3GPP TSG-RAN WG2 Meeting #112 Electronic R2-200xxxx

**Elbonia, 02 – 13 November 2020**

**Agenda item: 5.4.3**

**Source: Nokia, Nokia Shanghai Bell**

**Title: Summary of [Post112-e][052][NR15] BWCS for inter-ENDC BC with intra-ENDC band combination**

**Document for: Discussion and Decision**

1. Introduction

This document captures the understanding among companies for the following we discuss a possible issue

on the interpretation of bandwidth combination set (BWCS) for a scenario where the band combination

comprises of inter-band EN-DC with intra-band EN-DC part:

* [Post112-e][052][NR15] BWCS for inter-ENDC BC with intra-ENDC band combination (Nokia)

 Scope: Based on R2-2011044, collect comments, determine agreeable clarifications.

 Intended outcome: Report, possibly draft CR, (unclear what ambition level can be possible).

 Deadline: short (not for RP).

2. Intra-band EN-DC with inter-band CA component

The concept of bandwidth combination sets was introduced in LTE CA and indicates the set of carrier bandwidths that a UE supports in CA/DC, allowing network to avoid configuring something UE wouldn't support.

The [R4-1910249](http://www.3gpp.org/ftp/tsg_ran/wg4_radio/tsgr4_92/docs/R4-1910249.zip) was endorsed in RAN4#92 meeting that contained the following modifications:

A terminal which supports an EN-DC configuration shall support:

* If any subsets of the EN-DC configuration do not specify its own bandwidth combination sets in 5.3B, then the terminal shall support the same E-UTRA bandwidth combination sets it signals the support for in E-UTRA CA configuration part of E-UTRA – NR DC and shall support the same NR bandwidth combination sets it signals the support for in NR CA configuration part of E-UTRA – NR DC.
* Else if one of the subsets of the EN-DC configuration specify its own bandwidth combination sets in 5.3B, then the terminal shall support a product set of channel bandwidth for each band specified by E-UTRA bandwidth combination sets, NR bandwidth combination sets, and EN-DC bandwidth combination sets it signals the support.

Based on the RAN4 conclusion, for an inter-band EN-DC band combination with an intra-band EN-DC component, the UE needs to indicate the BWCS of LTE CA, BWCS of NR CA and BWCS of intra-band EN-DC. For example, consider a fictitious inter-band EN-DC combination as an example: 1A-2A-3A\_n3A\_n78A, the UE needs to report the BWCS of CA\_1A-2A-3A, CA\_ n3A-n78A and of the LTE-NR shared band component 3A\_n3A. For band 3 in LTE, the UE supports the intersection of channel bandwidth of CA\_1A-2A-3A and of the E-UTRA channel bandwidths of 3A n3A, and for band 3 in NR, the UE supports the intersection of channel bandwidth of CA\_n3A-n78A and of the NR channel bandwidths of 3A n3A.

To support reporting three BWCS for LTE CA, NR CA and intra-band EN-DC separately, the 3GPP RAN2 introduced the field *supportedBandwidthCombinationSetIntraENDC* in Rel-15 and Rel-16 via CRs [R2-2002390](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002390.zip) & [R2-2002127](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002127.zip).

The changes are pasted here from the specification for easy reference from TS 38.306.

| ***supportedBandwidthCombinationSet***Defines the supported bandwidth combination for the band combination set as defined in the TS 38.101-1 [2], TS 38.101-2 [3] and TS 38.101-3 [4]. For NR CA, NR-DC, and intra-band EN-DC with additional inter-band NR CA component, the field defines the bandwidth combinations for the NR part of the band combination. For intra-band EN-DC without additional inter-band NR and LTE CA component, the field indicates the supported bandwidth combination set applicable to the NR and LTE band combinations. Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-1 [2], TS 38.101-2 [3] and TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if the band combination has more than one NR carrier (at least one SCell in an NR cell group) or is an intra-band EN-DC combination without additional inter-band NR and LTE CA component or both. | BC | CY | No | No |
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| ***supportedBandwidthCombinationSetIntraENDC***Defines the supported bandwidth combination for the band combination set as defined in the TS 38.101-3 [4]. For intra-band EN-DC with additional inter-band NR/LTE CA component, the field defines the bandwidth combinations for the intra-band EN-DC component. Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component. | BC | CY | No | No |

**Observation 1: The reporting of the *supportedBandwidthCombinationSetIntraENDC* is per EN-DC BC.**

**Observation 2: The reporting of the *supportedBandwidthCombinationSetIntraENDC* is mandatory for UEs if the band combination is an "intra-band EN-DC combination with additional inter-band NR/LTE CA component", independent from whether the intra-band EN-DC part supports one or more BWCS.**

As such band combinations are being deployed currently, when determining the UE support for such bands, it was noticed that an ambiguity may still exist in the description of these capabilities. Thus, to avoid having issues with UEs in the field, a clarification may still be needed.

# 3. Description of the issue

Figure 3-1 shows an example of the four-band EN-DC band combinations with **DL as DC\_1A-2A-3A\_n3A/ DC\_1A-2A-3A\_n3A** and corresponding **UL as DC\_1A\_n3A/DC\_2A\_n3A/DC\_3A\_n3A.**



Figure 3-1: An example four-band band combination of inter-band EN-DC with intra-band EN-DC part

**Observation 3: UE supporting DC\_1A-2A-3A\_n3A is allowed to indicate that it does not support e.g. uplink DC\_3A\_n3A but only supports uplink DC\_1A\_n3A and uplink DC\_2A\_n3A.**

It is understood from the RAN2 specification that even if the UE supports **only** the band combinations **DC\_1A-2A-3A\_n3A and DC\_1A-2A-3A\_n3A (**where **RED** portion indicates the supported UL configuration as per Figure 3-1**)**, the *supportedBandwidthCombinationSetIntraENDC* IE still needs to be reported due to the RAN2 condition for the band combination. If the UE does not signal this, the BWCS for band combination part 3A\_n3A cannot be known by the network (i.e. network doesn't know whether BWCS 0 or 1 is supported). However, even though the UL cannot be placed in the band 3 in the above examples (since the UE doesn't support it), this still means that the band combination is an "intra-band EN-DC with inter-band CA component" despite the UL carriers not being "intra-band" since the DL carriers on (LTE) band 3 and (NR) n3 are still considered as "intra-band". Therefore, the presence of the intra-band BWCS capability *supportedBandwidthCombinationSetIntraENDC* is still mandatory according to TS38.306.

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| E-UTRA – NR configuration / Bandwidth combination set |
| DownlinkEN-DC configuration | Uplink EN-DC configurations | Component carriers in order of increasing carrier frequency | Maximum aggregated bandwidth (MHz) | Bandwidth combination set |
| Channel bandwidths for E-UTRA carrier (MHz) | Channel bandwidths for NR carrier (MHz) | Channel bandwidths for E-UTRA carrier (MHz) |
| DC\_3A\_n3A  | DC\_3A\_n3A(1) |  | 5, 10, 15, 20, 25, 30 | 5, 10, 15, 20 | 50 | 0 |
|  | 5, 10, 15, 20, 25, 30 | 5, 10, 15, 20 | 50 | 1 |
| 5, 10, 15, 20 | 5, 10, 15, 20, 25, 30 |  |

**Table 3-1: 38.101-3 (Table 5.3B.1.3-1)**

**Observation 4: Any UEs in the field reporting a band combination comprising of an intra-band EN-DC combination with additional inter-band NR/LTE CA component before the introduction of RAN2 CRs R2-2002390 & R2-2002127 would be impacted in a non-backward compatible manner.**

**Question 1: Do companies have a common understanding on the background and Observations 1 to 4? If something is not aligned could you please describe in detail?**

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| Company | Views (please be descriptive and even refer to the example above if necessary to explain your points) |
| Apple | Yes, the observations 1-4 are valid. For observation 4, from our recollection, RAN2 agreed to go with the NBC change, as all the options at the table then were NBC ☺…! |
| Huawei, HiSilicon | When these CRs were discussed in RAN2, we indeed discussed whether there were such UEs in the field. At that time no company assumed there would be such UEs in the field, this is why in the CR coversheet we had the below statement.If the network is implemented according to the CR and the UE is not, there is no inter-operability problem since such UEs would not advertise an intra-band EN-DC combination with additional inter-band NR CA component (i.e., the feature is mandatory for UEs advertising an intra-band EN-DC combination with additional inter-band NR CA component).If currently there are UEs in the field, which supports a BC with limited support of UL configuration instead of all UL configurations, this was not figured out during previous discussion in RAN2 and we are fine to have a solution to solve this issue. |
| OPPO | Yes, we agree with 4 observations |
| ZTE | Yes, we agree with 4 observations. |
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Based on the above discussion and to ensure this is clear to all UE implementations, we propose the following:

**Proposal 1: RAN2 to confirm that reporting of the *supportedBandwidthCombinationSetIntraENDC* is mandatory for UEs if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component independent from whether the intra-band EN-DC part supports one or more BWCS.**

**Question 2: Do companies confirm Proposal 1?**

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| Company | Views (Confim/Deny) – also supplement with examples if needed |
| Apple | We confirm proposal-1. But it might be better to clarify the definition of intra-band EN-DC that the uplink should be supported by the UE for both the LTE and NR “intra-bands” to make the corresponding intra-band EN-DC to work. Otherwise it becomes just an inter-band EN-DC.Then only the UEs which support the intra-band EN-DC would need to mandatorily report ***supportedBandwidthCombinationSetIntraENDC.***We would like to get more views from other companies as well. |
| Huawei, HiSilicon | This was the intention of the agreed CRs. Based on the Observation 3, we understand the current case is that the UE may not support 3A\_n3A for the UL as it is single UL only, but support 3A\_n3A for the DL and thus the UE would still report such a BC. We want to understand better in this case, whether the UE should report BWCS or not as currently BWCS does not differ UL and DL. In our view, the BWCS still needs to be reported because the DL still supports 3A\_n3A. If this is not the case, the UE has no reason to report such a BC as both UL and DL do not support 3A\_n3A. |
| TELUS | We believe there is a DL that involves 3A\_n3A, but only as a part of bigger combo (e.g., **DC\_1A-2A-3A\_n3A** ) and not as something that stands on its own. Since 3A\_n3A cannot operate as an EN-DC combo (due to lack of UL implementation), this should not be the blocking intra-band combo, should be simply ignored. Otherwise, a perfectly good larger order combo that has two valid anchor bands is blocked by a non-existent fallback 3A\_n3A only for the sake of satisfying the signalling condition.  |
| OPPO | Yes we confirm |
| ZTE | Yes, we agree with this proposal |
| Apple (second response) | RAN2 agreed to make the BWCS for the intra-band EN\_DC part as mandatory because the entire large inter-band EN-DC combination was hinged on the intra-band part. Even the field description and the proposal says this: **RAN2 to confirm that reporting of the *supportedBandwidthCombinationSetIntraENDC* is mandatory for UEs if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component independent from whether the intra-band EN-DC part supports one or more BWCS** .So UEs supporting intra-band EN-DC with additional parts, need to report the BWCS from 5.3B. But UEs which do not support the intra-band EN-DC (as RAN4 considers this optional) for a large inter-band EN-DC, do not have to support the intra-band EN\_DC specific BWCS (which was added specifically for this operation in 5.3B). If the UE does support the BWs in DL for the intra-band EN\_DC part even when the EN-DC operation is not supported for the intra-band part, it can reports, it can report the intra-band EN-DC BWCS and the absence of featureSetUplink clearly informs the NW that DL only BWs are supported, but the UE should not be mandated to support/report the additional BWCS.RAN4 already says (also captured in sec 2 above) that the BWs for the corresponding intra-band LTE and NR parts of the inter-band EN-DC are derived from the LTE CA and NR CA BWCS, and the NW should expect the UE to only support these.Actually, if we re-read the field description, it is pointing in this direction already. Maybe the wording can be changed to clearly imply this understanding as below:***supportedBandwidthCombinationSetIntraENDC***Defines the supported bandwidth combination for the band combination set as defined in the TS 38.101-3 [4]. For intra-band EN-DC with additional inter-band NR/LTE CA component, the field defines the bandwidth combinations for the intra-band EN-DC component. Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component, and optional if the inter-band EN-DC combination has additional intra-band LTE/NR components.  |
| TELUS (second response) | Fully agree with Apple’s view. If the UEs does not support the intra-band EN-DC, it should not affect the large inter-band EN-DC. Intra-band should be optional. |
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**Proposal 2: RAN2 to confirm that the reporting of the *supportedBandwidthCombinationSetIntraENDC* is mandatory even when the intra-band EN-DC component of the mixed intra/inter-band EN-DC band combination UE is not a fallback band combination (e.g. 3A\_n3A is not a fallback of DC\_1A-2A-3A\_n3A and DC\_1A-2A-3A\_n3A but still UE shall report the *supportedBandwidthCombinationSetIntraENDC* IE).**

**Question 3: Do companies confirm Proposal 2?**

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| Company | Views (Confim/Deny) – also supplement with examples if needed |
| Apple | “Deny”?? Pls see our comments for Q2. From that perspective, the UE does not actually support the intra-band EN-DC, and this is also not considered as a fallback as the parent “large” EN\_DC combination does not have support of UL for the LTE and NR intra-band parts anyway.In the above example, **DC\_1A-2A-3A\_n3A and DC\_1A-2A-3A\_n3A, there was no uplink on 3A at all.** |
| Huawei, HiSilicon | We think Proposal 2 is consistent with fallback BC definition. We understand **DC\_1A-2A-3A\_n3A** and **DC\_1A-2A-3A\_n3A** have different UL capabilities, and they cannot be regarded as the fallback BC from each other. |
| OPPO | Yes. If uplink band combination doesn’t contain intra-band ENDC part, still network need know the BWCS of DL intra-band ENDC part regardless of the definition. In addition we want to confirm another way around case i.e. inter-band DC with intra-band ENDC in uplink. In this case, I guess UE shall also report BWCS. |
| ZTE | Yes, we confirm the proposal 2 |
| Apple (second response) | RAN2 agreed to make the BWCS for the intra-band EN\_DC part as mandatory because the entire large inter-band EN-DC combination was hinged on the intra-band part. Even the field description and the proposal says this: **RAN2 to confirm that reporting of the *supportedBandwidthCombinationSetIntraENDC* is mandatory for UEs if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component independent from whether the intra-band EN-DC part supports one or more BWCS** .So UEs supporting intra-band EN-DC with additional parts, need to report the BWCS from 5.3B. But UEs which do not support the intra-band EN-DC (as RAN4 considers this optional) for a large inter-band EN-DC, do not have to support the intra-band EN\_DC specific BWCS (which was added specifically for this operation in 5.3B). If the UE does support the BWs in DL for the intra-band EN\_DC part even when the EN-DC operation is not supported for the intra-band part, it can reports, it can report the intra-band EN-DC BWCS and the absence of featureSetUplink clearly informs the NW that DL only BWs are supported, but the UE should not be mandated to support/report the additional BWCS.RAN4 already says (also captured in sec 2 above) that the BWs for the corresponding intra-band LTE and NR parts of the inter-band EN-DC are derived from the LTE CA and NR CA BWCS, and the NW should expect the UE to only support these.Actually, if we re-read the field description, it is pointing in this direction already. Maybe the wording can be changed to clearly imply this understanding as below:***supportedBandwidthCombinationSetIntraENDC***Defines the supported bandwidth combination for the band combination set as defined in the TS 38.101-3 [4]. For intra-band EN-DC with additional inter-band NR/LTE CA component, the field defines the bandwidth combinations for the intra-band EN-DC component. Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component, and optional if the inter-band EN-DC combination has additional intra-band LTE/NR components.  |
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However, this still leads to a question: If someone has interpreted this differently, i.e. a UE on the field does not support the RAN2 CRs [R2-2002390](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002390.zip) & [R2-2002127](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002127.zip) but still reports a band combination comprising of an intra-band EN-DC combination with additional inter-band NR/LTE CA component, the network does not know which BWCS the UE supports. To solve such issue, it could be assumed that the UE supports (at least) BWCS 0 if the above capability is not reported. To make such a case clear, the existing capability may be updated as shown in the below text proposal.

| ***supportedBandwidthCombinationSetIntraENDC***Defines the supported bandwidth combination for the band combination set as defined in the TS 38.101-3 [4]. For intra-band EN-DC with additional inter-band NR/LTE CA component, the field defines the bandwidth combinations for the intra-band EN-DC component. Field encoded as a bit map, where bit N is set to "1" if UE support Bandwidth Combination Set N for this band combination as defined in the TS 38.101-3 [4]. The leading / leftmost bit (bit 0) corresponds to the Bandwidth Combination Set 0, the next bit corresponds to the Bandwidth Combination Set 1 and so on. It is mandatory if the band combination is an intra-band EN-DC combination with additional inter-band NR/LTE CA component. If the band combination comprises of an intra-band EN-DC combination with additional inter-band NR/LTE CA component and this field is not reported, then the network may assume the UE only supports BCS 0. | BC | CY | No | No |
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However, this needs to be confirmed by RAN2 so we propose that RAN2 discusses whether this interpretation is acceptable to all vendors:

**Proposal 3: RAN2 to confirm if the network may assume the UE only supports BCS 0 if the UE does not report the *supportedBandwidthCombinationSetIntraENDC* field for a band combination comprising of an intra-band EN-DC combination with additional inter-band NR/LTE CA component.**

**Question 4: Would companies support network making a default assumption (one example is in the text proposal) if UE did not report the *supportedBandwidthCombinationSetIntraENDC* for relevant BC*?***

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| Company | Views (Confim/Deny) – also supplement with examples if needed |
| Apple | Deny. But, if we first agree the definition of intra-band EN-DC in a larger DC combination needs that the UL of the LTE and NR “intra-bands” is needed, then BWCS absence to imply BWCS set -0 can be discussed. We are interested in other company views as well. |
| Huawei, HiSilicon | We are OK to let the network always assume BCS0 by default, if the UE reports such a BC without indicating the BWCS. The point we want to confirm is whether this would not cause any ambiguity form UE side. Based on the observations, we understand there are two kinds of UEs which may not report the BWCS:* Case 1: UEs already in the field supporting such a inter-band ENDC BC with intra-band ENDC part, prior to the agreed CRs
* Case 2:UEs supported UL configuration like **DC\_1A-2A-3A\_n3A**

For Case 1, we think there should be no problem that we always assume BCS0.For Case 2, it depends on the conclusion on Q2. If companies agree in case 2 the UE shall be mandatory to report BWCS, this should not be a problem then. |
| OPPO | We think it makes sense for network to assume default BWCS in case some legacy UE doesn’t report it. But whether the default BWCS is BCS 0 or not should be left for RAN4 to decide. So we propose to send one LS to RAN4 to show RAN2’s common understanding of this issue and check whether BCS0 is the right default BWCS network can assume. |
| ZTE | “making a default assumption,e.g. BCS 0” is OK for us. |
| Apple (2nd version) | Our understanding of the problem is that the UEs are now expected to also support additional intra-band EN\_DC BWCS, just to comply with the “mandatory” requirement of reporting the BWCS for the intra-band EN\_DC with interband additional components, when the RAN4 introduced inter-band EN-DC with intra-band LTE/NR components where the support of intra-band EN-DC is optional and not considered a fallback. For eg: DC\_2A-7A-66A\_n66AThe other problem of UEs already present in the field which have not implemented CRs [R2-2002390](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002390.zip) & [R2-2002127](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002127.zip), was discussed and agreed to be not present. Meaning all the UEs have already implemented these CRs. From this perspective, introduction of an implicit assumption if the UE does not report intra-band EN\_DC BWCS is going in a separate direction, and we think this is not urgent now, and we may not even need this, if the UEs follows the current CR (assuming that all UEs have implemented the CRs [R2-2002390](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002390.zip) & [R2-2002127](http://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_109_e/Docs/R2-2002127.zip)). Otherwise this adds another complexity to the current issue. |
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**Question 5: Would companies support any other solution to resolve the issue*?***

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| Company | Views (Confim/Deny) – also supplement with examples if needed |
| Apple | Pls see our comments to Q2 and Q4. |
| Huawei, HiSilicon | As we explained above, we are fine on Proposal 3. But what we want to understand better is irrespective which solution to go, we need a clear understanding on how to deal with an intra-band ENDC with inter-band CA component, where the intra-band ENDC is clearly said in RAN4 that only single switched UL is supported. If this is the root reason triggering this discussion, another alternative could be to allow optional reporting of BWCS for such a case.  |
| Apple (2nd versions) | Pls see our 2nd comments to Q2 / Q3. |
| TELUS | If the UE does not report supportedBandwidthCombinationSetIntraENDC it should not be forced into having intra-band dependency. The ideal solution is to treat that combo as inter-band only. This would resolve another problem, and that is absence of contiguous (n)66AA for instance in the spec. For the contiguous scenario, current approach precludes the whole combo from being activated. |
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# 4. Conclusion

**[To be added at the end of the discussion]**

# 5. Contact Information

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