**3GPP TSG-RAN** **WG2 Meeting #113-e R2-210xxxx**

**Electronic, January 25 – February 5, 2021**

**Source: Qualcomm Incorporated**

**Title: Summary of email discussion [Post113-e][225][DCCA] Asynchronous and synchronous NR-DC cell grouping (Qualcomm)**

**Document for: Decision**

**Agenda Item: 6.8.3**

# Introduction

This document summarizes the following email discussion.

**[Post113-e][225][DCCA] Asynchronous and synchronous NR-DC cell grouping (Qualcomm)**

 Scope: Try to technically endorse a CR (for sync and async) illustrating how the signalling could work. Send LS to RAN4 to ask about the band entry vs. frequency band.

 Intended outcome: LS to RAN4 and technically endorsed CRs on NR-DC cell grouping (38.331, 38.306)

 Deadline: Short

RAN2 in #113e meeting made the following agreements on NR-DC cell grouping UE capability, with a few points for further study.

Agreements

2 RAN2 to take the following working assumption

 For asynchronous NR-DC cell group capability, adopt the LTE DC Style with MCG/SCG differentiation. (bitmap limited to same size as in LTE)

FFS if this limit corresponds to frequency band or band entry

3 Introduce cell group capability for synchronous NR-DC with the same signaling structure as cell group capability for asynchronous NR-DC. (bitmap limited to same size as in LTE)

FFS if this is the same bitmap as for async or different bitmap

FFS: allowing the UE to indicate it supports the same cell grouping for both sync and async.

# Discussion

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

|  |  |  |
| --- | --- | --- |
| Company | Name | Email Address |
| Ericsson | Stefan Wager | stefan.wager@ericsson.com |
| vivo | Wenjuan Pu | wenjuan.pu@vivo.com |
| ZTE | LiuJing | liu.jing30@zte.com.cn |
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## Band entry or frequency band

In LTE DC style signalling, each bit in the bitmap corresponds to one band entry in the DC band combination. For example, the band combination n2A\_n5A\_n260A\_n260C is considered a band combination with four band entries, i.e. each contiguous band block, n2A, n5A, n260A and n260C, is considered a band entry.

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| [From TS36.331]***supportedCellGrouping***This field indicates for which mapping of serving cells to cell groups (i.e. MCG or SCG) the UE supports asynchronous DC. This field is only present for a band combination with more than two but less than six band entries where the UE supports asynchronous DC. If this field is not present but asynchronous operation is supported, the UE supports all possible mappings of serving cells to cell groups for the band combination. The bitmap size is selected based on the number of entries in the combinations, i.e., in case of three entries, the bitmap corresponding to *threeEntries* is selected and so on.

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| **Nr of Band Entries:** | 5 | 4 | 3 |
| **Length of Bit-String:** | 15 | 7 | 3 |
| **Bit String Position** | **Cell grouping option (0= first cell group, 1= second cell group)** |
| 1 | 00001 | 0001 | 001 |
| 2 | 00010 | 0010 | 010 |
| 3 | 00011 | 0011 | 011 |
| 4 | 00100 | 0100 |  |
| 5 | 00101 | 0101 |  |
| 6 | 00110 | 0110 |  |
| 7 | 00111 | 0111 |  |
| 8 | 01000 |  |  |
| 9 | 01001 |  |  |
| 10 | 01010 |  |  |
| 11 | 01011 |  |  |
| 12 | 01100 |  |  |
| 13 | 01101 |  |  |
| 14 | 01110 |  |  |
| 15 | 01111 |  |  |

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A concern was raised that only 5 band entries as in LTE is too limiting, given the increased number of non-contiguous blocks for FR2, e.g. CA\_n5A-n260(8A) defined in TS38.101-3 which consists of 9 “band entries”.

Another possible solution is that each bit in the bitmap corresponds to one frequency band in the DC band combination. For example, the band combination n2A\_n5A\_n260A\_n260C will require only 3 bits.

* **Option 1:** Each bit in the bitmap corresponds to one band entry in the DC band combination
* **Option 2:** Each bit in the bitmap corresponds to one frequency band in the DC band combination
* **Option 3**: Each bit in the bitmap corresponds to “FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2” similarly to PUCCH group signaling

**Question 1:** Companies are requested to provide their preference.

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| **Company name** | **Option 1 / Option 2** | **Comments** |
| Apple | Option 2 | We do not see option 1 as a second choice as for one, the 5 band entry will not be useful even with current DC combinations and more importantly, we would like to make sure that the RAN4 intentions of having no simultaneous RxTx in TDD band (such as in n260) to avoid severe REFSENS impact from Tx are taken into considerations (which is not possible with option 1). |
| MediaTek | Option 2 | Option 2 basically has less granularity but would be sufficient in our understanding.  |
| Nokia | Option 2/3 is probably needed due to already existing combinations having more than 5 entries | Firstly we agree that there are already some band combinations in RAN4 specs with more than 5 band entries even for a band. Thus it makes sense to consider possibility that entry in the bitmap would correspond into a frequency band. We are wondering if we would go this way would this resemble more the PUCCH group capability signaling where one can indicate carrier types. If this approach works for PUCCH group capability signaling maybe we should use same approach for this capability signaling as well i.e. one possibility is that the entry in the bitmap would indicate on of following like in PUCCH group signaling: FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2. As this approach works for dual PUCCH group signaling it seems equally applicable for DC case as well. Probably we should ask RAN4 view on whether option 2/3 could be used. |
| Huawei, HiSilicon | Option 1/Option2 | We prefer to indicate the cell grouping at least per band. Between option 1 and option2, we could go with majority. |
| Ericsson | Option 2 or other | Using frequency band instead of band entry will reduce overhead somewhat and improve scalability. However, we agree with Nokia that this is actually a step towards PUCCH grouping like signaling, where the granularity was reduced further to {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}, which reduce overhead and increase scalability even further. RAN1 indicated this granularity was sufficient for PUCCH grouping. They also suggested the same can be applied for NR-DC cell grouping, at least for synchronous NR-DC. In email discussion [Post112-e][255], several companies agreed that the framework of FG 22-7 could be considered for NR-DC cell grouping. Exact implementation needs further discussion. Either list based, as in FG 22-7, or LTE-DC style, with four entries corresponding to {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} instead of one entry per band entry. We have not yet discussed what is the required granularity for cell group signaling for NR-DC. We agree with Nokia that an LS to RAN4 on the required granularity would be good. |
| vivo | Option2 | Option 2 is preferred as it is sufficient and has the similar structure as LTE. |
| ZTE | Option 2  | Option 2 seems sufficient, and we understand this is based on the assumption that RAN4 will not introduce intra-band NR-DC band combination (cross MCG and SCG) in the future, correct? |
| Samsung | Option1/2 | We prefer the granularity of either band entry or frequency band. However, we are fine to ask RAN4's view on all 3 options. |

## Sync vs Async

There seem to be three possible ways to signal cell grouping for sync NR-DC and async NR-DC.

* **Option 1:** Single Bit-String applicable to both sync and async (if *asyncNRDC-r16* is supported)
* **Option 2:** Two independent Bit-String for sync and async

Some concerns were raised for signaling overhead associated with option 2. Option 1 may result in under-reporting of UE capability because the UE must signal “common” capability between sync and async.

**Question 2:** Companies are requested to provide their preference.

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| **Company name** | **Option 1 / Option 2** | **Comments** |
| Apple | Option 2 | Here as well, we do not see option 1 as a second choice due to fundamentally different RF/front-end impact from asynchronous operation compared to synchronous operation. The UE would have to heavily under-report if using just one bit string. But having the option of indicating that same capability can be re-used for the other is one way of reducing the signaling size.  |
| MediaTek | Option 2 (with signaling optimization) | It doesn’t make too much sense to force same cell grouping for both sync and async DC, which may result in downgrade of sync NR-DC cell group capability. However, some optimization to reduce sync NR-DC cell group could be considered. As discussed online, we could have one bit to indicate that sync NR-DC supports same cell grouping as async NR-DC. (But still allow UE to report different bit string if necessary). |
| Nokia | Option 2 | Like Apple indicated with single bit indication it would seem that UE would underreport quite a bit its capability for synchronous DC case. So probably best would be to have similar signaling for async and sync DC cases. |
| Huawei, HiSilicon | Option 2 (with signaling optimization) | From signaling point of view, independent cell grouping capability reporting should be allowed for async and sync cases. And as APPLE and MTK commented, there could be 1 bit indicating if the same cell grouping capability supported for both cases to reduce signaling overhead. |
| Ericsson | Option 1 | Same as for LTE, our understanding is that a UE indicating support for asyncNRDC for a band combination supports also synchronous operation for that band combination. Thus, all fields, feature sets etc reported for that band combination applies to both synchronous and asynchronous NR-DC operation. The same principle should apply also to supportedCellGrouping, thus only one field is needed. |
| vivo | Option 2 | Agree with Apple and MTK. |
| ZTE | Option 2 | We think using separate signalling can provide more flexibility, and further optimization can be considered, e.g. allow UE to inform NW that the same capability is applied for both cases. However, we think it is not necessary to have an explicit bit for this. Based on the agreement:* For a Rel-16 UE supporting only synchronous NR-DC, absence of possible future cell grouping indication means that it only supports FR1-FR2 NR-DC (with MCG in FR1 and SCG in FR2).

If UE only supports sync NR-DC, then the absence of sync NR-DC cell grouping cap means the UE can only support FR1-FR2 NR-DC. But for UE supports both sync NR-DC and async NR-DC, we can simply clarify: the absence of sync NR-DC cell grouping capability means the UE supports the same grouping as indicated in async NR-DC cell grouping capability. If the UE has different bitmap for sync NR-DC in this case, then the UE can send the syncNR-DC bitmap independently.  |
| Samsung | Option 2 | We also agree with Apple and MTK. Basically, two independent cell grouping are needed for sync and async. In addition, an additional 1 bit can be used to indicate the same cell grouping for sync and async. |

## MCG vs SCG

RAN2 agreed in #111e meeting that MCG and SCG can be differentiated in cell grouping signaling (provided that we can finally agree on a signaling solution). Together with the agreement in #113e meeting “bitmap limited to same size as in LTE”, rapporteur’s understanding is that the length of Bit-String can be extended while the size of bitmap is maintained as follows (extension highlight in green). Value ‘0’ in the bitmap indicates MCG and value ‘1’ indicates SCG.

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| --- | --- | --- | --- |
| **Nr of Band Entries or Frequency Band:** | 5 | 4 | 3 |
| **Length of Bit-String:** | 30 | 14 | 6 |
| **Bit String Position** | **Cell grouping option (0= MCG, 1= SCG)** |
| 1 | 00001 | 0001 | 001 |
| 2 | 00010 | 0010 | 010 |
| 3 | 00011 | 0011 | 011 |
| 4 | 00100 | 0100 | 100 |
| 5 | 00101 | 0101 | 101 |
| 6 | 00110 | 0110 | 110 |
| 7 | 00111 | 0111 |  |
| 8 | 01000 | 1000 |  |
| 9 | 01001 | 1001 |  |
| 10 | 01010 | 1010 |  |
| 11 | 01011 | 1011 |  |
| 12 | 01100 | 1100 |  |
| 13 | 01101 | 1101 |  |
| 14 | 01110 | 1110 |  |
| 15 | 01111 |  |  |
| 16 | 10000 |  |  |
| 17 | 10001 |  |  |
| 18 | 10010 |  |  |
| 19 | 10011 |  |  |
| 20 | 10100 |  |  |
| 21 | 10101 |  |  |
| 22 | 10110 |  |  |
| 23 | 10111 |  |  |
| 24 | 11000 |  |  |
| 25 | 11001 |  |  |
| 26 | 11010 |  |  |
| 27 | 11011 |  |  |
| 28 | 11100 |  |  |
| 29 | 11101 |  |  |
| 30 | 11110 |  |  |

**Question 3:** Companies are requested to comment if they agree to rapporteur’s observation above.

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| --- | --- | --- |
| **Company name** | **Agree / Disagree** | **Comments** |
| Apple | Agree |  |
| MediaTek | Agree |  |
| Nokia | Agree (partly) | But it is not definite to say this at this point as we are still discussing what actual bit string position would refer to – would it be entry in band combination or something else.  |
| Huawei, HiSilicon | Agree |  |
| Ericsson | Agree | This means the effective signaling overhead of cell group signaling is double that of LTE-DC, caused by the previous agreement to explicitly indicate MCG/SCG. We still don’t see the need to differentiate MCG and SCG in the cell group signaling field. For the FR2 concerns, there is already the *pCell-FR2* capability to indicate whether PCell in FR2 is supported. If the UE supports FR2 PCell, it should also support FR2 MCG SCell? But even if we don’t see the need, we will not insist to revert the decision. |
| vivo | Agree |  |
| ZTE | Agree |  |
| Samsung | Agree |  |

# Conclusion

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# Reference

[1]