3GPP TSG-RAN WG2 #113-e R2-20xxxxx

Electronic Meeting, 25th Jan – 5th Feb 2021

Agenda Item: 6.8.x

Source: Ericsson (rapporteur)

Title: Summary of [Post112-e][255][R16 DCCA] Cell grouping for synchronous NR-DC

Document for: Discussion, Decision

# 1 Introduction

This document is to kick off the following email discussion:

* [Post112-e][255][R16 DCCA] Cell grouping for synchronous NR-DC (Ericsson)

 Scope: Discuss received RAN1 LS on cell grouping ([R2-2011118](https://www.3gpp.org/ftp/TSG_RAN/WG2_RL2/TSGR2_112-e/Docs/R2-2011118.zip)) and attempt to find agreeable way for signalling it for synchronous NR-DC. Can also take RAN4 agreements into account.

 Intended outcome: Email discussion report + agreeable CRs (if any)

 Deadline: Long

# 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 |
| MediaTek | Chun-fan.tsai@mediatek.com |
| Qualcomm Incorporated | mkitazoe@qti.qualcomm.com |
| Huawei, HiSilicon | wangrui46@huawei.com |
| CATT | erlin.zeng@catt.cn |
| Nokia | jarkko.t.koskela@nokia.com |
|  |  |

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

## 2.1 Background

In RAN2#111-e, the need for cell grouping in UE capability signalling for the case of synchronous NR-DC was discussed. It was discussed whether the UE would need to indicate per band combination which bands that could be configured in MCG and SCG respectively. The discussion could not be concluded, but the following agreement was made on the last day:

* [021] RAN2 intends to introduce a releasre-16 UE capability for sync-DC (can be 1 bit, cell grouping or else) in a future meeting. Absence of such UE capability parameter means the UE supports release-15 cell grouping only (i.e. FR1 MCG + FR2 SCG)

In addition, RAN2 sent an LS [1] to RAN1 and RAN4 to ask about the need for cell grouping for the case of synchronous NR-DC. In the LS, some of the views during the discussion were summarized as follows:

Some companies think it is not necessary for the following reasons.

* In LTE, cell grouping signaling is only defined for asynchronous DC, but not for synchronous DC.
* Synchronous NR-DC is almost the same as NR CA from the UE implementation perspective.
* Supported cell grouping will be limited by NR-DC band combinations defined by RAN4.

Some companies think it is necessary for the following reasons.

* NR supports FR2 (as a key difference from LTE)
	+ The UE may not support FR2 MCG and thus there might be need to indicate whether FR2 MCG is supported in NR-DC if RAN4 has such potential band combinations.
	+ The UE may not support FR1-FR2 CA and thus there might be need to differentiate whether it is a FR1-FR2 CA or a FR1-FR2 DC.
* The UE may not support inter-CG power sharing for a given frequency range.
* The UE may not support PUCCH group across serving cells with different numerologies.

## 2.2 Reply LS from RAN1

The response LS from RAN1 was received during RAN2#112-e and was briefly discussed already in [3], but no conclusions were made and decision was postponed to next meeting, to be discussed together with the LS from RAN4. In this section we continue the discussion on the RAN1 LS in order to understand the RAN1 agreements and the possible impact on cell grouping signalling for synchronous NR-DC.

The RAN1 LS [2] includes a set of new Rel-16 capabilities regarding PUCCH grouping support. RAN1 indicates that the framework of PUCCH grouping capability could possibly be used also for synchronous NR-DC, but that the decision is left for RAN2 to discuss.

The first cited agreement in the RAN1 LS [2] is for indicating the support of two PUCCH groups per BC for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}. The capability indicates per BC on which bands the primary and secondary PUCCH group can be mapped and also for each PUCCH group on which bands the PUCCH can be configured. This corresponds to FG 22-7 in the latest RAN1 UE feature list [4], copied below for easy reference.

As an example, let’s assume a BC with 8CCs such that cc1, cc2=15kHz FDD, cc3, cc4=30kHz licensed TDD and cc5, cc6, cc7, cc8=120kHz. With FG 22-7 the UE can e.g. indicate that it supports primary PUCCH group in {FR1 licensed TDD, FR1 licensed FDD}, meaning that the PUCCH group can span cc1, cc2, cc3 and cc4, but not cc5, cc6, cc7 or cc8. In addition, for PUCCH placement it could indicate {FR1 licensed FDD}, meaning that the PUCCH can only be configured in cc1 or cc2.

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| 22. NR Others | 22-7 | Support two PUCCH groups for NR-CA with 3 or more bands with at least two carrier types from carrier types {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} | For the BC, the UE reports one or multiple of supported configuration(s) of {primary PUCCH group config, secondary PUCCH group config} where for each supported configuration,* + the “primary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the primary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the primary PUCCH group
	+ the “secondary PUCCH group config” includes following information:
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} mapped to the secondary PUCCH group
		- One or multiple from {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} that can be configured with the PUCCH transmission in the secondary PUCCH group
	+ Note: for each {primary PUCCH group config, secondary PUCCH group config}, each carrier type of {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2} is mapped to either or both of the primary PUCCH group config and the secondary PUCCH group config.
 |  | Yes | N/A |  | Per BC | N/A | N/A  | N/A | Note: RAN1 will discuss on how to handle the SDL or SUL band, for example as below* SDL overlapping with either TDD or FDD can follow the same principle with TDD or FDD accordingly
* SDL having no overlapped TDD or FDD can follow the same principle with FDD

Note: When the carrier type of NUL is indicated for PUCCH transmission location, the SUL in the same cell as in the NUL can also be configured for PUCCH transmission* FFS: how to cover licensed/unlicensed and/or FR1/FR2 differentiations

Note: When the carrier type of NUL is indicated for one PUCCH group config, the SUL in the same cell as in the NUL can also be configured for the PUCCH groupFFS: SUL is counted as number of bands for the condition of this new FG reporting | Optional with capability signalling |

FG 22-7 is currently only defined for NR-CA and is not yet implemented in TS 38.331. There are still some FFS that need to be solved by RAN1 before implementation in TS 38.331. However, the RAN1 LS suggestion is that it could also serve as a potential solution for synchronous NR-DC cell grouping. Since exact implementation is not yet there, it is not possible at this point to make a detailed discussion of applicability for NR-DC, thus the first question is a general one on the framework.

***Question 1: Companies are requested to comment on whether and how the framework of 22-7 could also be used indicate MCG and SCG cell grouping for synchronous NR-DC.***

|  |  |
| --- | --- |
| Company | Comments |
| Ericsson | Currently 22-7 is defined for NR-CA only. If RAN2 concludes that there is a need to extend cell grouping support also for synchronous NR-DC, there seems to be two general approaches of extending this to NR-DC:1. Reuse the 22-7 field also for NR-DC. This is only applicable if there is a one to one mapping between the 2 PUCCH support on NR-CA and cell grouping for NR-DC. UE vendors need to comment, but this may not necessarily apply, e.g.
	1. A UE that indicates no support for 2 PUCCH groups for NR-CA, could anyway support NR-DC, in which 2 PUCCH is mandatory (one in MCG and one in SCG).
	2. A UE that indicates support for 2 PUCCH groups for NR-CA may not support the same grouping for NR-DC
2. Reuse the 22-7 framework, but add a new field for NR-DC case. This approach basically presents an alternative way to signal the cell grouping compared to what has been discussed so far for the asynchronous NR-DC case. In summary then, we have currently the following three options on the table for signalling cell grouping for NR-DC:
	1. LTE-DC style ([R2-2010593](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2010593.zip))
	2. Network filtering ([R2-2010029](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2010029.zip))
	3. Reuse PUCCH grouping framework ([R2-2011118](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2011118.zip))

Down selection among these will require among other careful overhead analysis of the different approaches, which will only be possible once 22-7 is implemented. This needs to await RAN1 conclusion of the FFSs. Then we can compare the three approaches for cell group signalling. |
| MediaTek | We understand that RAN1 discussed PUCCH group capability because, in LS [R2-2008662](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2008662.zip), RAN2 indicates that "*The UE may not support PUCCH group across serving cells with different numerologies*" is one of the reason to have synchronous NR-DC cell group capability. Strictly speaking, feature 22-7 is for PUCCH group in NR CA, not for NR-DC cell group. So, we don’t really think they are relevant. And we don’t want to bind PUCCH cell grouping capability with NR-DC cell group capability.However, RAN2 could discuss whether to use the same way of “grouping” in NR-DC cell group capability. Compared to LTE cell group capability, RAN1 provide another “granularity” for grouping – {FR1 licensed TDD, FR1 unlicensed TDD, FR1 licensed FDD, FR2}. We are open to discuss this alternative. |
| Qualcomm Incorporated | FG22-7 and the UE capability for NR-DC Cell Grouping should be independent, but the same framework can be used. |
| Huawei, HiSilicon | We prefer not to reuse CA capability 22-7 simply, since NR-DC cell grouping capability may not be the same as 2 PUCCH group for CA. And for the alternatives of signalling design on table now, we agree with Ericsson that more analysis and evaluation are needed, we can discuss this based on company contributions. |
| CATT | We are not sure if the signalling for PUCCH group can be reused. Further checking is needed.  |
| Nokia | Similar to the Rel-15 PUCCH grouping capabilities being independent of whether they were used for CA or for DC, these new capabilities that were originally motivated by CA deployment cases should be applicable as-is also for sync-DC. One could either duplicate the capability to separate CA and DC PUCCH group support, or follow the Rel-15 approach where the PUCCH group support works for both CA and sync DC if the UE supported both.The RAN1 FFS points should not have relation to the applicability to NR-DC |
| Apple | We share the same view as Qualcomm in that they are independent but can use the same framework. |

The second and third cited agreements in the RAN1 LS cover similar PUCCH mapping support for NR-CA BC with up to three or four numerologies respectively, where the UE is not configured with two PUCCH groups. This corresponds to FG 22-6 and 22-6a in the latest RAN1 UE feature list [4]. Rapporteur considers that these FGs are not relevant for NR-DC, because of the limitation to one PUCCH group.

***Question 2: Do companies think 22-6 and 22-6a are relevant for synchronous NR-DC? If yes, please explain why and how they could be used.***

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Ericsson | No | UE in NR-DC has to be configured with 2 PUCCH, one in MCG and one in SCG. |
| MediaTek | No | See also our comment in Q1. The PUCCH group capability feature 22-6, 22-6a, 22-7 are not relevant to NR-DC. There is no need to bind them together. |
| Qualcomm Incorporated | No |  |
| Huawei, HiSilicon | No | We understand 22-6 and 22-6a is CA capability, not necessarily related to NR-DC UE capability. Whether the CA capability is applicable to both MCG and SCG in NR-DC, could be discussed later if needed. |
| CATT | No |  |
| Nokia | It depends | As the capabilities are for 1 PUCCH group they do not apply directly to the DC cases. However, if the UE also indicated support for 2 PUCCH groups e.g. with 22.-7 one may need to clarify the relation. It would in principle be possible in this case that one or both PUCCH group would include carriers of three different types, and there maybe a need to clarify the interpretation of 22-6/6a if UE supports 2 PUCCH groups. |
| Apple | No | But we acknowledge Nokia’s views and a clarification would be needed. |

## 2.3 Reply LS from RAN4

The response LS from RAN4 was not received during RAN2#112-e and was therefore left out from the scope of this email discussion. Rapporteur did not find any relevant agreements for this discussion among the RAN4 meeting notes.

## 2.4 Cell grouping signalling

In this section we discuss additional aspects on top of the PUCCH grouping discussed in section 2.2, that have been raised so far regarding cell grouping signalling for synchronous NR-DC.

### 2.4.1 Legacy FR1-FR2 NR-DC support

One concern is that it shall be possible for a UE supporting the Rel-15 legacy NR-DC cell grouping with all MCG bands in FR1 and all SCG bands in FR2 to operate in a Rel-16 network. This concern lead to the below agreement in RAN2#111e:

* [021] RAN2 intends to introduce a releasre-16 UE capability for sync-DC (can be 1 bit, cell grouping or else) in a future meeting. Absence of such UE capability parameter means the UE supports release-15 cell grouping only (i.e. FR1 MCG + FR2 SCG)

Following the agreement, the highlighted text below was introduced in the description of *ca-ParametersNRDC*, used to indicate the UE supporting NR-DC.

| ***ca-ParametersNRDC***Indicates whether the UE supports NR-DC for the band combination. It contains the NR band combination parameters applicable across MCG and SCG. A UE indicating support for NR-DC shall support synchronous NR-DC configuration where all serving cells of the MCG are in FR1 and all serving cells of the SCG are in FR2. | BC | No | N/A | N/A |
| --- | --- | --- | --- | --- |

***Question 3: Do companies agree that the current description of ca-ParametersNRDC ensures that a UEs supporting only Rel-15 NR-DC cell grouping (all MCG bands in FR1 and all SCG bands in FR2) can operate in a Rel-16 network?***

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Ericsson | Yes |  |
| MediaTek |  | Current field description actually implies that only “*all serving cells of the MCG are in FR1 and all serving cells of the SCG are in FR2*” is supported in **both R15 and R16** UE for synchronous NR-DC operation. We need at least one more bit to indicate that UE supports more cell grouping for synchronous NR-DC operation. The agreement is not completely implemented in the SPEC. Since both R15 and R16 network support only one NR-DC cell grouping, we do not have issue for legacy UE in new network. Therefore, we do not understand the intention of this question. |
| Qualcomm Incorporated | Yes | This simply allows the release-16 UEs to have the same capability as release-15 UEs. So release-16 network can handle release-15 UEs and release-16 UEs in the same way.Further enhancement to address new release-16 NR-DC scenario can be further discussed as agreed in RAN2#111e. |
| Huawei, HiSilicon | Yes | Our understanding is the agreement means a R16 UE supporting NR-DC should at least support R15 cell grouping for sync NR-DC. On top of that, if the R16 UE supports more cell grouping cases, it can report a R16 UE capability of “a releasre-16 UE capability for sync-DC”.So the legacy NW can handle the R16 UE in the same way as R15 based on the R15 capability. And the R16 NW can configure based on R16 capability if reported by the UE. On the other hand, if a legacy UE supporting NR-DC accesses R16 NW, the UE can only reports the R15 UE capability, and the R16 NW understand the UE only supports sync NR-DC FR1+FR2 cell grouping. |
| CATT | Yes |  |
| Nokia | Yes | We see no issues. Although the added sentence could be interpreted to imply that UE cannot support FR1-FR1 DC. |
| Apple | Yes |  |

### 2.4.2 FR2 support

The following reasons were raised in the outgoing RAN2 LS [1] requiring cell grouping signalling for synchronous NR-DC:

* + The UE may not support FR2 MCG and thus there might be need to indicate whether FR2 MCG is supported in NR-DC if RAN4 has such potential band combinations.
	+ The UE may not support FR1-FR2 CA and thus there might be need to differentiate whether it is a FR1-FR2 CA or a FR1-FR2 DC.

Regarding the FR2 support, a first observation is that there is already the capability *pCell-FR2*, which indicates whether the UE supports PCell operation on FR2.

A second observation is that a UE supporting FR1-FR2 NR-DC, but not FR1-FR2 NR-CA for a FR1-FR2 BC can indicate this by indicating FSD0 for the FR2 bands of the BC in *ca-ParametersNR*. This was discussed in RAN2#109-e and the following was concluded:

NR-DC (from previous meeting)

[R2-2004436](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2/TSGR2_110-e/Docs/R2-2004436.zip) Signalling of NR-DC only band combination Qualcomm Incorporated discussion Rel-15 NR\_newRAT-Core

[021] DISCUSSION and DEC

- RAP half time: The offline discussion [023] seems to be converging towards the same direction

* [021] Half time: RAN2 confirms that the current UE capability signalling allows the UE to declare band combinations where NR-DC is supported, but NR CA is not supported.
* [021] Noted

***Question 4: Do companies agree the above observations solve the concerns of FR2 support?***

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Ericsson | Yes |  |
| MediaTek | Not all | First of all, *pCell-FR2* appears to be a Mandatory capability in R15, not sure it could solve this concern. Secondly, even with *pCell-FR2*. UE still cannot indicate whether FR2 could be MCG SCell or SCG SCell or both in a NR-DC BC.  |
| Qualcomm Incorporated | No | We understand pCell-FR2 was introduced for NR-CA in release-15. For NR-DC in release-15, it is clear from ca-ParametersNRDC that FR2 PCell (i.e. MCG) is not applicable. We do not think we can establish that pCell-FR2 can be reused for the purpose of release-16 NR-DC cell grouping.The concern on UE not supporting FR1-FR2 CA is about the fact that the UE supporting NR-DC where FR1 and FR2 bands are involved does not necessary support FR1-FR2 CA withing a Cell Group. |
| Huawei, HiSilicon | No | Instead, we think the R16 UE capability of *CarrierAggregationVariant* can/may already address this issue in NR-DC. |
| CATT | No |  |
| Nokia | Yes |  |
| Apple | No |  |

### 2.4.3 Inter-CG power sharing support

The following reason was raised in the outgoing RAN2 LS [1] requiring cell grouping signalling for synchronous NR-DC:

* The UE may not support inter-CG power sharing for a given frequency range.

RAN2 has defined the following capabilities for intra-FR power sharing:

| ***intraFR-NR-DC-PwrSharingMode1-r16***Indicates whether the UE supports intra-FR NR DC with semi-static power sharing mode1 between MCG and SCG cells of same frequency range as defined in TS 38.213 [11]. If this field is absent, the UE does not support intra-FR NR DC.  | BC | No | No | No |
| --- | --- | --- | --- | --- |
| ***intraFR-NR-DC-PwrSharingMode2-r16***Indicates whether the UE supports semi-static power sharing mode2 between MCG and SCG cells of same frequency range for synchronous intra-FR NR DC as defined in TS 38.213 [11]. The UE indicating the support of this also indicates the support of *intraFR-NR-DC-PwrSharingMode1-r16.* | BC | No | No | No |
| ***intraFR-NR-DC-DynamicPwrSharing-r16***Indicates the UE support of dynamic power sharing for intra-FR NR DC between MCG and SCG cells of same frequency range with long or short offset as specified in TS 38.213 [11]. The UE indicating the support of this also indicates the support of *intraFR-NR-DC-PwrSharingMode1-r16.* | BC | No | No | No |

UL power sharing between MCG and SCG is required for NR-DC configurations in which MCG and SCG contains bands of the same frequency range. Therefore, UE can indicate whether it supports such configurations by including or not including these capabilities for a BC. Absence of *intraFR-NR-DC-PwrSharingMode1-r16* indicates to the network that the UE does not support power sharing for a BC, and thus implicitly also that for this BC, the UE only supports a cell grouping where FR1 and FR2 bands are in separate cell groups.

***Question 5: Do companies agree the above observations solve the concern of inter-CG power sharing support?***

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Ericsson | Yes |  |
| MediaTek | Yes |  |
| Qualcomm Incorporated | Yes |  |
| Huawei, HiSilicon | Yes |  |
| CATT | Yes |  |
| Nokia | Yes |  |
| Apple | Yes |  |

### 2.4.3 Summary

Since the implementation of the PUCCH grouping capability is not yet completed, it may be a bit early to conclude on the need to introduce further fields to indicate cell grouping capabilities for synchronous NR-DC. In summary, companies are invited to raise any other aspects not raised in questions 1-5, affecting the cell grouping for synchronous NR-DC.

***Question 6: Companies are invited to raise possible other aspects affecting the cell grouping for synchronous NR-DC.***

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Ericsson | NA | The RAN1 LS did not provide input on whether cell grouping is needed or not for synchronous NR-DC. Before designing a solution for signalling the supported cell grouping for synchronous NR-DC, RAN2 needs to conclude on the necessity of this. |
| MediaTek |  | We would like check whether companies still want to wait the conclusion of **synchronous** NR-DC before introducing cell group capability for **asynchronous** NR-DC. Considering that it may not be easy to conclude the **synchronous** NR-DC case in the coming meeting, we prefer to have capability for **asynchronous** NR-DC first. The need for **asynchronous** NR-DC cell grouping has been concluded in both RAN1 and RAN2, it should be easier to define the ASN.1 details for **asynchronous** case. We believe that the proposal from [R2-2010593](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2010593.zip) is a good starting point.Rel-16 is going to be in maintenance phase. Postponing **asynchronous NR-DC** will result in ate ASN.1 change in Rel-16, which we would like to avoid if possible. |
| Qualcomm Incorporated |  | It is acceptable to discuss PUCCH grouping first based on the RAN1 feature list. RAN1 clearly indicated that the same can be used for NR-DC cell grouping. It is not a good idea to delay the discussion on release-16 NR-DC. It can delay the deployment of the feature. |
| Huawei, HiSilicon |  | We think it would be better to discuss cell grouping capability for sync case and async case together, to avoid possible misalignment or redundant signalling, which could be based on companies’ contributions in the next RAN2 meeting. |
| CATT |  | we can discuss the topic taking both R1/R4 input into account. |
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# Conclusion

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[Proposal 1 ffs.](#_Toc57738735)

#  References

1. [R2-2008662](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_111-e/Docs//R2-2008662.zip), LS on cell-grouping UE capability for synchronous NR-DC, Qualcomm

1. [R2-2011118](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2011118.zip), LS reply on cell-grouping UE capability for synchronous NR-DC, contact: Qualcomm

1. [R2-2010746](http://www.3gpp.org/ftp/tsg_ran/WG2_RL2//TSGR2_112-e/Docs//R2-2010746.zip), Summary of [AT112-e][227][DCCA] Remaining capability topics for DCCA, Ericsson

1. [R1-2009585](http://www.3gpp.org/ftp/tsg_ran/WG1_RL1//TSGR1_103-e/Docs//R1-2009585.zip), Updated RAN1 UE features list for Rel-16 NR, Moderators (AT&T, NTT DOCOMO, INC.)