3GPP TSG-RAN WG2 #114 Tdoc R2-21xxxxx

Electronic meeting, May 19th – 27th, 2021

Agenda Item: 6.5.2

Source: Ericsson (rapporteur)

Title: [AT114-e][221][DCCA] Cell grouping CR

Document for: Discussion, Decision

# 1 Introduction

This document is to kick off the following email discussion:

* [AT114-e][221][DCCA] Cell grouping CR (Ericsson)

Scope:

* + - Discuss CRs for R16 NR-DC cell grouping based on online agreements.

Intended outcome:

* + - Discussion summary in [R2-2106493](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_114-e/Docs/R2-2106493.zip) (by email rapporteur).
    - Agreeable CRs. Intermediate status of discussion will be checked during 2nd week Monday session.

Deadline for providing comments, for rapporteur inputs, conclusions and CR finalization:

* + - Deadline for CR finalization: 2nd week Wed, UTC 1000

In the online session Wednesday 1st week, the following was agreed:

* Work offline to provide CRs for the NW-filtering solution.
* Email discussion [221] (Ericsson)
* Checkpoint Monday 2nd week. If several possibilities, can have show of hands to see which direction has most support.

This discussion document is to gather comments from participating companies on the CRs for introducing cell grouping for NR-DC.

# 2 Discussion

To make it easier to find the correct contact delegate in each company for potential follow-up questions, the rapporteur encourages the delegates who provide input to provide their contact information in this table:

|  |  |
| --- | --- |
| Company | Delegate contact |

|  |  |
| --- | --- |
| Ericsson | stefan.wager@ericsson.com |
| Qualcomm Incorporated (Masato) | mkitazoe@qti.qualcomm.com |
| Apple Inc | naveen.palle@apple.com |
| MediaTek | Chun-fan.tsai@mediatek.com |
| Nokia | Jarkko.t.koskela@nokia.com |
| Convida | sunell.kai-erik@convidawireless.com |
| Intel | Youn.hyoung.heo@intel.com |
| Huawei, HiSilicon | wangrui@huawei.com |
| SoftBank | katsunari.uemura@g.softbank.co.jp |
| ZTE | liu.jing30@zte.com.cn |

Companies are requested to add their comments for each of the treated CRs of this email discussion in the boxes below.

## 2.1 Network based cell group filtering

Network based cell group filtering is described in:

[R2-2106017](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_114-e/Docs/R2-2106017.zip) Cell grouping for NR-DC Ericsson discussion LTE\_NR\_DC\_CA\_enh-Core

Based on the text proposal in Annex A, draft CRs for 38.331 and 38.306 introducing cell group filtering have been created and uploaded to the drafts folder (link).

### 2.1.1 General questions and comments

Companies are requested to provide their questions and comments on the CRs in the table below. Detailed comments can also be provided in the CRs themselves, if more feasible.

|  |  |
| --- | --- |
| Company | Questions/Comments |
| Qualcomm Incorporated | We should clarify the behaviour when requestedCellGrouping is not included in UE Capability Enquiry. The UE should report only FR1-FR2 NR-DC in that case.  [Ericsson] Agree, this is same as for legacy behaviour. We can clarify in the field description of requestedCellGrouping that ”If this field is absent, UE shall only inlude band combinations for which it supports NR-DC with only FR1 bands in MCG and only FR2 bands in SCG.” |
| Apple Inc | Agree with Qualcomm’s comments. We do not want UE implementations to handle the high/flexible cell-grouping combinations for the case where the NW does not provide the cell grouping filtering. The UE would assume that NW supports only FR1-MCG and FR2-SCG DC.  [Ericsson] Agree, see above.  [Apple2] Thanks for confirming. This is important from UE perspective to reduce signalling burden. We would like to make progress to try and come up with a filtering solution and conclude this in this meeting. Pls see some responses/comments further below.  In addition, we have some more comments:  In the proposed CR example, MCG=[n1, n7, n41, n66] and SCG=[n78, n261], we wonder on the NW flexibility or practical deployment options keeping in mind the future extensions. We can always have a DC combination just with n1, n7, n41 and n66. Does this mean that NW does not support this? We are also not sure if NWs have deployments where certain bands are always not considered as PCells ( n78/n261 in this case). What if the NW intends to support PCell on every band? What would be put into SCG group?  [Ericsson] From a network perspective, we believe just a few cell groupings will be sufficient to cover the different NR-DC deployments. Remember that NR-DC is for inter site deployments with relaxed backhaul. For co-sited deployments, CA can be used. So for n1, n7, n41, n66, those could all be co-located and use CA. Alternatively, n41 and n66 may be colocated with n261 and in that case a separate CellGrouping with MCG [n1, n7] and SCG [n41, n66, n261] could be added. But we do not expect a lot of different cell groupings inside one network. Note that the UE does not have to support all the bands listed in requestedCellGrouping. So looking at our example 1, the UE can report a BC with e.g. [n1, n7, n78], meaning that for that BC it supports MCG [n1, n7] and SCG [n78]. Also note that the cell grouping for NR-DC does not affect PCell placement for CA users.  [Apple2] If the NW provides MCG=[n1, n7, n41, n66] and SCG=[n78, n261] and MCG=[n1, n7] and SCG=[n41, n66, n261], then from UE perspective, combining different MCG/SCG pairs can defeat the purpose of filtering, as it is essentially the same as NW providing bands n1,n7,n41,n66,n261 and asking UE to come-up with DC groupings. If we are to make better use of this, the number of MCG/SCG grouping should be short (4 or less). We tend to agree with Ericsson’s comment that a few cell-groupings will be sufficient from NW perspective in terms of deployment. Can NWs cover their deployment with 4 pairs? We also need to bring in sync/async deployment info in this. Pls see below for more comments on this.  Also, can NW have the same band in both MCG and SCG..(we assume for the future intra-band DC case). In which case, the savings would be diminished.  [Ericsson] In Wednesday session we concluded cell grouping is only needed for inter-band NR-DC. If needed in future, separate capability could be added, so it may not affect this.  [Apple2] It is our view (talking to our RAN4) that intra-band NR-DC is not practical and we are ok to come back to this in future. But honestly, any additions to the current NW filtering based cell-grouping (if agreed) for intra-band could complicate things, and we hope we never get to discussing this.  Also, in the above example, how should the UE assume about the support of sync/async on the provided filtering bands..? Should the UE reports both async and sync DC, even when the NW can only support one of async/sync (it is our view that NW has deployed a config of timing across/within bands, and it cannot change the timing for different UEs). So it would be very useful to provide this info.  [Ericsson] For sync/async, the UE can use legacy *asyncNRDC-r16* capability to indicate whether it supports sync or async operation per BC. If the NW uses requestedCellGrouping filter to ask for certain (list of) cell grouping(s), the UE indicates in a BC which Cell Groupings it supports for that BC. If the UE would support cell grouping #1 for “sync” and “async” but cell grouping #2 only with “sync”, it can include the BC twice. In one instance it would indicate cell grouping #1 and *asyncNRDC-r16*. In the other it includes cell grouping #2 but omits the “asyncNRDC-r16”. Then as you say network filtering could be added to request UE support for async NR-DC, but it is not directly dependent on the solution for cell grouping signalling.  [Apple2] Sorry, looks like there is a misunderstanding. Our intention is to have the NW inform about sync/async NW deployment, so that UE can choose the DC grouping capability separately for sync/async (as Ericsson commented above). Our proposal is as below:  maxCellGroupings-r16 ::= 4  [[  requestedCellGrouping-r16 SEQUENCE (SIZE (1..maxCellGroupings-r16)) OF CellGrouping-r16 OPTIONAL  ]]  }  CellGrouping-r16 :: SEQUENCE {  MCG SEQUENCE (SIZE (1..maxBands)) OF FreqBandIndicatorNR,  SCG SEQUENCE (SIZE (1..maxBands)) OF FreqBandIndicatorNR,  syncOperation ENUMERATED {true} OPTIONAL  }  For each of the MCG/SCG pairs, the NW informs if the MCG AND SCG carriers operate in sync DC or not. The default assumption is that MCG and SCG are async, and all carriers within a CG are atleast slot-sync. This way, the UE knows that certain carriers are being operated in sync NR-DC and can only provide the sync DC grouping for these.  In our example, we can see that if NW provides the below, then we can assume that carriers n1, n7, n41, n66, are all slot-sync atleast. And n78 and n261 are also slot-sync as well.  MCG=[n1, n7, n41, n66] and SCG=[n78, n261]  Now if n66 is also co-located with n261 such that NW provides the two below pairs of MCG/SCG  MCG=[n1, n7, n41, n66] and SCG=[n78, n261] and MCG=[n1, n7] and SCG=[n41, n66, n261]  can we assume that carriers n1, n7, n41, n66, n261 are all slot-sync atleast. And even n78 is synch with the rest of the carriers?  In our view, the NW usually has a big deployments of carriers which are in sync and which are asynch, usually two groups of sync. So 1 pair of MCG/SCG is enough where the UE can assume that MCG carriers and SCG carriers are async across CGs, and carriers within CG are in sync. The NW would have to repeat the MCG/SCG pairs to provide UE with sync DC groupings (hence the optional *syncOperation* IE with in each MCG/SCG pair.  Can we request views from companies on this?  If we understand correctly, the proposed CR allows NW to provide more than one such MCG/SCG grouping? If so, will the bands from each of the group will not overlap? If they do, how does the UE interpret the overlap? If the NW provide atleast some bands that are the samea cross the diff MCG/SCG sets, then we think that the saving might not be practical.  [Ericsson] Correct, network can provide a list of CellGroupings, e.g. CG#0, CG#1 and CG#2. The UE then echoes back for each BC where it supports NR-DC which cell grouping it supports out of CG#0, CG#1, CG#2. In this way, each cell grouping is treated separately, as it reflects an individual configuration of the UE, and in that way we don’t see the issue of having one particular band, e.g. n7, represented in several requested cell groupings. But maybe you can explain the concern?  It is our view that the future-proof signaling should be able to allow the NW to provide this filtering info for every capability enquiry message.  [Ericsson] Yes, if the network wants to setup NR-DC with FR1 in both MCG and SCG, it has to provide the requestedCellGrouping. Otherwise UE will report only FR1-FR2 NR-DC.  Maybe, instead of providing bands for MCG and SCG, NW can provide bands that operate with time-sync and bands without any time sync and UE can build DC combinations for sync/async based on this. This allows the flexibility on the NW to assign P(S)Cell to diff bands.  [Ericsson] I think for sync/async, it needs to be coupled to the MCG/SCG relation. It is difficult to say for a single band whether it is sync or async, in relation to what? What would improve the flexibility for the network to assign P(S)Cell to diff bands would be to make the cell grouping MCG/SCG agnostic, as we had it in LTE-DC signalling. I.e. the network provides two lists cellGroup1 and cellGroup2, and each could then be configured either as MCG or SCG. But then we need to revert the agreement made last year to make cell grouping MCG/SCG explicit.  [Apple2] Pls see our views on couping MCG/SCG with sync/async above. Hope we can compromise on this to progress.  We also have other UE reporting options that can reduce the signaling size if UE has relations between bands (if band X in a CG, band Y cannot be in the same CG, band A can only be in the same CG as band X), and this sort of signaling can avoid comprehensive signaling (if UE can signal such relation for applicable DC combinations, based on the bands). |
| MediaTek | The major issue to the size of *maxCellGroupings*, which actually provide another kind limitation on the number of bands in NR-DC. We will discuss more in next question.  [Ericsson] As we mentioned above, we expect only a few cell groupings will be needed per deployed network.  Several other comments.  <1> The UE behavior while the filter is not provided should be clarified. QC proposal is okay for us.  [Ericsson] Agree, see our comment to QC.  <2> The aspect on sync and async NR-DC is missing. We probably need more capability bit to indicate the NW that the UE support cell group #X with sync or async NR-DC operation (or both support).  [Ericsson] Yes, see our comment above to Apple.  <3> Does the “fallback” principle apply the requested cell group. Using example 1 - MCG=[n1, n7, n41, n66] and SCG=[n78, n261], does this implies that MCG=[n1, n7, n41, ~~n66~~] and SCG=[n78, n261] is supported (and requested) by the network ? In other words, Is the UE requested to report the cell grouping that result in removing one or more bands in MCG or SCG of this cell grouping?  [Ericsson] Yes, the UE does not have to support all the bands listed in requestedCellGrouping. So looking at our example 1, the UE can report a BC with e.g. [n1, n7, n78], meaning that for that BC it supports MCG [n1, n7] and SCG [n78].  <4> We assume that intra-band NR-DC is not within this scope. So, the bands in MCG will be different from the bands in SCG. (Otherwise, it would be super complicate)  [Ericsson] Agree |
| Nokia | 1. Qualcomm proposal on UE handling when filter is not provided is fine 2. Asynchronous and Synchronous DC handling needs to be handled as well. Either UE provides both async and sync capability “bitmap or list” or then NW needs to explicitly request which one is of its interest. We would be fine to report both async and sync separately by UE corresponding to bands in the request. 3. In case NW makes the request for cell group for multiple bands and if UE does not supports only sub combinations is UE assumed to report those combinations. We assume this should be the case i.e. basically NW indicates bands on MCG and bands on SCG which are “used in the NW” and then UE reports all the combinations – even those that do not include all the requested bands. 4. Then if UE reports MCG of n1,n7,n41,n61 and SCG n78,n261 – does this mean UE also supports MCG of n1,n7,n41 and SCG n78,n261?   Regarding intra-band NR-DC – We assume this does not need any solution. |
| Convida | *requestedCellGrouping-r16* is an optional extension and is missing a Need code. Our understanding is that the code should be N.  MCG and SCG are introduced as fields in the *CellGrouping-r16* information element but they should be defined with lower-case letters, i.e. *mcg* and *scg*. Otherwise, the ASN.1 syntax is not correct, and the code will not compile. The same correction should be done in the *requestedCellGrouping* field description.  TABS should be replaced with spaces in *supportedBandCombinationList-v16xy.*  Comments on formalities:  NR\_newRAT-Core is a Rel-15 work item but the CR is written towards Rel-16. TEI16 is a better work item code for this CR because Rel-16 CRs (other than Category A) cannot be included in Rel-15 work item CR packs for TSG RAN approval.  The CR category is B (on the cover sheet) but Rel-16 is already frozen and Category B is prohibited to frozen Releases. Are there any reasons why Category F (essential correction) cannot be used? |
| Intel | We wonder if one set of requestedCellGroupngs is efficient to different frequency deployment.  For example, there could be NR-DC based on [n1, n7, n41, n66, n78, n261]. In other network deployment, there could be NR-DC based on [n2, n3, n8, n78, n261]. It is assumed that UE capability enquiry should not be frequently triggered depending on the different deployment considering signaling overhead.  If we support different NR-DC configuration with one set of requestedCellGroupings, the bitmap size (or list) of supportedCellGrouping from UE side would be dramatically increased.  In that sense, 2-D structure of requestedCellGrouping would be more desirable i.e. a set of requestedCellGrouping per interested band combination. We also assume that the *supportedCellGrouping* is indicated per band combination. |
| Huawei, HiSilicon | We have the similar question/concern as Apple that if there is a limitation on the number of cell grouping options supported by network considering real deployment. In our understanding, this cell grouping UE capability is raised due to UE capability restriction, but from network side there should be no such restriction. For instance, if the gNB deploys multiple bands, it is possible that any band could be either in MCG or in SCG. In this case, if network assumes a UE may only support several cell grouping options, in order to obtain the UE capability then the network should request all options in the filter proposed here. This is quite similar with the current filter of interested band, and the UE anyway needs to indicate which options are supported one by one, then the UL signaling overhead is similar with LTE DC style approach, but adding more DL signaling overhead. |
| SoftBank | We don’t think intra-band NR-DC is precluded from the scope. It is a practical scenario and would be deployed in the future. When the NW indicates the same band for MCG and SCG, we assume the UE can report only if all possible combinations are supported or RAN4 will define/restrict the cell grouping within the indicated band to be supported by the UE.  For example, the NW indicates MCG [n3, n77], SCG [n77] and n77 has two non-contiguous bands (let’s say n77\_L and n77\_H). 1) The UE can report this combination only if both MCG [n3, n77\_L] + SCG [n77\_H] and MCG [n3, n77\_H] + SCG [n77\_L] are supported. 2) the UE can report if the UE supports the cell grouping defined by RAN4.  But if majority companies don’t like to introduce this at this moment, we are OK to postpone it and discuss later. However, if RAN2 goes to the NW filtering, it is good to use it as a baseline for intra-band NR-DC case because unified solution is anyway preferred. |
| ZTE | Besides the concern on the limitation of maximum number of cell grouping (expressed by other companies), we also have the following questions/comments:   1. From network(MN) perspective, how does MN know the band(s) deployed in SN nodes that may be used for SCG cells deployment? Does it rely on OAM? And whether it works for inter-vendor scenario? 2. As we commented online, the reported “*supportedCellGrouping*” is incomprehensible to target cell during handover procedure. So should we forward the “requestedCellGrouping” configuration to target cell during handover procedure? 3. It is not desirable to do capability enquiry every time when UE enters RRC\_Connected, so RAN will store UE’s radio capability in CN, and retrieves the stored capability from CN when UE transmits from RRC\_IDLE to RRC\_Connected. For this filtered NR-DC capability, if we want to make it work, the UE should also feedback the *requestedCellGrouping* to network when it reports UE capability. (same as sending “*appliedFreqBandListFilter*”), so it will cause additional signalling overhead. |

*Rapporteur summary: tbd.*

### 2.1.2 Size of *maxCellGroupings*

One open issue that needs to be solved is to decide a suitable value for *maxCellGroupings* in the CR, i.e. what should be the maximum number of cell groupings that the network can filter for. The size affects the size of *supportedCellGrouping*, which is signalled as part of UE capability for each supported band combination. The target should be to not exceed the overhead per BC created by the LTE-DC cell group signalling approach, for which the cap of 5 bands created a bitmap of max 30 bits. Note that

Companies are requested to provide their input on the size of *maxCellGroupings* in the table below.

|  |  |  |
| --- | --- | --- |
| Company | Size | Motivation |
| Ericsson | 4 or 8 | Given that the UE does not need to support all bands in *requestedCellGroupngs,* we expect not many cell groupings will be needed. We added some examples in the field description to illustrate this. Mostly a single cell grouping should be sufficient, but the list could have max size of 4 or 8. |
| Qualcomm Incorporated |  | It is indeed important we have good visibility on the value of ” maxCellGroupings-r16”. This essentially tells if the network filtering scheme is more efficient than explicit signalling of Cell Grouping combinations by the UE.  We would like to rely on network vendors and operators on the exact value. But the principle should be that it is advisable that network includes Cell Grouping combinations used in the entire operators network rather than Cell Grouping used in the gNB. |
| Apple |  | Pls see our comments to Q2.1.1 |
| MediaTek |  | We are not sure if small number of cell groups does work as it will translate to deployment limitation. This is just another kind of 5-band limitation.  For a **single** band combination with 6 bands (e.g. {n1, n7, n41, n66, n78, n261}), there is 62 possible way of grouping. Example 1 is just one of them. And we have much more combinations from other BC with 6 bands, or with 7 bands, etc. In theory, the size *maxCellGroupings* could be large. But large number implies that the capability size does not really reduced.  [Ericsson] Yes, in theory the number of cellGroupings can be very large, but in practice we expect it to be quite limited. See our comments above in 2.1.1. Also, as explained above the UE does not have to support all the bands listed in requestedCellGrouping. This means that the network does not have to provide explicit filters for all band combinations, but can include many bands within each cell group, which can map to several band combinations reported by the UE.  It could only work if operator/network vendors confirm that extremely few combinations will be used in the field. |
| Nokia |  | We agree with Qualcomm comment cell grouping combinations needs to support all the reasonable groupings used in the NW – If we would only consider one cell grouping requirement then handover handling would be cumbersome as NW would always need to fallback to least capability approach.  Taking this into account It seems very unlikely that a operator will use many different band combinations within a reasonable area – country/state i.e. within coverage of operator requiring no roaming is very likely to only possess very limited set of combinations. |
| Intel | (2 or 4 or 8)xN | As we commented to Q2.1.1, one set of CellGrouping would not be desirable and 2-D structure is more preferred.  We should also discuss how many band combinations (i.e. “N”) is suitable to avoid frequent update of UE capability signaling based on different frequency deployment. We tend to agree with Nokia on that it is unlikely to use many different band combinations. However, it is hard to decide the exact number as signaling should be more future proof. |
| Huawei, HiSilicon |  | We still think from signaling point of view, it should allow network request the capability of any cell grouping if there is no restriction on network deployment. Otherwise, if network supports all options, but can only request some of them, then it may mismatch the real supported options of the UE. |
| SoftBank |  | Agree with Huawei. |
| ZTE |  | Smaller value will cause frequent capability enquiry, so larger value should be pursued. But we agree with others, it is hard to decide an exact number right now and the signalling should be more future proof. |

*Rapporteur summary: tbd.*

### 2.1.3 *supportedCellGrouping* as list or bitmap

Another open issue may be whether *supportedCellGrouping* should be encoded as list or bitmap in ASN.1. In the current draft CR it is encoded as list, which means the size will be variable depending on the number of *requestedCellGroupings* supported by the UE:

CA-ParametersNRDC-v16xy ::= SEQUENCE {

supportedCellGrouping SEQUENCE (SIZE (1..maxCellGroupings)) OF INTEGER(0..maxCellGroupings-1) OPTIONAL

Alternatively, it could be encoded as a bitmap, where each bit position points to a certain entry in the *requestedCellGroupings* list, e.g.:

CA-ParametersNRDC-v16xy ::= SEQUENCE {

supportedCellGrouping BIT STRING (SIZE(maxCellGroupings)) OPTIONAL

The benefit with the bitmap format is the more compact size through the bitmap representation, but the drawback it that the size is constant, i.e. it is the same regardless of the number of *requestedCellGroupings* provided by the network. Assuming though that network and UE vendors are aligned in what cell groupings that are supported, it can be expected that the UE normally supports all (or at least most of) requestedCellGroupings, and then bitmap could be more efficient.

Companies are requested to provide their input on the encoding of supportedCellGrouping in the table below.

|  |  |  |
| --- | --- | --- |
| Company | List or bitmap | Motivation |
| Ericsson | bitmap? | We originally had the list, but assuming UEs support all or most of cell groupings requested by the network the bitmap may be more efficient. |
| Qualcomm Incorporated |  | Depends on the value of maxCellGroupings-r16. Bitmap looks fine if it is in the range of 10 combinations. |
| Apple | Depends | we think this can be resolved once the open items are addressed in Q2.1.1. |
| MediaTek | Depends | We should design the size of *supportedCellGrouping* first. |
| Nokia | Both will work | No strong view – both approaches will work. Based on earlier questions probably resolvement this question is easy to answer once we know *supportedCellGrouping* size. |
| Convida | There is no difference between lists and bitmaps | It does not make any difference with respect to efficiency if it is defined as a list or bitmap. If the list has always the same size, SIZE can also be defined to be fixed where the list size is inferred from the syntax. Hence, the following encoding should be as compact as a bitmap, i.e.  CA-ParametersNRDC-v16xy ::= SEQUENCE {  supportedCellGrouping SEQUENCE (SIZE (~~1..~~maxCellGroupings)) OF INTEGER(0..maxCellGroupings-1) OPTIONAL  because   * SIZE (maxCellGroupings) is encoded with 0 bits and * INTEGER (0..maxCellGroupings-1) has the same number of code points and the same encoding size as BIT STRING (SIZE(maxCellGroupings)).   So, the key question is if the list size needs to be defined as a value range or fixed value.  We have a slight preference for a list definition because it is more human readable than a bitmap. |
| Intel | No strong preference | If the maxCellGroupings per BC is limited to 2-4, either BIMAP or list can be working. |
| Huawei, HiSilicon | Depends | No big difference. The former two issues are more critical. |
| SoftBank |  | There is no big difference. |
| ZTE | Depends | In fact, TS 38.331 has defined BIT STRING with variable length, see below example:  measurementSlots BIT STRING (SIZE (1..80)),  But this can be discussed after critical issues are solved. |

*Rapporteur summary: tbd.*

# Conclusion

Tbd