**3GPP TSG-RAN WG2 Meeting #121bis-e R2-230xxxx**

**e-meeting, April 17- 26, 2023**

**Source: Qualcomm Incorporated**

**Title: [Draft] Summary of [AT121bis-e][011][NR17] UE Caps BW related Corrections (Qualcomm)**

**Document for: Decision**

**Agenda Item: 6.1.3.2**

# Introduction

This document provides a summary for the following email discussion.

* [AT121bis-e][011][NR17] UE Caps BW related Corrections (Qualcomm)

Scope: Treat R2-2302436, R2-2302439, R2-2302440, R2-2302577, R2-2302729, R2-2303398, R2-2304169, R2-2303883  
Ph1: Determine agreeable parts and prepare on-line CB points if any.

Ph2: For agreeable parts, if any, reflect these in agreeable CRs.

Intended outcome: Report, If applicable: In-Principle-Agreed CRs

Deadline: Schedule 1

This email discussion essentially covers the following three topics that are all related to incoming LS from RAN4.

**Topic 1. Fallback group relation**

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| [1] | [R2-2302436](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302436.zip) | Reply LS on new contiguous BW classes for legacy networks (R4-2303631; contact: Nokia) | RAN4 |

**Topic 2. FR2 FBG5 CA BW classes**

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| [2] | [R2-2302440](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302440.zip) | LS on signaling for FR2 FBG5 CA BW classes (R4-2303689; contact: Apple) | RAN4 |
| [3] | [R2-2302577](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302577.zip) | Discussion on maximum aggregated bandwidth | OPPO |
| [4] | [R2-2303398](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303398.zip) | On servicing RAN4 request on aggregate BW signaling for FBG5 CA BW classes | Apple Inc, Ericsson Inc |
| [5] | [R2-2303883](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2303883.zip) | Consideration on the FBG5 Signaling | ZTE Corporation, Sanechips |
| [6] | [R2-2304169](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304169.zip) | Discussion on UE signaling for the maximum aggregated bandwidth | Huawei, HiSilicon |

**Topic 3. Maximum aggregated bandwidth for FR1 CA**

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| [7] | [R2-2302439](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302439.zip) | LS on UE signalling for the maximum aggregated bandwidth for FR1 CA (R4-2303685; contact: Qualcomm) | RAN4 |
| [8] | [R2-2302729](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302729.zip) | Maximum aggregated bandwidth for FR1 CA | Qualcomm Incorporated |
| [6] | [R2-2304169](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2304169.zip) | Discussion on UE signaling for the maximum aggregated bandwidth | Huawei, HiSilicon |

Companies are invited to provide their contact information for this email discussion.

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| --- | --- | --- |
| **Company** | **Delegate name** | **Email address** |
| Qualcomm Incorporated | Masato KITAZOE | mkitazoe@qti.qualcomm.com |
| OPPO | Qianxi Lu | qianxi.lu@oppo.com |
| Huawei, HiSilicon | Tong Sha | shatong3@hisilicon.com |
| Apple | Naveen Palle | naveen.palle@apple.com |
| ZTE | Wenting Li | Li.wenting@zte.com.cn |
| CATT | Jie Shi | shijie |
| Nokia, Nokia Shanghai Bell | Shehzad Ali Ashraf | shehzad.ashraf@nokia.com |
| Samsung | Seungri Jin | seungri.jin@samsung.com |
| Intel Corporation | Seau Sian Lim | seau.s.lim@intel.com |
| T-Mobile USA | John Humbert | John.humbert2@t-mobile.com |
| Ericsson | Håkan Palm | hakan.l.palm@ericsson.com |
| MediaTek | Mutai Lin | morton.lin@mediatek.com |

# Discussion

* 1. Fallback group relation

In [1] [R2-2302436](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302436.zip), RAN4 confirmed the problem RAN2 identified in [R2-2213312](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_120/Docs/R2-2213312.zip) regarding RAN4’s “Fallback Group” requirement in relation to fallback band combination requirement. RAN4 has taken necessary actions and asked “RAN2 to inform RAN4 if further any unsolved issues remain”.

It is moderator’s understanding, from the fact that no RAN2 document is submitted, that no remaining issue was identified. It is proposed to close the discussion without sending a reply LS to RAN4.

**Q1:** Do companies agree there is no remaining issue with RAN4’s Fallback Group requirement from RAN2’s perspective, hence no need to reply to RAN4?

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Qualcomm Incorporated | Yes |  |
| Huawei, HiSilicon | Yes |  |
| Apple | Yes | They have resolved this |
| ZTE | Yes |  |
| CATT | Yes |  |
| Nokia, Nokia Shanghai Bell | Likely yes | RAN2 can reply if there are unsolved issues after the discussion, but so far nothing has been identified. |
| Samsung | Yes |  |
| Intel | Yes |  |
| Ericsson | Yes |  |
| MediaTek | Yes | We think the result sets a precedent for future cases of how to handle the BCS inconsistencies across parent and fallback combinations in RAN4 configuration tables. |

* 1. FR2 FBG5 CA BW classes

In [2] [R2-2302440](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302440.zip), RAN4 revisited the UE capability signalling overhead issue for FR2 FBG5 CA BW classes. RAN4 identified a potential solution to repurpose the existing UE capability parameter defined for intra-band non-contiguous CA frequency separation classes to also be applicable to indicate UE’s maximum aggregated BW capability for intra-band contiguous CA.

Companies’ views according to the submitted documents are still split [3][4][5][6]. Some focus on the principle whether a solution is needed or not. Some analyse the new solution RAN4 identified.

**Q2:** Do companies observe the UE capability signalling overhead issue as identified by RAN4, and agree a solution is needed?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Qualcomm Incorporated | Yes |  |
| Huawei, HiSilicon | No | As stated in our paper[6], we think this solution requires same FS/FSPC for different BW combinations, which is not a typical case. Besides, it limits the flexibility of the UE on the supported BW combinations. |
| Apple | Yes | They have an LS indicating this, so RAN2 should honor this. |
| ZTE | No | We share the similar view as Huawei. |
| CATT | No | The same view as Huawei. |
| Nokia, Nokia Shanghai Bell | Not sure | Huawei has a point that this may not be the typical case. In general *featureSets* were intended for these kinds of cases, so we are not sure why RAN4 thinks this is overly complicated. |
| Samsung | No | We share the similar view as Huawei. |
| Intel | Neutral | It is unclear from the LS that RAN4 have discussed that such BC with intra-band contiguous are not atypical case. Anyway, it will be difficult for 3GPP to assess whether such BC is a typical case or not. We see this as a design trade off for the UE, where on one hand is the flexibility of the FSPCC and on the other hand against the signalling overhead which the new feature can reduce but probably at the expense of some flexibility. Hence some UEs will find this useful but others may not. |
| T-Mobile USA | No | UE capability size is purely within RAN2 scope, and the solution proposed in LS is functionally non-backwards compatible. |
| Ericsson | Yes | We observe that UEs today typically indicate/reuse the identical FS/FSpCC for all BCs with FR2 bands.  With the proposed signalling, the gain is not only on the actual signalling size, but also on the processing capability in gNB, with less combinations to examine. |
| MediaTek | No | RAN2 had discussed in Toulouse meeting last year and we thought that existing feature set signalling can be a solution baseline under different approaches of UE implementation. Furthermore, we don’t see anything new for reopening the discussion. |

**Q3:** Do companies agree to the solution to repurpose the existing UE capability parameter defined for intra-band non-contiguous CA frequency separation classes?

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Qualcomm Incorporated | No | We largely agree to the observations made by ZTE in [5]. The most critical part is that RAN4’s solution does not work in case of mix of contiguous and non-contiguous, e.g. n260R4+n260R3.  RAN2 can further discuss solution. |
| OPPO | No | Same view as stated in our paper 2577 |
| Huawei, HiSilicon | No | We share the same concern on the backward compatibility and forward compatibility. |
| Apple | Atleast RAN4 needs to be informed about this, to see if they have considered this type of BCs. | We are ok to have RAN2 device a solution that does not follow what RAN4 is suggesting, but need to have to informed to RAN4. |
| ZTE | No | As observed in our paper [5]  Observation 1：There is no essential difference between the solution with newly added maximum bandwidth and the solution with reusing the “intraBandFreqSeparationDL”.  Observation 2: “Re-purposing the existing IE “intraBandFreqSeparationDL” to indicate UE’s maximum aggregated BW capability for contiguous CA” are not applicable to the BC with both intra-band contiguous and non-contiguous CA. |
| CATT | No | Some NBC issue will be introduced to repurpose the existing IE. |
| Nokia, Nokia Shanghai Bell | No | We agree with the observations made by ZTE and Oppo. Repurposing an existing IE would lead to further confusions and inter-operability issues. |
| Samsung | No | We share the same concern on the backward compatibility and forward compatibility. |
| Intel | No | Agree with the ZTE’s observation that repurposing does not work for mix contiguous and non-contiguous BC. Our understanding is that RAN4 proposed this as RAN2 didn’t like the new UE cap in the previous LS. |
| T-Mobile USA | No | RAN2 already concluded that there’s no consensus to add a new parameter so it is a bit worrisome that RAN4 proposes to functionally non-backwards compatible change to an existing IE. |
| Ericsson | No | We agree with others. |
| MediaTek | No | We have similar understanding as abovementioned. Okay with Reply LS to RAN4. |

* 1. Maximum aggregated bandwidth for FR1 CA

In [7] [R2-2302439](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302439.zip), RAN4 identified a potential UE capability signalling overhead issue with FR1 inter-band CA where BCS4 or BCS5 is supported. In their analysis, the issue arises when the UE would signal a large number of combinations of feature sets. RAN4 identified a potential solution to introduce a new UE capability parameter indicating the supported maximum aggregated BW per band combination.

Companies’ view according to the submitted documents are split [6][8]. Necessary considerations are largely similar to the FBG5 BW class issue discussed in the previous section. [6] additionally raises a concern on the backward compatibility.

**Q4:** Do companies observe the UE capability signalling overhead issue as identified by RAN4, and agree a solution is needed?

|  |  |  |
| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Qualcomm Incorporated | Yes (Proponent) | It is understandable that different companies have different implementations in terms of how they signal feature sets. We hope those companies not seeing the same benefit will not simply ignore the implementations of companies seeing a signalling overhead reduction benefit. |
| Huawei, HiSilicon | See comments | We think in real deployment it may be not necessary for the UE to signal so many BW combinations for a BC. And the signalling overhead will decrease if the UE is able to support a bit higher maximum aggregated BW, as more cases can be supported as fallback. |
| ZTE | No strong view | We don’t have strong view on his issue, we are open to see other companies’ view. |
| CATT | No strong view | A bit of sympathy to Huawei’s comment. |
| Nokia, Nokia Shanghai Bell | No (see comments) | We agree with Huawei but would like to understand the chipset views as this largely depends on what UEs will implement in reality. We would like to avoid a situation where 3GPP ignores an issue that will anyway happen in IODT.  The most important thing to avoid here would be NBC changes as those could impact legacy networks. |
| Samsung | No strong view | We don’t have strong view on his issue, we are open to see other companies’ view. |
| Intel | No strong view | We again see this as a design tradeoff. Hence, we do not have a strong view. |
| T-Mobile USA | No | This isn’t a problem for real deployments, we looked into this problem and determined that chipsets are supporting limited BC’s and don’t see this as a problem that needs to be addressed.  Any issues related to UE capability size needs to be RAN2 led not RAN4 led. |
| Ericsson | Yes | In [R2-2212147](http://www.3gpp.org/ftp//tsg_ran/WG2_RL2/TSGR2_120/Docs//R2-2212147.zip), we presented data from real UE showing the signalling overhead as identified by RAN4.  Similar as for FR2, with the proposed signalling, the gain is not only on the actual signalling size, but also on the processing capability in gNB, with less combinations to examine. |
| MediaTek | No | Our views: No matter the maximum aggregated bandwidth for a certain band combination is explicitly specified (by RAN4) or not, they are all subject to ecosystem requirements or regulations, such as operator spectrum holding, maximum supported CBW of bandwidth class, or even ITU frequency allocation. Thus they should be taken into consideration while designing the UE and consolidating the radio access capabilities.  For the example in the LS, why bother configuring 3 bands CA while the target aggregated bandwidth could be achieved by 2 bands CA? |

**Q5:** Do companies agree to the new UE capability signalling solution, i.e. introducing a new UE capability parameter indicating the supported maximum aggregated BW per band combination?

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| --- | --- | --- |
| **Company** | **Yes/No** | **Comment** |
| Qualcomm Incorporated | Yes | We understand the new signalling has isolated impact to BCS4 and/or BCS5 (depending the applicability).  We do not understand the backward compatibility issue raised by Huawei in [6]. RAN4 solution is not about reducing the UE capability itself, but is intended to reduce the UE capability signalling overhead. Not sure why Huawei concluded RAN4 solution results in UEs not supporting mandatory BCS. |
| Huawei, HiSilicon | No | In our paper[6], we would like to highlight that the UE supporting BCS4/5 will use the same BC with previous BCS signalled for legacy NW. In this case, the new signalling solution will bring a NBC issue.  We can take an example for further clarification. With the new signalling solution, for a band combination bandA+bandB with BCS4/5, a maximum aggregated bandwidth of 140MHz is signalled, and the maximum CC bandwidth for bandA and bandB are respectively signalled as 80MHz and 100MHz through supportedBandwidth. For an upgraded NW, there would be no problem since the aggregated bandwidth will be configured no more than 140MHz. However, for a legacy NW, the new signalling cannot be identified, the configured bandwidth for the CCs in band A and band B may be 80MHz and 100MHz, exceeding the maximum aggregated bandwidth supported by the UE. |
| Apple | We do not object to this | We can try to have a common framework for FR1 and FR2 if possible. |
| ZTE | No strong view | We don’t have strong view on his issue, we are open to see other companies’ view. We also want to confirm whether it’s for the BCS5 only or for both the BCS4 and BCS5. |
| CATT | No | We are worried that NBC issue will be introduced by this method. |
| Nokia, Nokia Shanghai Bell | No (see comments) | We see the point in the Huawei example and that’s the reason why we would like to avoid NBC changes. We are open to discuss the matter more if the NBC issues can be resolved. |
| Samsung | No strong view | We don’t have strong view on his issue, we are open to see other companies’ view. |
| Intel | No strong view | Assuming that it is confirmed that there is no NBC issue with using BCS5 for the BC with the new UE cap, we agree there may not be NBC issue as our understanding is that legacy gNB that does not support BCS5 will ignore the corresponding band combination. We are just wondering whether the UE is effectively under reporting to the legacy gNB in this case. Again this maybe a design tradeoff, while expecting that NW will be upgraded eventually to support the new signalling. |
| T-Mobile USA | No | See above. |
| Ericsson | Yes | The backwards compatibility issue exemplified by Huawei can be avoided by introducing capability filter to indicate that the Nw is upgraded. |
| MediaTek | No | See our answer in Q4 and we also think the NBC concern mentioned by Huawei is valid when the legacy gNB receives a certain CA BC with the new signalling, and both BCS0 and BCS4/5 bits indicated. |

# Conclusion

**Topic 1. Fallback group relation**

Based on the discussion, it is proposed to simply note the following LS from RNA4.

**Proposal 1:** RAN2 to note the following LS without any RAN2 action.

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| [R2-2302436](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_121bis-e/Docs/R2-2302436.zip) | Reply LS on new contiguous BW classes for legacy networks (R4-2303631; contact: Nokia) | RAN4 |

**Topic 2. FR2 FBG5 CA BW classes**

**Topic 3. Maximum aggregated bandwidth for FR1 CA**

Companies’ views remain split for those items. Moderator observes that the underlying sticking points are very similar between those items, hence discussed together here.

It seems a common understanding that it depends on UE implementation whether the solutions suggested by RAN4 will bring a compelling UE capability signalling reduction gain. Some companies see they can benefit from such solutions. Some companies consider “typical” UE implementation will not benefit from the solutions. One infra-vendor indicated they observed real UE whose reported UE capability shows the signalling overhead as identified by RAN4.

Moderator believes it is difficult to discuss this very point in 3GPP, because normally UE vendors are not willing to share their UE implementation detail or chipset vendor cannot share the UE implementation detail of OEM UE vendors. It is therefore proposed to allow companies to have more offline discussions until the next RAN2 meeting.

**Proposal 2:** Allow companies to discuss offline until RAN2#122:

* UE capability signalling overhead for existing UE implementations.
* Additional UE capability signalling overhead caused by FGB5 and BCS4/5.
* Potential signalling overhead reduction gain in light of above.
* Any other relevant aspect.

Another sticking point is the backward compatibility of RAN4’s solutions. Moderator considers it may be worthwhile to check if there is any actual backward compatibility issue. FBG5 and BCS4/5 are rather new concepts and RAN4 may have assumed there are still some room to modify these functionalities without causing practical backward compatibility problems. As also commented, there are ways to circumvent backward compatibility problems if it is considered there are networks already implementing FBG5 and/or BCS4/5. It should be noted that legacy UEs already implementing FBG5 and/or BCS4/5, if any, just follow the legacy behaviour. So the existence of such legacy UEs won’t cause any backward compatibility issues.

**Proposal 3:** RAN2 to discuss whether there is any legacy network implementation for FBG5 or BCS4/5 that must be taken into account in further discussion.