” capability, which understanding is aligned with RAN1’s intention?*** **Understanding #1: This capability can also be applied to the NR-DC band combination with the inter-band CA operation on the MCG/SCG;**
* **Understanding #2: This capability can only be applied to the inter-band CA band combination**

Based on the Q1, RAN2 also went though the other parallex Tx capabilities and would like to confirm the below 2 further questions:**Q2: Whether Features listed in the Table 1 follow understanding #1 or understanding #2?****Table 1: Parallel Tx Capability with Inter-band CA**

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| **FG Index** | **Ran1 Description in the Feature list Table** | **Current Ran2 Field description** |
| 4-25(R15) | Parallel SRS and PUCCH/PUSCH transmission across CCs in inter-band CA | ***parallelTxSRS-PUCCH-PUSCH***Indicates whether the UE supports parallel transmission of SRS and PUCCH/ PUSCH across CCs in an inter-band CA band combination. |
| 4-26(R15) | Parallel PRACH and SRS/PUCCH/PUSCH transmissions across CCs in inter-band CA | ***parallelTxPRACH-SRS-PUCCH-PUSCH***Indicates whether the UE supports parallel transmission of PRACH and SRS/PUCCH/PUSCH across CCs in an inter-band CA band combination. |
| 9-3(R16) | Parallel MsgA and SRS/PUCCH/PUSCH transmissions across CCs in inter-band CA with msgA in PCell/PScell | ***parallelTxMsgA-SRS-PUCCH-PUSCH-r16***Indicates whether the UE supports parallel transmission of MsgA and SRS/ PUCCH/ PUSCH across CCs in an inter-band CA band combination. A UE supporting this feature shall also indicate support of *parallelTxPRACH-SRS-PUCCH-PUSCH*. |
| 25-18(R17) | Support simultaneous PUCCH and PUSCH transmissions of different priority on different cells for inter-band CA. | ***parallelTxPUCCH-PUSCH-r17***Indicates whether the UE supports simultaneous PUCCH and PUSCH transmissions of different priority on different cells for inter-band CA. |

**3: Whether Features listed in the Table 2 can also be applied to the NR-DC band combination with the intra-band non-contiguous CA operation on the MCG/SCG or only to intra-band non-contiguous CA band combination?****Table 2: Parallel Tx Capability with Intra-band non-contiguous CA**

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| **FG Index** | **Ran1 Description in the Feature list Table** | **Current Ran2 Field description** |
| 39-2(R17) | Parallel PRACH and SRS/PUCCH/PUSCH transmissions across CCs in intra-band non-contiguous CA | ***parallelTxPRACH-SRS-PUCCH-PUSCH-intraBand-r17***Indicates whether the UE supports parallel transmission of PRACH and SRS/PUCCH/PUSCH across CCs in an intra-band non-contiguous CA band combination. |
| 39-4(R17) | Parallel MsgA and SRS/PUCCH/PUSCH transmissions across CCs in intra-band non-contiguous CA(Prerequisite 9-3) | ***parallelTxMsgA-SRS-PUCCH-PUSCH-intraBand-r17***Indicates whether the UE supports parallel transmission of MsgA and SRS/ PUCCH/ PUSCH across CCs in an intra-band non-contiguous CA band combination. The UE indicating support of this field shall also indicate support of *parallelTxMsgA-SRS-PUCCH-PUSCH-r16* and *parallelTxPRACH-SRS-PUCCH-PUSCH-intraBand-r17*. |
| 39-1(R17) | Parallel SRS and PUCCH/PUSCH transmission across CCs in intra-band non-contiguous CA | ***parallelTxSRS-PUCCH-PUSCH-intraBand-r17***Indicates whether the UE supports parallel transmission of SRS and PUCCH/ PUSCH across CCs in an intra-band non-contiguous CA band combination. |

Therefore, RAN2 respectfully asks RAN1 to provide feedback on above questions**2. Actions****To RAN1****ACTION:** RAN2 respectfully asks RAN1 to provide feedback on above questions. |

# Contact information

**Please consider adding the contact info below for the convenience of email contact and F2F discussions.**

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| Company | Name | Email |
| ZTE | Xianghui Han | han.xianghui@zte.com.cn  |
| Nokia | Karri Ranta-aho | Karri.Ranta-aho@Nokia.com |
| NTT DOCOMO | Naoya Shibaike | Naoya.shibaike.eg@nttdocomo.com |
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# Discussion

In RAN2 LS, there are two different understandings, and RAN2 would like to confirm which understanding is aligned with RAN1’s intention for the following UE capabilities:

* Simultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells.
* Rel-15~17 parallel Tx capability with inter-band CA, as listed in Table 1 of LS R1-2401943.
* Rel-17 parallel Tx capability with intra-band non-contiguous CA, as listed in Table 2 of LS R1-2401943.

Companies’ views are summarize below based on the contributions [2~7].

* **Understanding #1:** This capability can also be applied to the NR-DC band combination with the inter-band CA operation on the MCG/SCG;
	+ Support: ZTE, Samsung, Qualcomm, NTT DOCOMO, Nokia
	+ In addition, Qualcomm proposes to introduce FR1/FR2 differentiation to indicate the feature applies to {FR1 only, or FR2 only, or both FR1 and FR2}.

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| * + - ‘The motivation to introduce per CG granularity is not mainly due to implementation, but IODT test. For example, in FR1+FR2 DC, NW may only deploy this feature in FR1 but not in FR2. Therefore, UE cannot find NW vendors to test this feature in FR2. To solve this problem, introducing FR1/FR2 differentiation is a reasonable solution.’
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* **Understanding #2:** This capability can only be applied to the inter-band CA band combination
	+ Support: Huawei, HiSilicon
	+ The reasoning is copied below.

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| * ‘RAN4 spec, TS 38.101-1 [2] specifies the band combinations for inter-band CA and NR-DC separately. In clause 5.5B “Configuration for DC” of TS 38.101, each uplink NR-DC configuration only contains two bands even three or a larger number of bands are involved. On the other word, for uplink transmissions, MCG/SCG only has one band respectively. Thus, from BC configuration perspective, inter-band parallel Tx capabilities is not applied to NR-DC currently.
* A typical UE is capable to support up to 2Tx only. For inter-band parallel transmissions, each Tx will correspond to one band. If CA+DC operation is allowed, at least 3Tx are needed for a UE (2Tx map two bands in one CG and 1Tx maps another band in the other CG). Thus, it is challenged from UE implementation aspect.
* Recalling the discussion history and taking the capability “Simultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells” as an example, it triggered by a scheduling restriction on UL TDD+FDD CA scenario and the agreement, especially the Note 2, is focusing the inter-band CA operation rather than NR-DC [3].’
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## First Round

**Q1: Do you agree that RAN1’s intention is the same for the following parallel Tx capabilities, regardless of which understanding is selected? If your answer is ‘No’, please elaborate the reason.**

* Simultaneous PUSCH and PUCCH transmissions of same priority on different inter-band cells.
* Rel-15~17 parallel Tx capability with inter-band CA, as listed in Table 1 of LS R1-2401943.
* Rel-17 parallel Tx capability with intra-band non-contiguous CA, as listed in Table 2 of LS R1-2401943.

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| Company | Inputs |
| Nokia | Agree |
| Samsung | Agree |
| NTT DOCOMO | Agree |
| ZTE | Agree |
| QC | Agree |

**Q2: Which understanding do you think is aligned with RAN1’s intention, Understanding#1 or Understanding#2?**

Companies are encouraged to address the views/concerns from the other camp as summarized at the beginning of this section.

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| Company | Inputs |
| Nokia | Understanding 1. |
| Samsung | Understanding 1. |
| NTT DOCOMO | Understanding 1.  |
| ZTE | Understanding 1.  |
| Huawei, HiSilicon | Understanding 2.We want to make the understanding clearer from both spec perspective and implementation perspective. In our contribution R1-2403361, we check the RAN4 spec, and provide following observation:* RAN4 spec 101-1 does not define band combinations for supporting inter-band CA and NR-DC at same time, in which at least 3 bands in a BC should be configured. Currently, RAN4 only specifies 2 bands in a BC, either CA or DC case.
* For a typical 2 Tx UE, it cannot support parallel transmissions simultaneously on three bands.

Therefore, from our side, understanding 2 is more practical.  |

**Q3: If Understanding#1 would be selected, do you agree to introduce FR1/FR2 differentiation to indicate the feature applies to {FR1 only, or FR2 only, or both FR1 and FR2} as proposed by Qualcomm?**

It is noted that, for the following capabilities, it is proposed NOT to change legacy UE features and only duplicate the definition of those features in Rel-18 with newly introduced FR1/FR2 differentiation to indicate the feature applies to {FR1 only, or FR2 only, or both FR1 and FR2}.

* Rel-15~17 parallel Tx capability with inter-band CA, as listed in Table 1 of LS R1-2401943.
* Rel-17 parallel Tx capability with intra-band non-contiguous CA, as listed in Table 2 of LS R1-2401943.

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| Company | Inputs |
| Nokia | Introduction of new UE features to Rel-18 seem to be beyond the scope of the discussion on how to respond to the LS at hand, but could be discussed under the corresponding Rel-18 UE feature agenda item. |
| Samsung | Open to discuss.  |
| NTT DOCOMO | Open to discuss but right now the motivation is not very clear to us. In our understanding x1943 raises an issue for IODT considering that e.g., FR1-FR2 case may not much implemented for both gNB and UE. However, since per-BC signaling can naturally enable vendors to select which BC to report, these legacy FG doesn’t have such an issue in our view. Or do we overlook something?  |
| ZTE | We share similar view with Nokia. What we need reply to RAN2 is RAN1’s intention. We would also like to hear the response from the proponent to NTT DOCOMO’s question.  |
| QC | To DCM and ZTE: imagine a UE vendor implemented simultaneous Tx in FR1-FR2 DC, e.g., implemented simultaneous Tx in FR1 CA for MCG, and implemented simultaneous Tx in FR2 CA for SCG. However, if no gNB vendors have implemented simultaneous Tx in both FR1 and FR2 (e.g., NW maybe only implemented it for FR1). Then, how could the UE vendor find a gNB vendor to do IODT test for this feature of simultaneous Tx functionality in case of FR1-FR2 DC, if the UE capability cannot differentiate FR1 VS FR2? |
| Huawei, HiSilicon | Open to discuss. |

**Q4: Any other additional views, if any?**

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| Company | Inputs |
| Nokia | Huawei argument for understanding 2 maybe pragmatic, but it would be an odd response to the question of RAN2, somewhat implying that they are not understanding their own question. From RAN1 perspective there is no restriction, and that response can be provided. |
| Huawei, HiSilicon | We can understand companies’ view which supports understanding 1 is considering from standard or spec perspective. In RAN1 spec, it does have no such a restriction to apply inter-band capabilities to NR-DC. However, we think it is also important to reflect current situation whether a UE can support such an inter-band CA+NR-DC mixture case or not.Thus, we suggest to reflect companies views in both aspects in reply LS to RAN2. |

## Second Round

All companies agree that the same understanding applies to all the parallel Tx capabilities asked in the LS.

@Huawei, HiSilicon, It is well known that RAN4 process is behind RAN1/RAN2. But it is not relevant to the discussion here and RAN2 should also well know this as commented by Nokia. Given you also agree that there is no restriction to also apply to NR-DC case, let’s reply only from RAN1 perspective.

Regarding FR1/FR2 differentiation, it seems majority companies are open to discuss, while think this should be a separate discussion. Therefore, moderator would suggest having a separate conclusion, which would NOT be included in the reply LS to RAN2.

**Proposed conclusion:**

* **To avoid UE under report this capability due to IODT testing issue, RAN1 may further discuss whether to introduce FR1/FR2 differentiation to indicate the parallel Tx UE features apply to {FR1 only, or FR2 only, or both FR1 and FR2}**

The main content of the draft reply LS is proposed as follows. You can also find the whole draft reply LS in [Draft Reply LS](http://10.10.10.10/ftp/RAN/RAN1/Inbox/drafts/5%28Inc_LS%29/Parallel%20Tx%20Capability/Draft%20Reply%20LS)

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| **RAN1’s answer to Q1**: RAN1’s intention is Understanding #1. From RAN1 perspective, this capability can also be applied to the NR-DC band combination with the inter-band CA operation on the MCG/SCG. **RAN1’s answer to Q2**: RAN1’s intention is Understanding #1. From RAN1 perspective, the UE features listed in the Table 1 can also be applied to the NR-DC band combination with the inter-band CA operation on the MCG/SCG.**RAN1’s answer to Q3**: RAN1’s intention is Understanding #1. From RAN1 perspective, the UE features listed in the Table 2 can also be applied to the NR-DC band combination with the intra-band non-contiguous CA operation on the MCG/SCG. |

**If any concerns on the proposed conclusion or draft reply LS, please provide your comments below.**

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| Company | Inputs |
| Nokia | We support the draft LS version 0, and we are also OK with the proposed conclusion. |
| NTT DOCOMO | We also support the draft LS version 0. Yes, we are fine to continue the discussion since we also believe the possibility of under reporting due to the lack of testing chance should be minimized as much as possible. @QC: Thanks for the follow-up. But such a IODT issue basically occurs in case where a capability targets wider scenario, and gNB is likely to support only a part of the scenarios, which results in that any UE (supporting though) cannot pass the IODT for all the targeted case (so cannot declare the support of the capability). Our point is that having per-BC granularity (which is there in the legacy capabilities) can avoid such a situation already. Per-BC, by its definition, can allow UEs to separately declare the support of 1) simultaneous Tx in FR1 CA for MSG AND simultaneous Tx in FR2 CA for SCG, and e.g., 2) simultaneous Tx in FR1 CA only, while supporting FR1-FR2 DC. In this case, the lack of gNB’s complete support for (1) doesn’t have a relation with the support of (2) for a UE directly. We think this is actually equivalent to what Qualcomm wants to avoid by having FR differentiation.  |
| Apple | OK with draft LS. For FR1/FR2 differentiation, we tend to agree with DCM and not to go that way. |

# Conclusion

TBD

# Reference

1. R1-2401943 LS on Parallel Tx Capability RAN2, ZTE
2. R1-2402159 Draft reply LS on parallel Tx Capability ZTE
3. R1-2402411 Draft reply LS on Parallel Tx Capability Samsung
4. R1-2403163 Discussion on LS on Parallel Tx Capability Qualcomm Incorporated
5. R1-2403216 Draft reply LS on Parallel Tx Capability NTT DOCOMO, INC.
6. R1-2403311 DRAFT Reply LS on Parallel Tx Capability Nokia
7. R1-2403361 Discussion on LS on Parallel Tx Capability Huawei, HiSilicon