3GPP TSG-RAN WG2 Meeting #115-e ***R2-210xxxx***

Electronic Meeting, August 16 – 27, 2021

**Agenda item:** 8.22

**Source:** Xiaomi Communications

**Title:** Summary of Report of [AT115-e][033][NR17] BCS5/4

**Document for:**  Discussion

# 1. Introduction

This document summarizes the following email discussion:

* [AT115-e][033][NR17] BCS5/4 (Xiaomi)

Scope: Take into account on-line progress. FOCUS first on Decision Option 1 vs 2, can also clarify rel-support for BCS5. Later need to clarify e.g. also whether text changes are required for BCS4, and wheter there are restrictions for using BCS4/BCS5.

Intended outcome: Report, (in the end also: Approved LS out, CRs)

Deadline: First CB Either Friday W1 or Monday W2.

**Phase 1:** FOCUS first on Decision Option 1 vs 2, can also clarify rel-support for BCS5. First CB on Friday W1.

Deadline: Thursday 2021-08-19 1600 UTC

**Phase 2:** Based on the achieved agreements in Phase 1, RAN2 later needs to clarify e.g. also whether text changes are required for BCS4, and whether there are restrictions for using BCS4/BCS5. In the end, RAN2 also provides the approved LS out and CRs.

Deadline: TBD after the first CB.

## 1.1 Contacts

Contact person for each participating company:

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| --- | --- | --- |
| Company | Name | Email Address |
| Xiaomi | Yumin Wu | wuyumin@xiaomi.com |
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| Qualcomm Incorporated | Masato Kitazoe | mkitazoe@qti.qualcomm.com |
| Huawei, HiSilicon | Yang Zhao | zhaoyang@huawei.com |
| Nokia |  | amaanat.ali@nokia.com |
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# 2. Phase 1

## 2.1 Solution 1 v.s. Solution 2

According to the LS [1] from RAN4, BCS4 is to “define a new type of BCS that would include all of the channel bandwidths that the UE supports for a given band in the band combination”, and “both BCS4 and BCS5 will define all the possible bandwidth configurations for each band in a band combination”. For BCS5, “the signalling to be introduced for BCS5 in Rel-17 would allow for implementations to limit the supporting channel bandwidth in each band within the band combination”. Two alternative solutions for the extra capability signalling for BCS5 are provided by RAN4 as follows:

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| * **Solution 1**: introduce a new UE signalling in IE FeatureSetUplinkPerCC /FeatureSetDownlinkPerCC (i.e., channelBWs-UL-ca/channelBWs-DL-ca) to allow UE to report the channel bandwidths it supports by bitmap on each CC of the band combination. * **Solution 2**: introduce a new UE signalling in IE FeatureSetUplinkPerCC /FeatureSetDownlinkPerCC to allow UE to report the minimum channel bandwidths supporting on each CC for the band combination, then UE can report maximum and minimum channel bandwidth supporting on each CC for the same band combination via multiple feature sets. Note that the signalling for maximum channel bandwidth has been specified as *supportedBandwidthUL /supportedBandwidthDL* in RAN2 specification. |

From the rapporteur’s understanding, both solutions are technically feasible to indicate the supporting channel bandwidth in each band within the band combination. The main difference is the potential signalling overheads introduced by Solution 1 or Solution 2.



Figure 1: Example of Solution 1

According to the example (as illustrated above) given in [3][5], Solution 1 requires extra 15bits (i.e. 13bits bitmap + 1 bit for CHOICE + 1 bit for OPTIONAL) in FSPC to indicate the supporting channel bandwidth in each band within the band combination.





Figure 2: Example of Solution 2

According to the example (as illustrated above) given in [7][9], Solution 2 requires extra 5bits (4bits for minBW + 1bit for CHOICE + 1bit for OPTIONAL ) in FSPC to indicate the supporting channel bandwidth in each band within the band combination.





Figure 3: fields in the current FSPC and FS of the current RRC specification

However according to the LS from RAN4 and the analysis given in [3][5], the UE needs to indicate “maximum and minimum channel bandwidth supporting on each CC for the same band combination via multiple feature sets”. When the UE needs to indicate 2 ranges of [minBW, maxBW], the UE would have to duplicate all capability bits 4 times in the feature set for 2-CC intra-band contiguous CA. As shown in the above Figure 3, when 2 feature sets are used for Solution 2, the number of extra bits required for Solution 2 are more than doubled compared with the number of extra bits required for Solution 1.

As the number of fields in the feature set could also increase in the future, the duplicated bits would also increase with the addition of extra fields in the feature set.

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| 38.300:  For each block of contiguous serving cells in a band, the set of features supported thereon is defined in a Feature Set (FS). The UE may indicate several Feature Sets for a band (also known as feature sets per band) to advertise different alternative features for the associated block of contiguous serving cells in that band. The two-dimensional matrix of feature sets for all the bands of a band combination (i.e. all the feature sets per band) is referred to as a feature set combination. In a feature set combination, the number of feature sets per band is equal to the number of band entries in the corresponding band combination, and all feature sets per band have the same number of feature sets. Each band combination is linked to one feature set combination. This is depicted on Figure 14-1 below: |

According to the 3GPP TS 38.300 as quoted above, when extra feature sets are added for a specific band, all bands in the same band combination need to add the same number of extra feature sets, as “all feature sets per band have the same number of feature sets”.

**Observation 1: When multiple feature sets are required for Solution 2 to indicate more than one ranges of [minBW, maxBW], lots of fields in the feature set are duplicated.**

**Observation 2: The duplicated bits of Solution 2 will increase when more fields in feature set are added in the future release.**

**Observation 3: When extra feature sets are added for a specific band for Solution 2, all bands in the same band combination need to add the same number of extra feature sets.**

#### Question 1: Do you agree that when multiple feature sets are required to indicate more than one ranges of [minBW, maxBW], the number of extra bits of Solution 2 is much more than the number of extra bits of Solution 1?

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| **Company** | **Answer (Yes/No)** | | **Comments** | |
| Xiaomi | Yes | | As the analysis given in [3][5], when multiple feature sets are required to indicate more than one ranges of [minBW, maxBW], the UE needs to duplicate lots of fields in each feature set. The extra signalling overheads for solution 2 would be much higher than those for solution 1. However we would also accept that if Solution 2 is restricted only for the use of one feature set case, the extra signalling for solution 2 is less than that of solution 1. | |
| OPPO | Yes | | So the key issue here is whether that dis-contiguous range needs to be taken into account: we got the same understanding from R4 colleagues that when this LS was being drafted, dis-contiguous range was considered by some companies as explained by email rapp, which lead to our paper in [3].  So the proponents of solution-2 may clarify their understanding on the dis-contiguous range, and if the common understanding is contiguous range is sufficient, we are open to solution-2, and it is necessary to **clarify the R2 understanding on this (dis)contiguous range issue explicitly in the LS back to R4 to avoid any gap between WGs**. | |
| Qualcomm Incorporated | |  | | Unfortunately this question is crafted in a way that an answer atomically shows disadvantage of solution 2.  The question should be asked if more than range of min-max BW needs to be signalled. To that end, our view is that there is no strong use case for the UE to use multiple ranges. Note that the UE must downgrade the existing capability for maximum CC BW to indicate the lower part of the ranges. This actually disallows the UE to indicate its true UE capability. |
| Huawei | No | | Only one range of [minBW, maxBW] needs to be indicated in the FSPC, as the network can derive the supported bandwidths based on the per band capability of channelBW if some special channel bandwidth within the range is not supported by the UE. | |
| Nokia | No | | There are two fundamental assumptions that proponent makes which is incorrect:   * The requirement on extra feature sets is not binding. In the design of capability the feature sets are shared among several bands and introducing an additional feature set does not increase the overhead as the index is what is put which is a pointer not the entire object. So the increase in size argument does not hold any water * We are not sure of the claim that proponent makes is that there will always be more than 1 feature set required. In most cases the way we understand RAN4 discussion the minBW is just a compromise from BCS4 where the instead of supporting everything one additional limiting factor is added.   The full flexibility that Solution 1 “seems” to offer is not required at this stage and in the future as no UE would really use that flexibility. In the light of these arguments we don’t see why we need Solution 1. | |
| ZTE | No | | For the solution 1, we also have concern on the signaling overhead for that it’s a per CC capability. Furthermore,the existing {channelBWs-UL/DL, supportedBandwidthDL/UL} has filtered some unsupported bandwidth. We don’t see the strong motivation to introduce another bitmap again.  Then back to the question itself, we don’t think “multiple feature sets are required to indicate more than one ranges of [minBW, maxBW]” is a normal case. For the BC in the Fig4, I guess the UE can only report BCS0, there is no need to report BCS5 and together with the new signalling. So we don’t think it’s reasonable to take BCS0 as an example to analyse solution 1/2.  Instead, the BCS4/5 were introduced for the cases that the UE can support all most all of the bandwidth, a minimum supported bandwidth is enough, the over-design shall be avoid, otherwise, the existing BCS(0~3)/ {channelBWs-UL/DL, supportedBandwidthDL/UL} would lose its meaning. | |
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Figure 4: Example of CA n1A-n77A

According to the current RAN4 specification 38.101, the UE could support several ranges of bandwidths for a specific band, when this band is included in a band combination. For example, for CA n1A-n77A, the n77 supports 3 ranges of bandwidth (i.e. [10MHz, 20MHz], [40MHz, 60MHz] and [80, 100MHz]). And the supported bandwidths of n77 is [10, 100]. If Solution 2 is used, the UE indicating BCS5 has to indicate 3 feature sets for n77, and Solution 1 only needs to indicate 1 feature set for n77. As also highlighted in yellow from the RAN4 LS quoted above, RAN4 considers that multiple feature sets are needed for Solution 2.

#### Question 2: Do you agree that the case of multiple feature sets of Solution 2 is included in the RAN4 BCS5 discussion?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Xiaomi | Yes | The RAN4 LS has explicitly indicated that “multiple feature sets” are required for Solution 2. And in the RAN4 specification 38.101, it is common that the UE would support several ranges of bandwidths for a specific band in a band combination. |
| Qualcomm Incorporated | No |  |
| Huawei | No | See the answer in Q1. We did not see enough motivation to support multiple sets. |
| Nokia | No | See our detailed response to Q1 |
| ZTE | No | See our detailed response to Q1 |
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#### Question 3: Do you support Solution 1 or Solution 2?

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| **Company** | **Answer (Solution 1**  **Or Solution 2)** | **Comments** |
| Xiaomi | Solution 1 | When multiple feature sets are required for Solution 2 to indicate multiple ranges of supported bandwidths, the extra signalling overheads of Solution 2 are not acceptable. |
| OPPO |  | We are OK for solution-1.  And we are OK for solution-2 as well only if R2 converge on the contiguous range understanding and including that understanding in the LS back to R4 to sync. |
| Qualcomm Incorporated | Solution 2 |  |
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| Huawei | Solution2 with comments | 1. There is more signalling overhead of solution 1 when the bandwidth entry increases with evolution and we think we should have balance on signalling overhead and essential requirements. Thus if this needs RAN2 signalling supports, we prefer Solution 2. 2. If Solution 2 is the way forward, we think the following should be first discussed to ensure inter-operability: 3. The relation between new reported BCS5 and BCS0-3. We are wondering whether BCS 0~3 should still be reported when BCS is reported? 4. We understand minBW only applies to BCS5 and can minBW be absent for a FSPC when BCS5 is indicated? 5. Irrespective which solution to go, it should also discuss the following bullets: 6. Whether this change has impact on fallback per cc featureset. 7. To avoid inter-operability issue, we suggest any new introduced bandwidth in future should be reported in per band channel BW, even it is optional. In this case the supported bandwidth by the UE can always be deduced correctly by the network via the reported BCS5 [minBW, maxBW] and per band channel BW. 8. The consequence of introducing this new signalling should also be considered. Originally the BCS is per BC and there is only limited number of bandwidth combinations defined and need to be tested. However by introducing minBW FSPC means any kind of bandwidth combinations across all the CCs within the range of [minBW, maxBW] is supported by the UE, when the UE reports support of BCS5. This adds more requirements on IoT testing and we hope all the companies understand this consequence before modification. |
| Nokia | Solution 2 |  |
| ZTE | Solution 2 | Based on our response to the question 1, we support solution 2.  Then for the solution 2 itself, we’d like to clarify the below issue:  To keep the backward compatibility, for the UE report BCS5 together with minimum supported bandwidth, the UE shall also report one or more BCS among the BCS0~3(e.g. BCSx),  then  =>the legacy gNB can determine the supported bandwidth based on the {channelBWs-UL/DL, supportedBandwidthDL/UL, BCSx}  =>While the R17 gNB would determine the supported bandwidth based on {channelBWs-UL/DL, supportedBandwidthDL/UL, minsupportedBandwidthDL/UL, BCSx, BCS5}  We assume that the minimum supported bandwidth based on the {channelBWs-UL/DL, supportedBandwidthDL/UL, BCSx} = 10M,  Then there are 2 questions:   1. Can the UE report the minsupportedBandwidthDL/UL larger than 10M? e.g. 30M 2. If can, does it mean that the R17 gNB would determine the supported bandwidth that lower than 30M based on{channelBWs-UL/DL, supportedBandwidthDL/UL, BCSx}, meanwhile determine the supported bandwidth that no less than 30M based on{channelBWs-UL/DL, supportedBandwidthDL/UL, minsupportedBandwidthDL/UL, BCS5} |
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#### Question 4: If RAN2 agreed to support Solution 2, do you think that RAN4 should be informed to clarify whether the case of multiple feature sets of Solution 2 is common?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Xiaomi | Yes | If RAN2 cannot achieve the common understanding on whether the case of the multiple ranges of supported bandwidths in a band of a band combination is common or not, we think that RAN2 should ask RAN4 for further clarifications on the use cases of BCS5, as the extra signalling overheads of Solution 2 are too much compared with Solution 1, when multiple feature sets are required for Solution 2. |
| OPPO | Yes | As replied above, our understanding is the solution-2 only works in case of contiguous range. The view on it should be informed to R4 explicitly if solution-2 is adopted. |
| Qualcomm Incorporated | No | Sufficient explanation why multiple range is necessary in the solution 2 is not given. |
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| Huawei | No | We agree with Qualcomm there is no need to ask this. |
| Nokia | No | We agree with Qualcomm and Huawei |
| ZTE | No |  |
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## 2.2 Release for BCS5

According to the LS [1] from RAN4, “RAN4 agreed to introduce BCS4 release independent with no new signalling, and BCS5 with new signalling in Rel-17”. According to [2], company considers that BCS5 can also be supported in release independent manner. From the rapporteur’s understandings, it seems that there is no specific technical issue of supporting BCS5 for the early release.

#### Question 5: Do you agree that BCS5 can be supported in release independent manner?

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| **Company** | **Answer (Yes/No)** | **Comments** |
| Xiaomi | Yes |  |
| OPPO |  | We support BCS5 at least since Rel-17.  For Rel-15/16, we understand it can be supported by early implementation, but no need for Rel-15/16 CR. |
| Qualcomm Incorporated | Yes | We do not see any technical reason why it cannot be supported in release independent manner. |
| Huawei | No | RAN4 asks release independence on BCS4 only, and we do not see much need to support BCS5 since Rel-15. |
| Nokia | Yes | BCS5 should be supportable with a magic sentence and it is up to UE vendor to support it if required from Rel-15. So we would not preclude that possibility given that BCS5 has signalling associated with it (min supported channel bandwidth DL/UL) |
| ZTE | No | On this issue we share the view with Huawei |
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## 2.1 Summary of Phase 1

# 3. Phase 2

## 2.1 void

# 4. Summary

# 5. Reference

[1] [R2-2106957](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2106957.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2106957.zip) LS on NR CA capability for BCS5 (R4-2108002; contact: Xiaomi) RAN4 LS in Rel-17 NR\_BCS4-Core To:RAN2

[2] [R2-2107126](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2107126.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2107126.zip) Introduction of BCS4 and BCS5 Qualcomm Incorporated, Nokia, Nokia Shanghai Bell discussion Rel-17 NR\_BCS4-Core

[3] [R2-2107183](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2107183.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2107183.zip) Discussion on BCS5 OPPO discussion Rel-17 NR\_BCS4-Core

[4] [R2-2108589](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108589.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108589.zip) Discussion on the signalling for BCS5 Huawei, HiSilicon discussion Rel-17 NR\_BCS4-Core

[5] [R2-2108801](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108801.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108801.zip) NR CA capability for BCS5 Xiaomi Communications discussion Rel-17 NR\_BCS4-Core

[6] [R2-2108043](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108043.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108043.zip) Consideration on the BCS4/5 supporting ZTE Corporation, Sanechips discussion Rel-17 NR\_BCS4-Core

[7] [R2-2107127](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2107127.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2107127.zip) Introduction of supported minimum bandwidth per CC for BCS5 Qualcomm Incorporated, Nokia, Nokia Shanghai Bell CR Rel-16 38.331 16.5.0 2713 - B NR\_BCS4-Core

[8] [R2-2107128](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2107128.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2107128.zip) Introduction of supported minimum bandwidth per CC for BCS5 Qualcomm Incorporated, Nokia, Nokia Shanghai Bell CR Rel-16 38.306 16.5.0 0611 - B NR\_BCS4-Core

[9] [R2-2108041](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108041.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108041.zip) CR on the BCS4/5 supporting-38331 ZTE Corporation, Sanechips CR Rel-17 38.331 16.5.0 2750 - B NR\_BCS4-Core

[10] [R2-2108042](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108042.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108042.zip) CR on the BCS4/5 supporting-38306 ZTE Corporation, Sanechips CR Rel-17 38.306 16.5.0 0620 - B NR\_BCS4-Core

[11] [R2-2108044](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108044.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108044.zip) CR on the BCS4 supporting-r15 ZTE Corporation, Sanechips CR Rel-15 38.306 15.14.0 0621 - B NR\_BCS4-Core

[12] [R2-2108045](file:///D:\\Documents\\3GPP\\tsg_ran\\WG2\\TSGR2_115-e\\Docs\\R2-2108045.zip" \o "D:Documents3GPPtsg_ranWG2TSGR2_115-eDocsR2-2108045.zip) CR on the BCS4 supporting-r16 ZTE Corporation, Sanechips CR Rel-16 38.306 16.5.0 0622 - A NR\_BCS4-Core