**3GPP TSG-RAN WG2 Meeting #123 *R2-23xxxxx***

**Toulouse, France, 21st – 25th August 2023**

Agenda Item: 6.1.3.2

Source: Qualcomm Inc

Title: [Post123][044][NR17] independentGapConfig-maxCC (Qualcomm)

Document for: Discussion, Decision

# Introduction

During the meeting, we deliberated the necessity of amending the existing description of the parameters outlined within the independentGapConfig-maxCC feature. It was observed that the current description does not comprehensively address all potential scenarios. Although there was unanimous consensus among the attending companies regarding the need for modification, certain companies initially expressed reservations regarding the proposed alterations presented in Qualcomm CRs [1][2]. Subsequently, these apprehensive companies were reassured and came to an agreement after additional clarifications were provided. However, because we had reached the conclusion of the meeting, it became impractical to secure a consensus and finalize these CRs.

[Post123][044][NR17] independentGapConfig-maxCC (Qualcomm)

Scope: Continuation of offline 011, determine unclarities in current signaling if any, e.g. interpretation of parameters, and if applicable converge on solution, e.g. decide if new parameters are needed. Make CRs if applicable.

Intended outcome: Report, Agreeable CRs

Deadline: Long

Although it is a long discussion, please provide your feedback by the 15th of September, as CR may need to be prepared and shared with other companies.

# Discussion

## Contact information

|  |  |  |
| --- | --- | --- |
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## Issue Details

### DC cases:

In the current spec, this feature has 3 parameters defined. Each of these 3 paramter is independently configured by UE in 3 different containers to address the followign cases cases: NR-SA, NR-DC and MR-DC. Hence when UE reports the support of this feature, it will be provide **9 independent values** to the network.

Based on the current definition of these 3 parameters only NR-SA and NR-DC cases are considered:

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Description automatically generated

Nevertheless, the previously mentioned definition does not hold true in the context of MR-DC scenarios, such as EN-DC, (NG)EN-DC, and NE-DC. In MR-DC, not all of the serving cells are NR cells, as there are consistently EUTRA serving cells configured alongside them.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| UE Capability Container | UE capability fields | LTE serving cell counted? | NR FR1 serving cell counted? | NR FR1 serving cell counted? | Applicable scenario |
| NR SA | fr1-Only-r17 |  | YES |  | NR FR1 |
| fr2-Only-r17 |  |  | YES | NR FR2 |
| fr1-AndFR2-r17 |  | YES | YES | NR FR1+NR FR2 |
| NR-DC | fr1-Only-r17 |  | YES |  | NR FR1 |
| fr2-Only-r17 |  |  | YES | NR FR2 |
| fr1-AndFR2-r17 |  | YES | YES | NR FR1+NR FR2 |
| MR-DC | fr1-Only-r17 | YES | YES |  | LTE+NR FR1 |
| fr2-Only-r17 | YES |  | YES | LTE+NR FR2 |
| fr1-AndFR2-r17 | YES | YES | YES | LTE+NR FR1+NR FR2 |

### LTE SA case:

In the current capability description, we specified that if feature is supported, UE is capable of performing gapless measurements on NR FR2 cells while UE is in LTE SA.

Due to the recent introduction of the independentGapConfig-maxCC feature, where we have implemented a limit on the number of serving cells beyond which this feature is not supported in NR SA, NR-DC, and MR-DC scenarios, it is now imperative to extend this limitation to the LTE SA case as well. In other words, when the number of EUTRA serving cells exceeds a certain threshold, the UE is not anticipated to support gapless measurements to NR frequencies in the FR2 band. We have 2 options:

* Option-1: as suggested in our CR ([[1]](#_Reference), [[2]](#_In-sequence_SDU_delivery)), by introducing a new parameter “*eutra-Only-r17"* under the same capability, where it will be used exculsively to describe the number of EUTRA serving cell when UE is in LTE. This parmeter will only be valid or reported by the UE under “UE-MRDC-Capability”. The caveat of this approat is the need to dummify the exsiting capability and create a new one after introducing the additional parameter.

- *eutra-Only-r17* indicates the maximum number of configured serving cells when only E-UTRA serving cells are configured.

* Option-2: introduce a new separate capaibility, with one parameter “*eutra-Only-r17”* with similar descripton as above. If this capability is not supported by the UE, network should assume gap is required when performing measurements on NR FR2 frequencies (even when reporting the support of the independentGapConfig-maxCC). There are 2 flavors of this option:
  1. New capability to be introduced in the LTE spec.
  2. New capability to be introduced in the NR spec.

# Discussion

The suggested change per CR [1], is to modify the existing definition as provided in the current spec by introducing the part related to the **MR-DC** case as follow:

- *fr1-Only-r17* indicates the maximum number of configured serving cells when only FR1 serving cells are configured for NR SA and NR-DC or when only FR1 and E-UTRA serving cells are configured for EN-DC.

- *fr2-Only-r17* indicates the maximum number of configured serving cells when only FR2 serving cells are configured for NR SA and NR-DC or when only FR2 and E-UTRA serving cells are configured for EN-DC.

- *fr1-AndFR2-r17* indicates the maximum number of configured serving cells when both FR1 and FR2 serving cells are configured for NR SA and NR-DC or when both FR1, FR2 and E-UTRA serving cells are configured for EN-DC.

**Q1: Do companies agree with the suggested modification? If not, please provide an alternative in the comment section.**

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Qualcomm Inc | Yes |  |
| Ericsson | Yes |  |
| Nokia | No | As commented by several companies during [AT123][011] discussion, we do not see a good reason to include LTE under *fr2-Only-r17*. Considering LTE cells are more like FR1 cells than FR2, it seems odd to have a UE signal the *fr2-Only-r17* parameter for LTE+FR2 (NG)EN-DC/NE-DC scenarios, when we have clearly restricted that parameter to the FR2 only case for NR SA and NR-DC scenarios.  For the purposes of this capability, we think it is sufficient to include E-UTRA cells under FR1. If this is captured as a note in the capability description it should not create ambiguity:  ***independentGapConfig-maxCC-r17***  This field indicates whether the UE supports two independent measurement gap configurations for FR1 and FR2 as specified in clause 9.1.2 of TS 38.133 [5] while the number of configured serving cells is less than or equal to the indicated number.  The capability signaling includes the following parameters:  - *fr1-Only-r17* indicates the maximum number of configured serving cells when only FR1 serving cells are configured  - *fr2-Only-r17* indicates the maximum number of configured serving cells when only FR2 serving cells are configured  - *fr1-AndFR2-r17* indicates the maximum number of configured serving cells when both FR1 and FR2 serving cells are configured  The absence of the *fr1-Only-r17* or *fr2-Only-r17* field indicates that per-FR gap is not supported when only FR1 or FR2 serving cells are configured. Absence of the *fr1-AndFR2* field, indicates that per-FR-gap is not supported when both FR1 and FR2 serving cells are configured. Value "1" for *fr1-Only-r17* or *fr2-Only-r17* indicates support of the per-FR gap when only PCell is configured (no additional CC). Value "2" for *fr1-Only-r17* or *fr2-Only-r17* indicates support of the per-FR gap when PCell and 1 additional CC are configured, and so on. Value "1" or "2" for *fr1-AndFR2-r17* indicates the support of per-FR gap when PCell and "1" additional CC are configured.  UE indicating support of this feature shall not indicate support of *independentGapConfig*.  NOTE: For this capability, the term FR1 serving cell refers to an NR FR1 serving cell or an E-UTRA serving cell. |
| MediaTek | No | We think LTE cell should be considered as FR1, not FR2.  So to clarify how this *independentGapConfig-maxCC* is applied to MR-DC cases, we suggest below modification.  - *fr1-Only-r17* indicates the maximum number of configured serving cells when only FR1 serving cells are configured for NR SA and NR-DC or when only FR1 and E-UTRA serving cells are configured for EN-DC.  - *fr2-Only-r17* indicates the maximum number of configured serving cells when only FR2 serving cells are configured for NR SA and NR-DC.  - *fr1-AndFR2-r17* indicates the maximum number of configured serving cells when both FR1 and FR2 serving cells are configured for NR SA and NR-DC or when FR2 serving cells are configured for EN-DC.  [QC] the proposal above seems to lack very crucial information which may yield to a misalignment behavior between UE and network:   * When UE signals the *fr2-Only-r17* in the MR-DC container, what is the limit on the number of LTE serving cells for LTE+FR**2** EN-DC case? no limit? Any reason? given we’re already considering the LTE serving cells for the LTE+FR**1** EN-DC case (*fr1-Only-r17* in MR-DC container), why creating a discrepancy in the behavior? * When UE signals the *fr1-AndFR2-r17* in MR-DC container, what is the limit of the LTE and FR1 serving cells for the LTE+FR2+FR2 EN-DC case? No limit? Any reason? Given we’re already considering the NR FR1 serving cells for the same parameter (fr1-AndFR2-r17) in the NR-DC container, why excluding it from the MR-DC container? |
| Samsung | No | We understand that the benefit of adding LTE cell to fr2-Only-r17 provides finer granularity by differentiating LTE+FR1+FR2, LTE+FR2 and LTE+FR1.  If majority wants, we could change the general definition of fr2-Only-r17. But, it doesn’t seem to be essential because it doesn’t break the system. |
| ZTE | No | We still think it is better to keep consistency in different scenarios, i.e. LTE serving cell is considered as FR1 cell.  The modification from MediaTek looks good to us. |
| Huawei, HiSilicon | No | Similar view with MTK. |
| Apple | No | Similar view as MTK. |

**Rapporteur summary**

* **2 companies agreed on the suggested change per the discussion paper.**
* **6 companies did not support the change, instead they provided an alternative proposal (proposed by MediaTek), ~~however this proposal seems to be missing some key aspects (review QC response on MediaTek comment section)~~**
* **After further discussion of Option-3 (MediaTek proposal), it seems that both approaches (MediaTek & Qualcomm) are proposing almost the same behavior with one difference:**
  + **Nullifying the parameter “**fr2-Only-r17**” in the MR-DC container**
  + **Broadening the scope of the “**fr1-AndFR2-r17**” parameter in the MR-DC container to cover the missing case of the nullified “**fr2-Only-r17**” parameter.**

**Recommend further discussion in the next meeting.**

For the part related to the LTE SA, we have 2 options to select from in order to introduce a sub-capability (***eutra-only***) that indicates the max number of LTE serving cell beyond which inter-RAT gapless FR2 measurement is not supported by the UE.

**Q2: provide your preferred option used to specify the max number of LTE serving cells beyond which UE does not support the gapless measurements to NR FR2 cells?**

|  |  |  |
| --- | --- | --- |
| Company | Yes or No | Comments |
| Qualcomm Inc. | Option-2b | Between option-1 and option-2, we are fine either way, will go with the majority.  Between option-2a and option-2b, we are leaning more into option-2b for the following reasons:   * A precedent exists: the same original inter-RAT gap-less FR2 measurement capability (UE-MRDC-Capability🡪 MeasAndMobParametersMRDC🡪independentGapConfig) for LTE SA is already defined in MR-DC container.   [ZTE] This is because a single capability is reused to indicate two functions. If we split the functions, then things become different.   * it was acceptable to use MR-DC container because it is visible to eNB, given this capability is applicable only when the UE supports EN-DC.   [ZTE] So, an LTE UE without supporting EN-DC can never report this capability? E.g. the LTE UE supports gap-less measurement on FR2 for inter-RAT mobility.  [QC] yes if LTE UE without supporting EN-DC, UE can’t use the NR independentGapConfig-maxCC to indicated gapless on FR2 for inter-RAT mobility. There is other capability in LTE for the LTE UE to use to indicate the support of gapless IRAT measurements (including FR2 gapless).   * Defining ‘eutra-only’ in TS36.306 may make it difficult for readers to get full context on all the related UE capabilities. |
| Ericsson | Option-2b | We are also fine with either option 1 or 2, but we have some preference for option 2b for the reasons described by QC above. |
| Nokia | None | We do not see a strong reason to enhance the *independentGapConfig-maxCC* capability for the LTE SA scenario. As commented above, we think it is sufficient to clarify that LTE serving cells are treated as FR1 serving cells within the scope of the existing capability and parameters. Then the case where a UE is configured with LTE cells only is already covered by *independentGapConfig-maxCC* >> *fr1-Only-r17*.  However, if most companies wish to enhance this somehow, we are open to adding a new IE/capability to LTE or NR (Option 2). We are against ummifying the existing capability (Option 1). |
| MediaTek | See comment | We disagree the ummifying proposal in option 1.  We think there should be optional 3, which is reuse existing *fr1-Only-r17* also for LTE SA, which would be ok for us.  We are also fine to add a new capability for LTE SA. In this case, we prefer to have it in NR SPEC. More specifically, it should be in MR-DC container similar to the legacy one (without maximum CC limitation) in *UE-MRDC-Capability* > *MeasAndMobParametersMRDC* > *independentGapConfig*.  The name and the description for the new capability should be further discussed. But it should be clear it is about whether the UE supports FR2 inter-RAT measurement without gaps in LTE SA (i.e. not actually independent gap configuration). Furthermore, it should be mutually exclusive with legacy *independentGapConfig* capability to avoid confusion. The UE report this new capability shall not indicate support of legacy *independentGapConfig*. |
| Samsung | See comment | If we choose between option 1 and option 2 i.e. we go with adding a new UE capability, we prefer Option-2 especially option 2b.  However, we think that option 3 can also solve the issue on how to indicate inter-RAT capability. |
| ZTE | See comment | Although we prefer to introduce new capability in LTE capability container, if companies confirm this can only be reported when EN-DC is supported, then we can accept to define it in UE-MRDC-Capability.  But as commented before, if separate capability is defined, this capability is not related to independent gap, so it does not make sense to put it under existing *independentGapConfig-maxCC*. Especially when the UE only reports this capability.  We are also fine to reuse *independentGapConfig-maxCC* -> *fr1-Only-r17* for LTE SA. |
| Huawei, HiSilicon | Option-2b with comment | since this capability is only used if the network intend to add EN-DC, this IE is not related to pure LTE SA, it can be introduced in the NR spec, e.g. in MR-DC container. Then for which IE to be added, we are fine with reusing existing *fr1-Only-r17*. |
| Apple | See comment | First, we don’t think we should dummify the existing field. It’s a too drastic change.  We still hold the same opinion that we can rely on *fr1-Only-r17* to indicate the maximum CC number when UE is in LTE SA. There is no strong need to report a separate value for LTE only configuration as any way it is a rough number without considering the carrier bandwidth and MIMO layer configured to UE on each CC.  By the way, when RAN2 introduced the UE capability *independentGapConfig-maxCC*, the context was only in NR where the maximum CC bandwidth and MIMO layer are much higher than LTE CC. If companies think for LTE only CA configuration there is a need to indicate maximum CC number as well for inter-RAT gapless measurement on FR2 NR, we would like to consult RAN4 for confirmation. |

**Q3: if companies has other alternate solution, please provide it below?**

|  |  |
| --- | --- |
| Company | Alternate solution |
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|  |  |
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|  |  |
|  |  |

**Rapporteur summary**

**Majority of companies are open to support option-2b:**

* **2 companies strictly prefer option-2b**
* **5 companies prefer the usage of either:**
  + **Option-3 (newly suggested): The parameter fr1-Only-r17 (currently used for ~~NR SA~~MR-DC) to be also used for LTE SA, i.e., one value to cover both cases (NR SA and LTE SA).**

**OR**

* + **Open to support Option-2b**
* **1 company (Apple) supports option-3 above. Apple indicated that if separate capability to be introduced (i.e., Option-2b), RAN2 needs to consult with RAN4.**

# Conclusion

We have the following proposal:

[Proposal 1 xxxxxxx.](#_Toc143548235)

[Proposal 2 xxxxxxx.](#_Toc143548236)

[Proposal 3 xxxxxxx.](#_Toc143548237)

# Reference

[1] R2-2308826 Correction of the capability independentGapConfig-maxCC Qualcomm Incorporated, Ericsson CR Rel-17 38.306 17.5.0 0947 - F NR\_MG\_enh-Core

[2] R2-2308827 Correction of the capability independentGapConfig-maxCC Qualcomm Incorporated, Ericsson CR Rel-17 38.331 17.5.0 4290 - F NR\_MG\_enh-Core