3GPP TSG-RAN WG2 Meeting #117 Electronic R2-220xxxx

Online, 21 February – 03 March 2022

**Agenda item: 8.24.1**

**Source: Nokia (Rapporteur)**

**Title: Offline [AT117-e][059][NR17] FR2 CA BW Classes and CBM (Nokia)**

**WID/SID: NR\_RF\_FR2\_req\_enh2-Core**

**Document for: Discussion and Decision**

# 1 Introduction

This document is the report of the following email discussion:

* [AT117-e][059][NR17] FR2 CA BW Classes and CBM (Nokia)

 Scope: Treat R2-2202377, R2-2202904, R2-2203122, R2-2203024, R2-2202905, R2-2202389, R2-2202390, R2-2202910, R2-2202911, R2-2202912, R2-2202913, R2-2203493, R2-2203494, R2-2202365, R2-2202366. Ph1 Determine agreeable parts and converge on discussion points if any, Ph2 agree CRs and Reply LS out.

 Intended outcome: Report, Agreed CRs (CRs with certain early impl. character need to be separate CRs), Approved LS out

 Deadline: Schedule 1

RF FR2 - CA BW Classes and CBM

Offline

* [AT117-e][059][NR17] FR2 CA BW Classes and CBM (Nokia)

 Scope: Treat R2-2202377, R2-2202904, R2-2203122, R2-2203024, R2-2202905, R2-2202389, R2-2202390, R2-2202910, R2-2202911, R2-2202912, R2-2202913, R2-2203493, R2-2203494, R2-2202365, R2-2202366. Ph1 Determine agreeable parts and converge on discussion points if any, Ph2 agree CRs and Reply LS out.

 Intended outcome: Report, Agreed CRs (CRs with certain early impl. character need to be separate CRs), Approved LS out

 Deadline: Schedule 1

**Topic 1: FR2 CA BW Classes**

[1] R2-2202377 Reply LS on release independence aspects of newly introduced FR2 CA BW Classes and CBM/IBM UE capability Nokia, Nokia Shanghai Bell LS out Rel-17 NR\_RF\_FR2\_req\_enh2-Core R2-2200843 To:RAN4

[2] R2-2202904 Consideration on the FR2 CA bandwidth classes ZTE Corporation, Sanechips discussion Rel-17 NR\_RF\_FR2\_req\_enh2-Core

[3] R2-2203122 Introduction of new FR2 CA bandwidth classes Xiaomi Communications discussion Rel-17 NR\_RF\_FR2\_req\_enh2-Core R2-2201385

[4] R2-2203024 Discussion on FR2 new bandwidth class Huawei, HiSilicon discussion Rel-17 NR\_RF\_FR2\_req\_enh2-Core

[6] R2-2202389 Introduction of FR2 FBG2 CA BW classes Nokia, Nokia Shanghai Bell CR Rel-17 38.331 16.7.0 2867 1 B NR\_RF\_FR2\_req\_enh2-Core R2-2200839

[7] R2-2202390 Introduction of FR2 FBG2 CA BW classes Nokia, Nokia Shanghai Bell CR Rel-17 38.306 16.7.0 0678 - B NR\_RF\_FR2\_req\_enh2-Core

[8] R2-2202910 CR on the FR2 CA bandwidth classes-38331 ZTE Corporation, Sanechips CR Rel-17 38.331 16.7.0 2915 - B NR\_RF\_FR2\_req\_enh2-Core

[9] R2-2202911 CR on the FR2 CA bandwidth classes-38306 ZTE Corporation, Sanechips CR Rel-17 38.306 16.7.0 0689 - B NR\_RF\_FR2\_req\_enh2-Core

[12] R2-2203493 Introduction of new FR2 CA bandwidth classes Huawei, HiSilicon draftCR Rel-17 38.331 16.7.0 B NR\_RF\_FR2\_req\_enh2-Core

[13] R2-2203494 Introduction of new FR2 CA bandwidth classes Huawei, HiSilicon draftCR Rel-17 38.306 16.7.0 B NR\_RF\_FR2\_req\_enh2-Core

**Topic 2: CBM/IBM reporting**

[5] R2-2202905 Consideration on the CBM/IBM reporting ZTE Corporation, Sanechips discussion Rel-17 NR\_RF\_FR2\_req\_enh2-Core

[10] R2-2202912 CR on the CBM/IBM reporting-38331 ZTE Corporation, Sanechips CR Rel-17 38.331 16.7.0 2916 - B NR\_RF\_FR2\_req\_enh2-Core

[11] R2-2202913 CR on the CBM/IBM reporting-38306 ZTE Corporation, Sanechips CR Rel-17 38.306 16.7.0 0690 - B NR\_RF\_FR2\_req\_enh2-Core

[14] R2-2202365 Introduction of CBM capability Nokia, Nokia Shanghai Bell CR Rel-17 38.331 16.7.0 2868 1 B NR\_RF\_FR2\_req\_enh2-Core R2-2200840

[15] R2-2202366 Introduction of CBM capability Nokia, Nokia Shanghai Bell CR Rel-17 38.306 16.7.0 0668 1 B NR\_RF\_FR2\_req\_enh2-Core R2-2200841

# 2 Contact Points

Respondents to the email discussion are kindly asked to fill in the following table.

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Nokia (Rapporteur) | Amaanat Ali | amaanat.ali@nokia.com |
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# 3 Discussion

The rapporteur proposes to continue the discussion from the previous meeting. To summarize the way forward from last meeting.

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| [R2-2201928](file:///D%3A%5CDocuments%5C3GPP%5Ctsg_ran%5CWG2%5CTSGR2_116bis-e%5CDocs%5CR2-2201928.zip) Offline 037 on FR2 CA BW class Nokia* [037] Noted, reflected below
* [037] Continue discussion for solution options for introducing the extended bandwidth class for FR2 CA bandwidth class in FBG2 (early implementation target as Rel-15)
* [037] FFS if RAN2 aims to harmonize solution to also include  “dual bandwidth class across FBG” which is under discussion in RAN4
* [037] Introduce CBM-only capability from Rel-17 (allowing early implementation from Rel-16) and dummify CBM enumeration from Rel-16 capability
* [037] FFS if IBM/CBM capability apply to DL and/or UL
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**Topic 1: FR2 CA BW Classes**

First some views from different companies:

Listing the proposals from [2]

**Proposal 1: Take solution direction 2 that a UE reports one of the new bandwidth classes and also reports the older one for a BC as baseline.**

**Proposal 2: The similar method to R/S/T/U reporting can be adopted for the “dual bandwidth class across FBG”.**

**Proposal 3: Do not extend the Aggregatedbandwidth (maxBandwidthRequestedDL/UL), the network can set the maxBandwidthRequestedDL/UL as absent and meanwhile limit the maxCarriersRequestedDL/ maxCarriersRequestedUL to achieve the similar result.**

Listing the proposals from [3]

**Proposal 1: When the UE indicates a new bandwidth class (i.e. R, S, T, U), the UE shall also indicate bandwidth class F.**

**Proposal 2: The indication of the new bandwidth classes (i.e. R, S, T, U) is via new capability signalling of *ca-BandwidthClassDL-NR-v17xy/ ca-BandwidthClassUL-NR-v17xy*.**

**Proposal 3: The indication of the new bandwidth classes (i.e. R, S, T, U) is allowed for early implementation from Rel-15.**

Listing the proposals from [4]

**Proposal 1: To ensure backward compatibility, it is suggested to consider select one of the solution below:**

**Solution 1: Introduce separate capability signalling to indicate support of new bandwidth classes (e.g. R, S, T, U).**

**Solution 2: Introduce a capability filter from the network side indicating new introduced bandwidth classes.**

**Proposal 2: Considering the future compatibility and signalling overhead, it is recommended to adopt solution 1.**

From a check of also the CRs on the FR2 CA BW topic, there is clear consensus that the introduction of these new BW classes should take into account that the new UEs supporting these changes must also be able to signal the legacy BW class for those networks that may not be upgraded. This implies the following:

* UE reports one of the new bandwidth classes and also reports the older one for a BC as baseline i.e. UE indicates a new bandwidth class (i.e. R, S, T, U), the UE shall also indicate bandwidth class F.
* Introduce separate capability signalling to indicate support of new bandwidth classes (e.g. R, S, T, U) via Rel-17 specific extension using capability signalling of *ca-BandwidthClassDL-NR-v17xy/ ca-BandwidthClassUL-NR-v17xy*

**Question 1: Do companies agree to the following principle: “*A UE that indicates a new bandwidth class (i.e. R, S, T, U), the UE shall also indicate bandwidth class F”* or more generically *“UE reports one of the new bandwidth classes and also reports the older one for a BC as baseline”***

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| Answers to Question 1 |
| Company | Yes/No | Technical Arguments |
| Nokia | Yes | Yes, to avoid the regression issue that the legacy network will not be able to understand the new bandwidth classes and may not be able to configure the UE and that results in reconfiguration failure it is good to have the principle agreed. |
| Huawei, HiSilicon | Yes | We understand the non-backward compatibility should be considered when introduction of new FR2 CA bandwidth classes. The solution above can avoid repeated BC reporting. |
| Qualcomm Incorporated | Yes | It should be clarified that the UE shall include at least as many FeatureSetDownlinkPerCC in a feature set according to the new ca-BandwidthClassDL-r17. See ZTE document in R2-2202904. |
| ZTE | Yes (and prefer the more general way) | Similar view as Nokia, and considering that more new bandwidth classes would be added in the future, to keep forward compatibility, we prefer the more general description that “UE reports one of the new bandwidth classes and also reports the older one for a BC as baseline” |
| Samsung | Yes | This approach seems the best solution with small specification impact. |
| OPPO | No with comment | Although we fine with the intention to use separate field for old/new gNB who does not know / does know the new BWC.Yet the sentence is is a bit confusing “***A UE that indicates a new bandwidth class (i.e. R, S, T, U), the UE shall also indicate bandwidth class F***”, how to interpret this1. If UE support a BC of band x and band y, e.g., xU-yU, the UE must support the BC of xF-yF
2. If UE support a BC of band x and band y, e.g., xU-yU, and if BC of xF-yF is a fallback BC of xU-yU, UE report the old BWC of F

There is a difference between 1 and 2 since currently UE does not necessarily support 1 (R2 previously discussed this, i.e., we understand a BC with lower BWC does not necessarily to be a fallback of a BC with higher BWC). So the Q1 is only fine if the interpretation-2 is the thinking behind.[OPPO] to further clarify, i.e., our doubt on interpretation-1 comes from the same root-reason as commented by Ericsson below, i.e., a BC with lower BWC does not necessarily support less BW combination than the BC with higher BWC.So if one goes for interpretation-1, the question is why not simply use two BC entries to do that as in legacy (especially considering the case when the BC with lower BWC may have more BW combination than the BC with higher BWC, so it is not a fallback case of the latter.Besides, we understand the two-BWC report has nothing to do with the “**dual bandwidth class**” issue being discussed in R4, which focuses on cross-FBG case, yet here we are talking about two BWC in the same FBG. |
| Intel | Yes | We also prefer the more generic one “UE reports one of the new bandwidth classes and also reports the older one for a BC as baseline” |
| Ericsson | No | First of all, we believe that RAN2 should **postpone** the introduction of the new BWC values/fields until RAN4 has settled their still ongoing discussion (beyond R, S, T, U). Otherwise, we might need yet another extension one quarter later. As said earlier, it is **not necessary to introduce a second BWC field** since RAN4’s early Rel-15 decision to define BCs and BCSs in table format anyway requires frequent updates of the corresponding gNB code. Furthermore, if the gNB cannot comprehended a new BWC value this will not lead to a reconfiguration failure of the UE. The only consequence is that the gNB cannot configure CA based on the given BC. The same is true since Rel-15 for any new BC/BCS that RAN4 introduces in their tables and for which the gNB hasn’t been upgraded yet. And like for such unknown BC/BCS entries, the gNB may still use a BC with non-comprehended BWC values to configure the UE according to the BC’s single-carrier fallback combinations. Secondly, the addition of a second BWC field can have far reaching consequences for UE and for NW: As RAN2 observed earlier, RAN4 did not specify the BCSs of parent BCs and their fallback BCs consistently. Sometimes the parent BC supports more carrier bandwidths than its fallback BCs... and sometimes it is the other way around. If this happens in RAN4 for a parent BC that uses a new BWC value (sent in a new BWC field) and a fallback BC that uses the legacy BWC value (sent in the legacy BWC field), the UE must ensure that it supports the union of the carrier bandwidths enabled by the parent BC and the fallback BCs (of course only when configured with a number of carriers that is supported by the fallback BC). The reason is that an upgraded network may pick carrier bandwidths which are allowed according to the parent BC whereas (at least) a legacy network may choose carrier bandwidths allowed according to the fallback BC.While this is somewhat difficult to keep track of in a UE, it can become very challenging for a network: If an upgraded gNB obtains a BC that contains both BWC fields in a BandParameter, it would in principle have to validate the intended UE configuration against both BCS-rows in the RAN4 tables. And while this might be OK’ish in a BC with a single such BandParameter, the search space grows considerably when there are multiple such BandParameters. For example, if a UE offers something like CA\_n258F/R-n261F/U (where F:s are in the legacy field and R and U are in the new BWC fields), the UE actually promises to support...CA\_n258F-n261FCA\_n258F-n261UCA\_n258R-n261FCA\_n258R-n261U... which could all be defined with non-consistent carrier bandwidths in the RAN4 specs. Hence, a network that comprehends all BCs/BCSs could be expected to check configuration against all those BCs.And if RAN2 intends to make it a general principle that new BWC values are always added as an additional field in the BandParameters, one may soon end up with BCs like CA\_n1D/Q-n258F/R-n261F/U/X ... which unfolds into 12 BCs... which may or may not be defined consistently. But to cater for potentially occurring inconsistencies in the RAN4 tables, a network may be expected to do a substantial amount of additional processing. Hence, we still **prefer to add the new BWC values to the extensible “ca-BandwidthClassDL-NR”**If RAN2 anyway prefers adding a second BWC field in the BandParameter IE, we could accept this in principle. But we cannot accept the additional parsing and processing effort that this could require to cater for potential bugs in the RAN4 tables. Therefore, we **require at least a statement in the field description of the BWC fields: “*If ca-BandwidthClassDL-NR-r17 is present, a network comprehending this field disregards the ca-BandwidthClassDL-NR (without suffix)*”**.  |
| Huawei, HiSilicon |  | According to the comments from Qualcomm, OPPO and Ericsson, we share our further analysis at this version.We agree with Qualcomm that for a band with the legacy and the new BWCs reported at the same time, the UE shall include the FeatureSetDownlinkPerCCs according to the new BWC. As analysed in our paper R2-2203024, in this case, a legacy gNB can use any supported number of CCs indicated for the band according to its own capability, this is already allowed in the current specification. For example, for a BWC-R band with 5 CCs which indicated as BWC-F in the legacy field at the same time, a legacy gNB supporting only 4 CCs can use any 4 out of the 5CCs reported by UE.For the two interpretations raised by OPPO, we understand the interpretation1 is correct (i.e. If UE supports a BC of band x and band y, e.g., xU-yU, the UE must support the BC of xF-yF). When we talk about the BWCs in the same fallback group, we consider the BC with lower order BWC shall be a fallback of the BC with higher order BWC, and that is reflected in the 38.101 as below. We think the principle is a common understanding both in RAN2 and in RAN4.NOTE 2: It is mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration within a fallback group. It is not mandatory for a UE to be able to fallback to lower order NR CA bandwidth class configuration that belong to a different fallback group.We want to clarify again that the original intention to introduce new FR2 BWCs in separate signalling is to avoid inter-operability issue with legacy network. Considering the two BWCs are reported for the same band, the legacy field is only used by a legacy network. An updated network shall understand the new BWC for the band, and disregard the legacy one. In our view, the proposal by Ericsson is just aligned with the original intention of this solution. We are fine to add such clarification if that is majority view.[OPPO] I think the above is the gap. Just to clarify my understanding For BC-1 of CA\_nxR-nyU and BC-2 of CA\_nxF-nyF, OPPO understanding: the BW combination of BC-2 is not always a fallback case of BW combination of BC-1Huawei understanding: the BW combination of BC-2 is always a fallback case of BW combination of BC-1We expect R2 to give an clear statement here before concluding on this issue, because1. We are not sure if it is the common understanding as said by Huawei by reading Ericsson comment that “As RAN2 observed earlier, RAN4 did not specify the BCSs of parent BCs and their fallback BCs consistently. Sometimes the parent BC supports more carrier bandwidths than its fallback BCs... and sometimes it is the other way around.”
2. Our understanding of the FBG is that its fallback requirement is limited to single-CC case but not for CA case.
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**Summary 1**: TBD.

**Proposal 1**: TBD.

On the need to update the Aggregated bandwidth capability filter, company in [2] proposes not to update the filter as the number of CC’s range is sufficient for the network to elicit the UE to report the new bandwidth classes. Company in [4] lists it as possible solution option but does not recommend to update so essentially aligned to Proposal 3 in [2]. Rapporteur proposes to check within the companies if there is a network vendor that would rely on the aggregated bandwidth capability filter only for asking UE to report one of the new bandwidth classes.

**Question 2: From a network perspective is it sufficient to just use the maxCarriersRequestedDL/ maxCarriersRequestedUL to enable UE to report the new bandwidth class (i.e. no further updates to Aggregatedbandwidth (maxBandwidthRequestedDL/UL))?**

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| Answers to Question 2 |
| Company | Yes/No | Technical Arguments |
| Nokia | Tend to No | * We would also prefer that the network has the option of using the ***Aggregatedbandwidth*** part of the filter as this is one possible network implementation and we would propose not to rule this out.
	+ So we request RAN2 to update the maximum bandwidth in accordance to the RAN4 table so as to support the new bandwidth classes.
* From a specification impact perspective this is not intensive change, so we request RAN2 to do it
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| Huawei, HiSilicon | No | We agree with Nokia that AggregatedBandwidth filter should be extended to support the new bandwidth classes, and how to use the filter is up to network.  |
| Qualcomm Incorporated | No strong view | maxCarriersRequestedDL/UL has the benefit that it is comprehensible by legacy UE. Extension of Aggregatedbandwidth is not visible to legacy UEs. So we assume the network indicates both legacy and new field. It should be clear how the network populates legacy field and new field, and how the UE supporting both should handle the case, e.g. ignore the legacy field if new field is signalled. |
| ZTE | Yes(proponent) | We think the key issue is whether we need to extend the Aggregatedbandwidth in the UE capability filter or just use the maxCarriersRequestedDL/ maxCarriersRequestedUL to achieve the similar result. In the last meeting, we raised the question about whether to extend the Aggregatedbandwidth in the UE capability filter for that the legacy maximum Aggregatedbandwidth is 800M (and absence of Aggregatedbandwidth means 1200M ) , while the Aggregatedbandwidth of R/S/T/U are larger than it (e.g. 1000M/1200M/1400M/1600M). However after further thinking, we also find that there are several issues to be solved if we extend the Aggregatedbandwidth in the UE capability filter:1. Modification to the UE capability reporting procedure to include newly added aggregated bandwidth
2. For the legacy filter, absent means the UE can report 1200Mhz, then we need to clarify how to set the legacy field when the the newly extended AggregatedBandwidth-r17 was set to 1000Mhz.
* Option 1: Set the legacy field to be 800mhz, then the problem is that when handover to the old gNB, the old gNB will take it as 800M (Though the UE has also reported the bandwidth that support 1000M) Maybe this option can work for that 1000M was not supported in the Rel15/16
* Option 2: Set the legacy field to be absent-> then the problem is that When handover to old gNB, the old gNB will take it as 1200Mhz (which is the maximum aggregated bandwidth in Rel-15), however the UE that support RSTU may not report the BC with aggregated bandwidth 1200M for that the AggregatedBandwidth-r17 was set to 1000Mhz
1. The extend aggregated bandwidth shall also be included in the UE capability information as the legacy FreqBandlist (as below) has done

appliedFreqBandListFilter FreqBandList OPTIONAL,Based on the above 3 issues, and also considering that maxCarriersRequestedDL/ maxCarriersRequestedUL can be used to achieve the similar result ( as analyzed in [2] that when the aggregated bandwidth was increased, the number of carriers are also increased), we prefer not to extend the legacy aggregated bandwidth. |
| Samsung | No strong view | Same view with Qualcomm that the handling of Extension of Aggregatedbandwidth from legacy UE should be clear if this approach is used.If this is not clear enough in the specification, the approach of maxCarriersRequestedDL/UL method is better than Extension of Aggregatedbandwidth. |
| Intel | No strong view | Both the approaches can be made to work |
| Ericsson | No strong view |  |
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**Summary 2**: TBD.

**Proposal 2**: TBD.

**Topic 2: CBM/IBM reporting**

There was single FFS from last meeting.

* FFS if IBM/CBM capability apply to DL and/or UL

Based on the contributions in [5] and the rapporteur company’s understanding as well there seems to be no need to distinguish DL from UL and also CRs in [10], [11] and [14], [15] implement the decision from the last meeting.

* Introduce CBM-only capability from Rel-17 (allowing early implementation from Rel-16) and dummify CBM enumeration from Rel-16 capability

**Question 3**: Do companies agree that for IBM/CBM capability there is no need to distinguish DL from UL?

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| Answers to Question 3 |
| Company | Yes/No | Technical Arguments |
| Qualcomm Incorporated | Yes |  |
| ZTE | Yes (no need to distinguish) | After internal discussion, our understanding is that the network determine the DL/UL CBM/IBM supporting based on the beam correspondence as defined below

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| **Beam correspondence:** the ability of the UE to select a suitable beam for UL transmission based on DL measurements with or without relying on UL beam sweeping. |

According to the RAN4’s discussion, in Rel-17 the beam correspondence can be simply summarized as below:

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| DL: CBM --->UL: only support single carrierDL: IBM ----> UL: IBM for the CA or single carrier |

From beam correspondence aspect, the network can determine the UL beam management based on the DL, thus there is no need to distinguish DL from UL. Otherwise, some restriction to the UL and DL capabilities shall be added, e.g. when the UE support DL IBM the UE shall also support UL IBM. |
| Samsung | Yes |  |
| OPPO | Yes with comment | Yet we need to clarify that there is still difference between UL and DL, e.g,, it can be that DL supports CBM, but UL does not support. The only point is that by limited to 2-band case, R4 further ruled out the combination of IBM for DL and CBM for UL (or vice versa), so a single indiation is sufficient, but does not mean that this single indication always applies to both DL and UL. |
| Intel | Yes | It seems RAN4 discussed IBM/CBM capability in the context of DL CA. Similar to Rel-16, we could just avoid mentioning DL and UL.  |
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**Summary 3**: TBD.

**Proposal 3**: TBD.

# 4 Conclusion

TBD.