**3GPP TSG-RAN WG4 Meeting #111 R4-2408939**

**Fukuoka, Japan, May 20 - 24, 2024**

**Agenda item:** 10.7.3

**Source:** Moderator **(**KDDI)

**Title:** Topic summary for [111][128] NonCol\_intraB\_ENDC\_NR\_CA

**Document for:** Information

# Introduction

This part includes contributions in agenda 5.2.7 of Rel-18 and 10.7 of Rel-19.

# Topic #1: Rel-18 Type-2

## CRs for 38.101-1

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| --- | --- | --- | --- |
| **T-doc** | **Company** | **Title/Comments** | **Recommendation** |
| R4-2407282  Rel-18  CAT-F: | Apple | (NonCol\_intraB\_ENDC\_NR\_CA-Core) On applicability of diversity characteristic  *Moderator’s note:*  *This CR is to clarify how the reuiqrment should be verified for UE with 4Rx antenna and CA type 2 UE.* |  |

## CRs for 38.101-3

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc** | **Company** | **Title/Comments** | **Recommendation** |
| R4-2407283  Rel-18  CAT-F: | Apple | (NonCol\_intraB\_ENDC\_NR\_CA-Core) On applicability of diversity characteristic  *Moderator’s note:*  *This CR is to clarify the following two points.*  *- For UE indicating capability interBandMRDC-WithOverlapDL-Bands-r16 and capable of nonCollocatedTypeMRDC-r18, it shall be vieried with both four Rx antenna ports and 2Rx antenna ports requirements.*  *- For UE indicating capability interBandMRDC-WithOverlapDL-Bands-r16 and not capable of nonCollocatedTypeMRDC-r18, it shall be vieried with 2Rx antenna ports requirements.* |  |
| R4-2408522  Rel-16  CAT-F: | Huawei, DOCOMO, KDDI, SoftBank, LGU Plus | (NonCol\_intraB\_ENDC\_NR\_CA-Core) CR 38.101-3 v16.19.0 Clarifications on RF requirement for non-collocated inter-band EN-DC with E-UTRA contiguous CCs  *Moderator’s note:*  *This CR is to extend Rx power imbalances to inter-band EN-DC band combinations with multiple contiguous E-UTRA CCs/band.* |  |
| R4-2408530  Rel-17  CAT-F: | Huawei, DOCOMO, KDDI, SoftBank, LGU Plus | *Moderator’s note: Not uploaded yet. Withdrawn?* |  |
| R4-2408531  Rel-17  CAT-F: | Huawei, DOCOMO, KDDI, SoftBank, LGU Plus | (NonCol\_intraB\_ENDC\_NR\_CA-Core) CR 38.101-3 v17.13.0 Clarifications on RF requirement for non-collocated inter-band EN-DC with E-UTRA contiguous CCs  *Moderator’s note:*  *This CR is to extend Rx power imbalances to inter-band EN-DC band combinations with multiple contiguous E-UTRA CCs/band.* |  |
| R4-2408532  Rel-18  CAT-F: | Huawei, DOCOMO, KDDI, SoftBank, LGU Plus | (NonCol\_intraB\_ENDC\_NR\_CA-Core) CR 38.101-3 v17.13.0 Clarifications on RF requirement for non-collocated inter-band EN-DC with E-UTRA contiguous CCs  *Moderator’s note:*  *This CR is to extend Rx power imbalances to inter-band EN-DC band combinations with multiple contiguous E-UTRA CCs/band.* |  |

# Topic #2: Rel-19 Type-4

## Sub-topic 2-1 : UE RF requirements for Type 4 EN-DC/NR-CA

### Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc#** | **Company** | **Proposals / Observations** |
| R4-2407276 | Apple | ***Proposal 1:*** No limitation on DL frequency separation is needed for type 4 UE.  ***Proposal 2:*** it is proposed to reuse the side condition on minimum frequency separation for type 4 UE as,   * Center of BWanother relative to edge of BWwanted is assumed to be at least 80MHz+BWanother/2 away from the edge of the wanted CC.   ***Proposal 3:*** 25dB power imbalance and 1dB REFSENS degradation can be reused for type 4 UE where the REFSENS is the one for 4R instead.  ***Proposal 4:*** It is proposed to include type 4 UE power imbalance requirement in the same table by adding a new note clarifying the applicable REFSENS for type 4 UE based on 4 Rx.  ***Proposal 5:*** The to-be-defined power imbalance requirement is applicable for type 4 UE operating in non-collocated scenario and conventional intra-band non-contiguous CA requirement for eight Rx is applicable for type 4 UE operating in collocated scenario.  ***Proposal 6:*** Clarification on requirement applicability should be added (by a note in Table 5.5A.2-1) for type 4 UE after signalling details are clear. |
| R4-2407393 | KDDI, LG Uplus | ***Observation 1:*** There are still needs from operators to deploy non-collocated EN-DC/NR-CA.  ***Observation 2:*** The working assumption of RP-240101 can be reused in RAN4.  ***Proposal 1:*** Reuse 25dB power imbalance requirements on Type 2 for Type 4a/4b  ***Proposal 2:*** Reuse other UE RF requirements except on Type 2 for Type 4a/4b |
| R4-2407454 | Murata | ***Observation 1****:* Type 4 UE with 25dB carrier imbalance allows 1.7dB more margin [- ΔRIB,4R.-1] than the Type 2 UE requirement when referencing to 2RX REFSENS.  ***Observation 2****:* Type 4 UE should use the 4RX REFSENS requirement for the same 25dB carrier imbalance as was used for the Type 2 UE unless sufficient justification for additional relaxation is provided.  ***Proposal 1:*** Use 25dB carrier imbalance for 4RX REFSENS + 1dB for Type 4 UE.  ***Proposal 2:*** The minimum DL frequency separation should be max (5/2\* BWanother, [50] MHz).  ***Proposal 3:*** No limit on the maximum DL frequency separation. |
| R4-2407626 | Samsung | ***Proposal 1:*** Same methodology and RF requirements for Type-2 EN-DC/NR-CA could be reused to Type-4a/b EN-DC/NR-CA.   1. Define in-band blocking requirements (25dB power imbalance, 1dB REFSENS relaxation) |
| R4-2407805 | Xiaomi | ***Observation 1:*** The UE RF requirements defined for type 2 UE can be used as baseline for type 4a/4b UEs.  ***Proposal 1:*** The power imbalance requirement for type 4a/4b UE is defined as 25dB.  ***Proposal 2:*** The REFSENSE requirement for type 4a/4b UEs is enhanced compared to type 2 UE, e.g., with 1dB relaxation. |
| R4-2408360 | ZTE | ***Proposal 1.*** To reuse 25dB power imbalance and 1dB REFSENS relaxation RF requirements of type 2 for type 4a/4b.  ***Proposal 2.*** The NOTE 4 in table 7.10A.2-1 should be updated to include type 4a/4b UE.  ***Proposal 3.*** Not to limit DL maximum frequency separation for type 4a/4b UE. |
| R4-2408718 | Nokia | < Issue 2-2-1: Power imbalance requirements and REFSENS >  Way Forward:   * Check 25dB power imbalance and 1dB REFSENS Relaxation and conclude them in the next meeting.   ***Nokia view:*** We support the WF of 25dB power imbalance and 1dB REFSENS Relaxation.  < Issue 2-2-2: How to capture the power imbalance and REFSENS requirements >  Way Forward:   * Continue further discussion in the next meeting.   ***Nokia view:*** For CA add new normative text under 7.10A.2 that refers to Table 7.10A.2-1. For EN-DC add new normative text under 7.10B.3 that refers to Table 7.10B.3-1.  < Issue 2-2-4: DL frequency separation >  Way Forward:   * Check and conclude the following requirement in the next meeting.   + No limitation on DL maximum frequency separation is needed for type 4 UE.   + For DL minimum frequency separation for type 2 and type 4 UE, 80MHz is used.   ***Nokia view:*** Agree the WF. |
| R4-2408821 | OPPO | ***Proposal 1:*** To use 80MHz and 600MHz as the minimum and maximum frequency separation in Rel-19. |
| R4-2408823 | OPPO | ***Observation 1:*** The 25dB power imbalance with 1 dB REFSENS degradation is based on two separate RF chains considering the same noise number of IBB1 and IBB2.  ***Observation 2:*** For type 4a/4b UE, the separate RX chains as including the AGC, antenna and filters apply.  ***Proposal 1:*** To reuse the 25dB imbalance with 1dB REFSESNE degradation requirement for type 4 UE.  ***Proposal 2:*** To reuse 7.10A.2-1 in TS 38.101-1, note 3 might need further refinement.  ***Proposal 3:*** The requirement description in subclause 7.10A.1 and 7.10A.2 needs to be updated considering the signalling design in Rel-19. |
| R4-2408852 | Qualcomm | ***Proposal 1****:* Use REFSENS + 1 dB for Wanted Carrier, and 25 dB Imbalance between Carriers for Type 4 UE’s  ***Proposal 2****:* Capture Type 4 RF requirements in Table 7.10A.2-1  ***Proposal 3****:* 80MHz separation between Carriers holds in both Type 2 and Type 3. No Maximum DL frequency separation. |
| R4-2409060 | Ericsson | ***Observation 1:*** For baseline approved specifications we have agreed a power imbalance of 25 dB for UE Type 2.  ***Observation 2:*** Type 4a and 4b UE architectures we have no LNA sharing, similar to the type 2 architecture.  ***Proposal 1:*** RF power imbalance requirements for NRCA and ENDC is 25 dB.  ***Observation 3:*** existing specification already have a 4 RX REFSENS based on 2 RX REFSENS table and an additive modification term ΔRIB,4R.  ***Proposal 2:*** Use existing 4 RX REFSENS as a specification of REFSENS for Type 4. |
| R4-2409112 | Huawei | ***Proposal 1:*** consider the requirement updates for TS 38.101-1 and TS 38.101-3 as given in section 2.1.  ***Proposal 2:*** For type 4 UE, no minimum or maximum DL separation is needed to be specified in RAN4. |

### Open issues summary

*Sub-topic description:*

R4-2407276(Apple), R4-2407393(KDDI/LG Uplus), R4-2407626(Samsung), R4-2408360(ZTE), R4-2408718(Nokia), R4-2408823(OPPO), R4-2408852(Qualcomm) and R4-2409112(Huawei) propose to reuse 25dB power imbalance and 1dB REFSENS Relaxation of Type 2 for Type 4a/4b. And then, R4-2407454(Murata) proposes to use 25dB carrier imbalance for 4RX REFSENS + 1dB for Type 4 UE and also R4-2409060(Ericsson) proposes to reuse 25dB power imbalance, and also use existing 4 RX REFSENS as a specification of REFSENS for Type 4.

On the other hand, R4-2407805(Xiaomi) proposes to use 25dB power imbalance but also the REFSENSE is enhanced compared to type 2 UE, e.g., with 1dB relaxation.

*Open issues and candidate options before e-meeting:*

**Issue 2-1-1: Power imbalance requirements and REFSENS**

* Proposals
  + Option 1: (Apple/KDDI/Samsung/ZTE/Nokia/OPPO/Qualcomm/Huawei)

To reuse 25dB power imbalance and 1dB REFSENS Relaxation RF requirements of Type 2 for Type 4a/4b.

* + Option 2: (Murata)

Use 25dB carrier imbalance for 4RX REFSENS + 1dB for Type 4 UE.

* + Option 3: (Ericsson)

To reuse 25dB power imbalance, and also use existing 4 RX REFSENS as a specification of REFSENS for Type 4.

* + Option 4: (Xiaomi)

To reuse 25dB power imbalance, and also the REFSENSE requirement for Type 4a/4b UEs is enhanced compared to Type 2 UE, e.g., with 1dB relaxation.

* Recommended WF
  + Considering Type 4, proposals of Murata and Ericsson would be more precise
  + Moderator’s proposal is as follows.

Use 25dB power imbalance for 4Rx REFSENS + 1dB for Type 4.

Nokia: OK. What does it mean ”considering Type 4...” ?

Agreement:

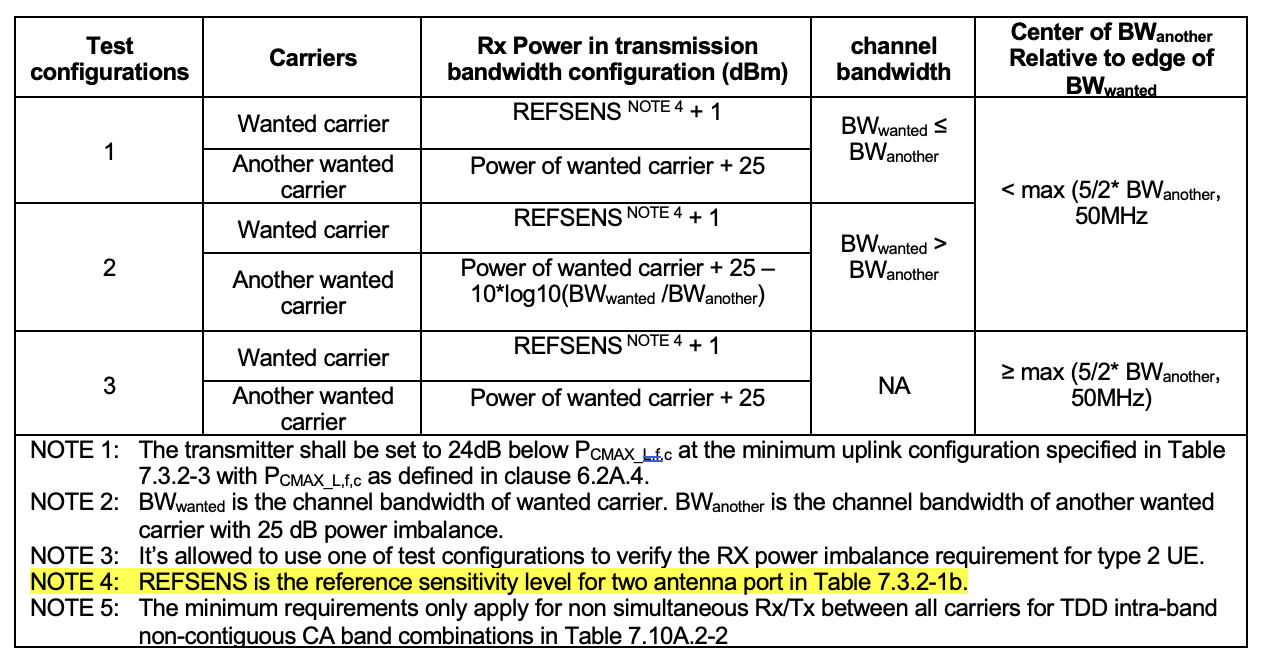
* Use 25dB power imbalance for 4Rx REFSENS + 1dB for Type 4

**Issue 2-1-2: How to capture the power imbalance and REFSENS requirements**

* Proposals
  + Option 1: (Apple/ZTE/Murata)

To include Type 4 UE power imbalance requirement in the same table by adding a new note clarifying the applicable REFSENS for Type 4 UE based on 4 Rx.

38.101-1 Table 7.10A.2-1



* + Option 2: (OPPO)

To reuse 7.10A.2-1 in TS 38.101-1, note 3 might need further refinement.

* + Option 3: (Qualcomm)

Capture Type 4 RF requirements in Table 7.10A.2-1.

* + Option 4: (Nokia)

For NR-CA, add new normative text under 7.10A.2 that refers to Table 7.10A.2-1.  
For EN-DC, add new normative text under 7.10B.3 that refers to Table 7.10B.3-1.

* + Option 5: (Huawei)

For NR-CA, add new normative text under 7.10A.2 that refers to Table 7.10A.2-1 and modify note 3 and note 4 in Table 7.10A.2-1.   
For EN-DC, add new normative text under 7.10B.3 that refers to Table 7.10B.3-1 and modify note 4 in Table 7.10B.3-1.

* Recommended WF
  + Firstly, RAN4 needs to wait for concluding <Issue 2-1-1>.
  + Next, if Issue 2-1-1 is concluded, agree the following proposal.

For NR-CA, add new normative text under 7.10A.2 that refers to Table 7.10A.2-1 and modify note 3 and note 4 in Table 7.10A.2-1.   
For EN-DC, add new normative text under 7.10B.3 that refers to Table 7.10B.3-1 and modify note 4 in Table 7.10B.3-1.

* + And then, the specific contents should be discussed based on the draft CR after CR works splitting.

Nokia: need look at the modification of note 3 and note4.

Apple: we do not need to look into details for this.

Huawei: Define the receiver requirement in the same table.

Agreement:

* Define the Type 4 receiver imbalance requirements in the same table as for Type 2.
  + FFS on the details of modification

*Sub-topic description:*

R4-2407276(Apple) and R4-2408718(Nokia) propose 80MHz for minimum DL frequency separation.

On the other hand, R4-2407574 (Murata) proposes 50MHz. On the other hand, and also R4-2409112(Huawei) acknowledges that 80MHz of DL separation is needed, but it does not need to be specified in RAN4, and RAN5 can use the instructions on LS R4-2316951 for type 4, too.

*Open issues and candidate options before e-meeting:*

**Issue 2-1-3: Minimum DL frequency separation**

* Proposals
  + Option 1: (Apple/Nokia/Qualcomm/Huawei)

Center of BWanother relative to edge of BWwanted is assumed to be at least 80MHz+BWanother/2 away from the edge of the wanted CC.

* + Option 2: (Murata)

Max (5/2\* BWanother, [50] MHz).

* Recommended WF
  + Collect companies’ views for Option 1 and 2.
  + If RAN4 agree with Option 1 or 2, RAN4 doesn’t need specify anything in RAN4, but also needs to send LS to RAN5 same as LS R4-2316951(Ericsson)for Type 2, as proposed by Huawei.

Murata: For Type 2 the minimum frequency separation will be defined in the table. That is how the last column defined. Not against any change but need understand the justification.

Apple: For type 2, we agreed on option 1 and send LS to RAN5 asking them to focus on some configuration. For type 4 we can follow the same. The equation provided by Murata. The same condition should be applied for Type 4.

NTT DOCOMO: For DL frequency separationg, following option 2, it means the minimum separation. It is not aligned with the frequency in our scenario.

Huawei: Support Option 1. We can follow the same approach and sent LS to RAN5.

Murata: I need double check whether the requirement is too tighten. Will it change the requirement in the table or keep the same.

*Sub-topic description:*

R4-2407276(Apple), R4-2407574(Murata), R4-2408360(ZTE), R4-2408718(Nokia), propose no limitation for maximum DL frequency separation. On the other hand, R4-2408821(OPPO) proposes to use 600MHz.

*Open issues and candidate options before e-meeting:*

**Issue 2-1-4: Maximum DL frequency separation**

* Proposal
  + Option 1: (Apple/Murata/ZTE/Nokia/Qualcomm/)

No limitation.

* + Option 2: (OPPO)

600MHz

* Recommended WF
  + Collect companies’ views.

Samsung: in my view, Option 1 and Option 2 are aligned. There is no operator holding the spectrum with separation larger than 600MHz. But we can follow Type 2 to use option 1

OPPO: Our proposal is based on the rationale for minimum DL frequency separation. We can accept opiton 1.

Agreement: No limitation for maximum DL frequency separation

## Sub-topic 2-2 : UE Capability/UE behavior and network signaling for Type 4 EN-DC/NR-CA

### Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc#** | **Company** | **Proposals / Observations** |
| R4-2407277 | Apple | ***Proposal 1:*** it is proposed to clarify Type 1 mainly refer to the capability of handling multiple CCs (e.g. 2) with a single Rx chain. And it’s better to mention which kind of Type 1, e.g. 4Rx Type 1 or 8Rx Type 1, in future discussion.  ***Proposal 2:*** it is proposed to introduce new IE to indicate capabilities for Type 4a and Type 4b UE respectively.  ***Proposal 3:*** It is proposed to consider clear network indication to support switching between 8Rx Type 1 and Type 4 capability.  ***Proposal 4:*** If Type 4 capability is indicated, Type 2 capability shall be deemed as supported by default. e.g. 4Rx Type 1 capability and Type 2 capability shall be supported by default for Type 4 UE.  ***Observation:*** there is no benefits for Type 4 UE fall back to Type 2 capability compared to single CC 4Rx operation.  ***Proposal 5:*** it is proposed that Type 4 UE only support fall back to single CC 4Rx operation and single CC 8Rx operation.  ***Proposal 6:*** there is no need to introduce network signaling to support Type 4 UE fall back to single CC 4Rx operation or single CC 8Rx operation. |
| R4-2407626 | Samsung | ***Proposal 1:*** Same methodology and RF requirements for Type-2 EN-DC/NR-CA could be reused to Type-4a/b EN-DC/NR-CA.   1. New UE capability(s) needed for Type-4a/b EN-DC/NR-CA support indication; New NW control signaling(s) needed to allow NW configure UE work under Type-4 mode or Type-1 mode(collocated), if absent, Type-4 requirements apply. Details up to RAN2.   ***Proposal 2:*** In case Type-4 reuse same requirements of Type-2, we further propose:  If Type-4 capability is indicated, Type-2 capability shall be deemed as support by default regardless of whether UE indicates Type-2 capability or not, in this case NW can control this UE via signaling to work under Type-2 mode.   * Detailed signaling design left to RAN2.   ***Observation 1:*** Note that if UE indicates both Type-4 and Type-2 (though not necessary, but not precluded), new BS signaling should be utilized to instruct UE, existing BS signaling (“*nonCollocatedTypeMRDC*” or “*nonCollocatedTypeNR-CA*”) should be discarded.  ***Proposal 3:*** If proposal 1/2 can be agreed, we further propose:  If UE indicates the support of Type-4 capability, Type-4 requirements shall be verified, Type-2 requirements are not necessarily to be verified.  ***Proposal 4:*** On association with RAN2, there are two alternatives can be considered.  -Alt1: Do not inform RAN2 the demand on new UE capability(s) and new NW signaling(s) until there is a clear conclusion of Type-3 capability, in order to facilitate RAN2 design with all UE capability(s)/NW signaling(s) considered as a package.  -Alt 2: Inform RAN2 the demand on new UE capability(s) and new NW signaling(s) for Type-4, meanwhile remind RAN2 that there is a checkpoint for Type-3 in Dec RAN-P. Whether to hold on the work is up to RAN2. |
| R4-2408361 | ZTE | ***Observation 1.*** It is not expected that a UE reports both type 2 capability and type 4a/4b capability.  ***Proposal 1.*** To introduce new UE capability signaling for type 4a/4b.  ***Proposal 2.*** UE that supports type 4a/4b capability supports type 2 by default.  ***Proposal 3.*** New Rel-19 BS signaling is needed for type 4a/4b intra-band CA and inter-band ENDC.  ***Proposal 4:***  When Rel-19 NW signaling is provided, Type 1 UE requirements are applied  When Rel-19 NW signaling is not provided:  - Type 2 UE requirements are applied if only Type 2 UE capability is reported.  - Type 4 UE requirements are applied if only Type 4 UE capability is reported.  - Type 4 UE requirements are applied if both Type 2 UE and Type 4 capabilities are reported. |
| R4-2408637 | MediaTek | ***Proposal 1:*** We propose add new UE capabilities for Type 4a(EN-DC) and 4b(EN-DC/NR-CA) support indication. The new capability shall also include whether the type 4 UE can support 8 DL MIMO layer on each CC that is optional capability, up to UE implementation.  ***Observation 1:*** UE need collocation/non-collocation indication from network to config itself for type 4 UE.  ***Proposal 2:*** The existing BS signalling indications “*nonCollocatedTypeNR-CA-r18*” and “*nonCollocatedTypeMRDC-r18*” can be re-used to configure type 4a/4b UE’s DL receiving hardware configuration when SCell is activated. |
| R4-2408719 | Nokia | < Issue 2-3-1: New UE Capabilities for Type 4a(EN-DC) and 4b(EN-DC/NR-CA) >  Way Forward:   * Continue further discussion on the following two options in the next meeting.   + Option 1     - Add new UE capabilities for Type 4a(EN-DC) and 4b(EN-DC/NR-CA) support indication.   + Option 2     - Reuse *intraBandNR-CA-non-collocated-r18* and *maxNumberMIMO-LayersPDSCH=*4 for FR1 NR intra-band CA and *interBandMRDC-WithOverlapDL-Bands-r16* and *maxNumberMIMO-LayersPDSCH=*4 for FR1 inter-band non-contiguous EN-DC with overlapping or partially overlapping bands.   **Nokia view: Option 1.**  < Issue 2-3-3: Whether to support Type 2 capabilities by UE having Type 4 capability >  Way Forward:   * Continue further discussion on the following proposal in the next meeting.   + If Type-4 capability is indicated, Type-2 capability shall be deemed as support by default regardless of whether UE indicates Type-2 capability or not.   **Nokia view: We think that Type 4 UE has to support also Type 2 behaviour, whether type 2 signalling is mandatory in such case is FFS .**  < Issue 2-4-1: New NW Signaling to switch between Type 1 and Type 4 >  **Nokia view: Switching is needed and needs to be under NW control**  <Issue 2-4-2: UE behavior between Type 1, Type 2 and Type 4 with new NW Signaling >  **Nokia view: Switching is needed and needs to be under NW control.**  < Issue 2-4-3: When to inform RAN2 the demand on new UE capability(s) and new NW signaling(s) >  **Nokia view: RAN4 RF session needs to conclude before sending LSs to other WGs.** |
| R4-2408754 | KDDI, LG Uplus | ***Observation 1:*** The working assumption of RP-240101 can be reused in RAN4.  ***Proposal 1:*** Add new UE capability for Type 4a/4b support indication and add new network signaling to configure UE behavior between Type 4a/4b (non-collocated) and Type 1 (collocated). Details up to RAN2 decision. |
| R4-2408822 | OPPO | ***Observation 1:*** The signalling for Rel-18 only depends on the UE RF and RRM requirement as MTTD/MRTD and power imbalance.  ***Observation 2:*** The Rel-18 signalling together with the network signalling and also the maxMIMO-layers together determine the UE behaviour.  ***Proposal 1:*** To define a new type 4 UE capability.  ***Proposal 2:*** The new type 4 capability should include the MIMO layer perspective to differentiate it from the type 2 capability in case the RRM and RF requirements are the same.  ***Proposal 3:*** For Rel-19, if the UE report type 4 capability, then the network can assume the type 2 capability is supported.  ***Proposal 4:*** New NW capability for type 4 is needed. |
| R4-2408852 | Qualcomm | ***Proposal 5****:* New UE capabilities for Type 4a and Type 4b shall be specified.  ***Proposal 6****:* The practical benefit behind mandating Type 4 UE to support Type 2 must be discussed before making agreement. At least this should not be tied to aspect of whether to reuse Type 2 UE capabilities.  ***Proposal 7****:* Discuss NW signaling to switch between Type 1 and Type 4 after UE capabilities for Type 4 are agreed.  ***Proposal 8****:* Discuss UE behavior between Type 1, Type 2 and Type 4 with new NW Signaling after UE capabilities for Type 4 are agreed.  ***Proposal 9****:* RAN2 should be informed the demand on new UE capability(s) and new NW signaling(s) after RAN4 has conclusions on all related matters. |
| R4-2409061 | Ericsson | ***Proposal 1:*** Reuse *intraBandNR-CA-non-collocated-r18* and *maxNumberMIMO-LayersPDSCH*=4 for FR1 NR intra-band CA and *interBandMRDC-WithOverlapDL-Bands-r16* and *maxNumberMIMO-LayersPDSCH*=4 for FR1 inter-band non-contiguous EN-DC with overlapping or partially overlapping bands. |
| R4-2409126 | Huawei | ***Proposal 1:*** No UE capability to distinguish between Type 4a and Type 4b.  ***Proposal 2:*** Send an LS to RAN2 to define new UE capabilities to cover the type 4 UE capability set 1 for NR CA and EN-DC. The case of type 4 UE capability set 2 does not need a UE capability as it is already included in the specification with 8Rx requirements for FWA.  ***Proposal 3:*** There should be a network signaling to inform the UE to switch from type 4 set 1 (default set) to set 2 (type 1 8Rx), when co-located deployment is required.  ***Proposal 4:*** Technically a type 4 set 1 can operate as type 2 UE. No need for a network signaling to switch from type 4 to type 2. It would be better to ask RAN2 to design new UE capabilities for type 4 set 1 for NR-CA an EN-DC as proposed in the LS R4-2409122.  ***Proposal 5:*** Introduce a BS NW signalling to switch from the default set, type 4 set 1 to type 1 with 8 Rx.  ***Proposal 6:*** No need to switch between type 4 to type 2. A switching mechanism from the default set, type 4 set 1 to type 1 with 8 Rx, is required. |

### Open issues summary

*Sub-topic description:*

R4-2407277(Apple), R4-2407626(Samsung), R4-2408361(ZTE), R4-2408637(MediaTek), R4-2408719(Nokia), R4-2408754(KDDI/LG Uplus), R4-2408822(OPPO) and R4-2408852(Qualcomm) propose to add new UE capabilitis for Type 4a and 4b support indication. And then, R4-2409126(Huawei) proposes to define new UE capabilities to cover the Type 4 UE capability set 1 for NR CA and EN-DC.

On the other hand, R4-2409061(Ericsson) proposes that no new UE capability is needed for UE Type 4 UE architecture and the existing UE capabilities should be enough for reporting its capabilities.

*Open issues and candidate options before e-meeting:*

**Issue 2-2-1: New UE Capabilities for Type 4a(EN-DC) and 4b(EN-DC/NR-CA)**

* Proposals
  + Option 1-1: (Apple/Samsung/ZTE/MediaTek/Nokia/KDDI/LG Uplus/OPPO/Qualcomm)

To add new UE capabilities for Type 4a and 4b support indication.

* + Option 1-2: (Huawei)

To add new UE capabilities to cover the type 4 UE capability set 1 for NR CA and EN-DC.

* + Option 2: (Ericsson)

To reuse *intraBandNR-CA-non-collocated-r18* and *maxNumberMIMO-LayersPDSCH=*4 for FR1 NR intra-band CA and *interBandMRDC-WithOverlapDL-Bands-r16* and *maxNumberMIMO-LayersPDSCH=*4 for FR1 inter-band non-contiguous EN-DC with overlapping or partially overlapping bands.

* Recommended WF
  + Firstly, discuss to go with Option 1-1/1-2 or Option 2.
  + Next, in case of going with Option 1-1/1-2, discuss whether to merge Option 1-1 and 1-2.

Moderator: We need clarify between option 1-1 and option 1-2. Option 1-2 is the same as option 1-1?

Huawei: Option 1 means two capabilities. Our option is to define just one new UE capability.

Nokia: Option 1-1 is better written.

Apple: this is something new and not aligned with Type 2. It is better to reuse the approach for type 2.

Ericsson: received comments from Huawei for option 2. There is some limitation of our proposal. When coming to capaiblity for type 4a and 4b we prefer one capability for type 4.

Qualcomm: Type 4a and type 4b are different. We are OK with separate capabilities.

Samsung: at least for type 2 in Rel-18 we have two separate capabilities: one for CA and one for EN-DC. For NR-DC we only have type 4, but for EN-DC we have type 4a and type 4b and we need 1 capability to differentiate them. We cannot reuse type 2 capability + MIMO layer to indicate the type 4 capable UE. MIMO layer signaing is shared by collocated and non-collocated. Teh signaling won’t be re-reported when the scenaior is changed.

Nokia: we do not need separate capabilities for NR-CA/DC and EN-DC, which is too complicated.

OPPO: It is not CA and EN-DC difference. We need different signaling. For NR-CA, when reporting MIMO-layer 4, UE can support 2-layer for non-collocated.

Huawei: Type 4 is intended to have FWA. We do not need force UE to change the internal architecture from 4a to 4b.

Qualcomm: We are OK to discuss this aspect further. Rationale of our separate capabilites is based on the Table of archtiecture.

Nokia: Further discuss it in the next meeting.

Apple: better to leave it to next meeting since there are so many new ideas.

Huawei: the idea is around Rel-18. For non-collocated, we have already had so many UE capaiblities. We should avoid the complicated capabilities.

Samsung: OK to further discuss. Question: Nokia think one capaiblity is enough with respect to CA and EN-DC. Huawei think type 4a is redudant.

Huawei: we are aligned with Nokia proposal.

**Issue 2-2-2: Whether to support Type 2 capability by UE having Type 4 capabilities**

* Proposal
  + Option 1: (Apple/Samsung/Nokia/ZTE/OPPO/Huawei)

If Type-4 capability is indicated, Type-2 capability shall be deemed as support by default regardless of whether UE indicates Type-2 capability or not.

* + Option 2: (Qualcomm)

The practical benefit behind mandating Type 4 UE to support Type 2 must be discussed before making agreement. At least this should not be tied to aspect of whether to reuse Type 2 UE capabilities.

* Recommended WF
  + If Qualcomm’s proposal is not clear objection to Option 1, go with Option 1.

Qualcomm: We know that type 2 is subset of type 4. But what is the benefit? Our concern is the complexity when defining the capabilities.

Nokia: LTE is with 2-layer. NR has 4-layer.

Samsung: to Nokia, for most of LTE bands, they are mandated for 2-layer. For this band, 4-layer is opitonally supported for LTE. For NR DC, 4-layer is enough. It is related to network assumption. Can network assume type 2 is supported no matter what capability is reported? It is for fallback mode.

Huawei: Distinguish: RAN2 signaling vs RF capability. Two options are aligned. It is not related to capability. Fallback to type 2 is not complicated just configuring the proper layer.

Apple: Agree with Huawei.

Qualcomm: it will cause the UE burden.

Tentative agreement:

* If Type-4 capability is indicated, Type-2 capability shall be deemed as support by default regardless of whether UE indicates Type-2 capability or not.
  + If UE reports the Type-4 capability, UE is not requested to report Type-2 capability.
  + If the issue is identified for these bullets, RAN4 will revisit them.

*Sub-topic description:*

R4-2407277(Apple), R4-2407626(Samsung), R4-2408719(Nokia), R4-2408361(ZTE), R4-2408754(KDDI/LG Uplus) and R4-2408822(OPPO) propose to add new BS signalling to switch between Type-4 capability or Type-1 capability. And then, R4-2409126(Huawei) proposes to Introduce a new BS signalling to switch from the default set, Type 4 set 1 to Type 1 with 8 Rx.

On the other hand, R4-2404258 (MediaTek) proposes to reuse the existing BS signalling indications “*nonCollocatedTypeNR-CA-r18*” and “*nonCollocatedTypeMRDC-r18*”. Additionally, R4-2407277(Apple) proposes the other aspect on the fall back of UE capability(s).

*Open issues and candidate options before e-meeting:*

**Issue 2-2-3: New BS Signaling to switch between Type 4a/4b and Type 1(collocated)**

* Proposals
  + Option 1-1: (Apple/Samsung/ZTE/Nokia/KDDI/LG Uplus/OPPO)

To add new BS signalling to switch between Type 4 capability or Type 1 capability(collocated).

* + Option 1-2: (Huawei)

Introduce a BS signalling to switch from the default set, Type 4 set 1 to Type 1 with 8 Rx.

* + Option 2: (MediaTek)

The existing BS signalling indications “*nonCollocatedTypeNR-CA-r18*” and “*nonCollocatedTypeMRDC-r18*” can be re-used to configure type 4a/4b UE’s DL receiving hardware configuration when SCell is activated.

* + Option 3: (Apple)

Type 4 UE only support fall back to single CC 4Rx operation and single CC 8Rx operation.

* Recommended WF
  + Firstly, discuss to go with Option 1-1/1-2 or Option 2.
  + Next, in case of going with Option 1-1/1-2, discuss whether to merge Option 1-1 and 1-2.
  + Lastly, discuss whether Option 3 is needed.

Mediatek: if UE reportes type 4, then UE needs support Type 1 with 8Rx first.

Ericsson: We have two type 1. Type 1 Rel-18 and Type 1 Rel-19. What does Type 1 mean in the Rel-19 context.

Apple: We echo the Ericsson. What does Type 1 mean?

Huawei: For FWA, when we switch from collocated to non-collocated, we will get gain with 8Rx.

*Sub-topic description:*

R4-2407626(Samsung) proposes to add new BS signalling to switch between Type 4 capability or Type 2 capability.

On the other hand, R4-2409126(Huawei) proposes not to add a new BS signalling. Additionally, R4-2407277(Apple) proposes the other aspect on the fall back of UE capability(s).

*Open issues and candidate options before e-meeting:*

**Issue 2-2-4: New BS Signaling to switch between Type 4a/4b and Type 2**

* Proposals
  + Option 1: (Samsung)

To add new BS signalling to switch between Type-4 capability or Type-2 capability.

* + Option 2: (Huawei)

No need to switch between type 4 to type 2.

* + Option 3: (Apple)

Type 4 UE only support fall back to single CC 4Rx operation and single CC 8Rx operation.

* Recommended WF
  + Option 2 and 3 seems to have a same intention eventually. Collect companies’ views.

Qualcomm: this is so tighted to the previous discussion for Type 2.

*Sub-topic description:*

R4-2404987(Samsung) proposes to firstly discuss when and how to send LS to RAN2. And then, R4-2408719(Nokia) and R4-2408852(Qualcomm) propose to send LS to RAN2 after RAN4 has concluded all related matters.

On the other hand, R4-2409126(Huawei) proposes to send LS to RAN2 ASAP based on their LS.

*Open issues and candidate options before e-meeting:*

**Issue 2-2-5: When to inform RAN2 the demand on new UE capability(s) and new BS signaling(s)**

* Proposals
  + Option 1: (Samsung)

Do not inform RAN2 the demand on new UE capability(s) and new NW signalling(s) until there is a clear conclusion of Type-3 capability, in order to facilitate RAN2 design with all UE capability(s)/NW signalling(s) considered as a package.

* + Option 2: (Samsung)

Inform RAN2 the demand on new UE capability(s) and new NW signalling(s) for Type-4, meanwhile remind RAN2 that there is a checkpoint for Type-3 in Dec RAN-P. Whether to hold on the work is up to RAN2.

* + Option 3: (Qualcomm/Nokia)

RAN2 should be informed the demand on new UE capability(s) and new NW signalling(s) after RAN4 has conclusions on all related matters.

* + Option 4: (Huawei)

Send LS to RAN2 ASAP based on R4-2409122(Huawei).

* Recommended WF
  + Collect companies’ views.

Samsung: Given the discussions on UE capabilites and network siganlling, it is not hurry to send this.

**Issue 2-2-6: UE behavior between Type 1, Type 2 and Type 4a/4b with new BS Signaling**

* Proposals
  + Option 1: (Samsung)
    - * If the new BS signaling is absent, Type-4 requirements apply  
        → Default type (Similar discussion as in Rel-18)
      * If indicate as "0", Type-2 requirements apply.
      * If indicate as "1", Type-1 requirements apply, collocated.
  + Option 2: (ZTE)
    - * If the new BS signaling is provided, Type 1 UE requirements are applied.
      * If the new BS signaling is not provided:
        + Type 2 UE requirements are applied if only Type 2 UE capability is reported.
        + Type 4 UE requirements are applied if only Type 4 UE capability is reported.
        + Type 4 UE requirements are applied if both Type 2 UE and Type 4 capabilities are reported.

Table 2-2. Combination of different UE capability reporting and BS configuration signaling for NRCA

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Index | UE indicates type 4a/4b? | UE indicates type 2? | Rel-19 NW signaling provided? | UE type |
| 1 | × | × | × | Type 1 |
| 2 | × | ○ | × | Type 2 |
| 3 | ○ | × | × | Type 4a/4b |
| 4 | ○ | × | ○ | Type 1 |
| 5 | ○ | ○ | × | Type 4a/4b? |
| 6 | ○ | ○ | ○ | Type 1? |

* + Option 3: (Huawei)
    - * If the new BS signaling is provided, Type 1 UE requirements with 8Rx /CC are applied.
      * If the new BS signaling is not provided:
        + Type 4 UE requirements are applied if Type 4 UE capability is reported (regardless of reported type 2 UE capability).
        + Type 2 UE requirements are applied if only Type 2 UE capability is reported.
        + If none is reported type 1 UE requirements with 4Rx/CC are applied.
* Recommended WF
  + Discuss UE behavior between Type 1, Type 2 and Type 4a/4b with new BW Signalling after UE capabilities for Type 4a/4b are agreed, as Qualcomm proposed.
  + Collect companies’ views.

Moderator: Postpone it. This is controversial topic.

## Sub-topic 2-3 : Other aspects (incl. clarification of contiguous LTE CCs)

### Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc#** | **Company** | **Proposals / Observations** |
| R4-2407278 | Apple | ***Proposal:*** it is proposed to make terminology change for power imbalance requirement to take into account multiple CCs in LTE mode.   * Wanted carrier. 🡪 wanted carrier (s) * Another wanted carrier 🡪 other wanted carrier (s) * BWanother 🡪 BWohter   ***Proposal 2:*** It is proposed to agree the modified NOTE 6 wording as below:   * NOTE 6: For Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs in one band, BWwanted and BWother for E-UTRA with multiple CCs represent the aggregated BWs of all the CCs. If E-UTRA with multiple CCs are wanted carriers, REFSENS equals to 5MHz REFSENS+10\*log(aggregated BW(MHz)/5) of all the contiguous CCs. if E-UTRA with multiple CCs are other wanted carriers, the calculated Rx power are total power for all component CCs. The maximum power spectral density imbalance between the contiguous E-UTRA CCs in one band, is within 6 dB.” |
| R4-2407626 | Samsung | ***Proposal 5:*** If there is demand from operators to introduce Type-4 capability for multiple CC cases, same handling as Rel-18 leftover issues (captured in [7], for EN-DC) can be adopted, i.e.,  “NOTE X: For Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs in one band, REFSENS in this table equals to 5MHz REFSENS+10\*log(aggregated BW(MHz)/5) of all the contiguous E-UTRA CCs of the wanted band. BWwanted and BWanother represent the aggregated BWs of all the CCs of the wanted and another wanted band, respectively. The maximum power spectral density imbalance between the contiguous E-UTRA CCs in one band, is within 6 dB.” |
| R4-2408718 | Nokia | < Issue 2-2-5: The number of CCs >  ***Nokia view:*** Based on operator need. |
| R4-2408756 | KDDI, LG Uplus | ***Observation 1:*** There are still needs from operators to deploy non-collocated EN-DC/NR-CA.  ***Observation 2:*** The working assumption of RP-240101 can be reused in RAN4.  ***Proposal 1:*** The number of CCs for Type 4a/4b.   * Non-collocated EN-DC * B42: multiple contiguous CCs, all collocated.   + For Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs in one band, REFSENS in this table equals to 5MHz REFSENS+10\*log(aggregated BW(MHz)/5) of all the contiguous E-UTRA CCs of the wanted band. BWwanted and BWanother represent the aggregated BWs of all the CCs of the wanted and another wanted band, respectively. The maximum power spectral density imbalance between the contiguous E-UTRA CCs in one band, is within 6 dB. * n77/n78: one CC * Non-collocated NR-CA * n77/n78: Non-contiguous two CCs, non-collocated   ***Proposal 2:*** If TU is still remained in Rel-19, discuss other scenario(s) of the number of CCs and contiguous cases later. |
| R4-2408821 | OPPO | ***Proposal 2:*** For EN-DC of type 4 UE, number of LTE CCs can be up to 4 and only co-located contiguous LTE CCs is considered.  ***Proposal 3:*** For NR CA of type 4 UE, number of NR CCs need more operator input. If more then 2 CCs are needed, the aggregated channel bandwidth of the contiguous CCs might need to be limited. |
| R4-2408852 | Qualcomm | ***Proposal 4****:* The following applies for Type 4 UE’s, unless concern raised by interested operators:   * Non-collocated EN-DC   + B42: multiple contiguous CCs up to four, collocated   + n77/n78: one CC * Non-collocated NR-CA   + n77/n78: Non-contiguous two CCs, non-collocated |
| R4-2409062 | Ericsson | ***Proposal 1:*** In case of Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs modify REFSENS as in R4-2406628, WF on clarification of RF requirements in case of contiguous LTE CCs in non-collocated scenario, for ‘Wanted carrier’ and ‘Another wanted carrier’. |
| R4-2409112 | Huawei | ***Proposal 3:*** The number of CCs:  -Non-collocated EN-DC  -B42: multiple contiguous CCs (the upper limit to be set by operators), collocated  -n77/n78: one CC  -Non-collocated NR-CA  -n77/n78: Non-contiguous two CCs, non-collocated |

### Open issues summary

*Sub-topic description:*

R4-2407626(Samsung), R4-2408756(KDDI/LG Uplus), and R4-2409062(Ericsson) propose to align to the agreed WF R4-2406628(Huawei) on the number of B42 CCs for EN-DC.

On the other hand, R4-2408821(OPPO) proposes up to four, and also R4-2409112(Huawei) proposes the upper limit to be set by operators.

*Open issues and candidate options before e-meeting:*

**Issue 2-3-1: The number of B42 CCs for EN-DC**

* Proposals
  + Option 1: (Samsung/ KDDI/LG Uplus/Ericsson)

Based on WF R4-2406628 agreed in the last meeting, B42: multiple contiguous CCs, collocated

* + - * For Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs in one band, REFSENS in this table equals to 5MHz REFSENS+10\*log(aggregated BW(MHz)/5) of all the contiguous E-UTRA CCs of the wanted band. BWwanted and BWanother represent the aggregated BWs of all the CCs of the wanted and another wanted band, respectively. The maximum power spectral density imbalance between the contiguous E-UTRA CCs in one band, is within 6 dB.
  + Option 2: (OPPO/Qualcomm)

Up to four, collocated.

* + Option 3: (Huawei)

The upper limit to be set by operators, collocated.

* Recommended WF
  + Collect companies’ views.

Nokia: Based on operator need.

KDDI: we need to decide the number as 4. We can accept option 1 and 2.

NTT DOCOMO: 4 is needed.

Apple: is the proposed number based on the current spectrum situation or future consideration?

OPPO: based on the current requested band combiantion.

Huawei: depend on operator requests. We do not need.

Softband: Check futher in the next meeting. How about the Korean situation.

Qualcomm: Strongly support operator views.

Chair: Check the number until next meeting.

*Sub-topic description:*

R4-2407626(Samsung) and R4-2408718(Nokia) propose that the number of NR CCs for EN-DC and NR-CA is based on operator need. And then, R4-2408852(Qualcomm), R4-2409112(Huawei) propose the number same as Type 2. Additionally, R4-2408756(KDDI/LG Uplus) proposes to discuss other scenario(s) of the number of CCs and contiguous cases later, if TU is remained in Rel-19.

On the other hand, R4-2408821(OPPO) mentions that in case of increasing CCs the aggregated channel bandwidth of the contiguous CCs needs to be limited.

*Open issues and candidate options before e-meeting:*

**Issue 2-3-2: The number of NR CCs for EN-DC and NR-CA**

* Proposals
  + Option 1: (Samsung/Nokia)

Based on operator need.

* + Option 2: (Qualcomm/Huawei/KDDI/LG Uplus)

Same as Type 2 as follows.

* Non-collocated EN-DC
  + - * + n77/n78: one CC
* Non-collocated NR-CA
  + - * + n77/n78: Non-contiguous two CCs, non-collocated
  + Option 3: (KDDI/LG Uplus)

Adding to Option 2, if TU is still remained in Rel-19, discuss other scenario(s) of the number of CCs and contiguous cases later.

* + Option 4: (OPPO)

For NR CA of type 4 UE, number of NR CCs need more operator input. If more than 2 CCs are needed, the aggregated channel bandwidth of the contiguous CCs might need to be limited.

* Recommended WF
  + Prioritize the following number of NR CCs same as Type 2.
* Non-collocated EN-DC
  + - * + n77/n78: one CC
* Non-collocated NR-CA
  + - * + n77/n78: Non-contiguous two CCs, non-collocated
  + If TU is remained in Rel-19, discuss other scenario(s) of the number of CCs and contiguous cases later.

Chair: Encourage the operators to check the number until next meeting.

*Sub-topic description:*

R4-2407278(Apple) proposes to modify the terminology on B42 CCs for EN-DC.

*Open issues and candidate options before e-meeting:*

**Issue 2-3-3: Terminology for power imbalance requirement to take into account multiple B42 CCs**

* Proposal (Apple)
  + Make terminology change for power imbalance requirement to take into account multiple CCs in LTE mode.

- Wanted carrier. 🡪 wanted carrier (s)

- Another wanted carrier 🡪 other wanted carrier (s)

- BWanother 🡪 BWother

* + Agree the modified NOTE 6 wording as below:

NOTE 6: For Inter-band EN-DC configurations with multiple contiguous E-UTRA CCs in one band, BWwanted and BWother for E-UTRA with multiple CCs represent the aggregated BWs of all the CCs. If E-UTRA with multiple CCs are wanted carriers, REFSENS equals to 5MHz REFSENS+10\*log(aggregated BW(MHz)/5) of all the contiguous CCs. if E-UTRA with multiple CCs are other wanted carriers, the calculated Rx power are total power for all component CCs. The maximum power spectral density imbalance between the contiguous E-UTRA CCs in one band, is within 6 dB.”

* Recommended WF
  + Collect companies’ views.

Huawei: in the last meeting we have WF on the other text. There are two approaches: keeping the initial approach. Insist on the agreements last meeting.

Apple: Something is overlooked, e.g., how to adjust the power.

Ericsson: this WF is negotiated last meeting. We do not need change it again.

Moderator: there are two directions. Huawei proposal is based on the previous agreement. Apple has the update. We should go with Huawei CR.

## Sub-topic 2-4 : LS to RAN2

### Companies’ contributions summary

|  |  |  |  |
| --- | --- | --- | --- |
| **T-doc** | **Company** | **Title/Comments** | **Recommendation** |
| R4-2409122 | Huawei | LS on signaling support for intra-band non-collocated NR-CA and inter-band EN-DC with overlapping or partially overlapping bands for type 4 UE  *Moderator’s note:*  *To RAN2:*  *ACTION: RAN4 respectfully requests RAN2 to specify the above UE capabilities for intra-band non-collocated NR-CA and TDD-TDD inter-band EN-DC with overlapping or partially overlapping bands in Rel-19, and the above new BS signalling by RRC to indicate whether Type 4 set 1or Type 1 capability requirements with 8Rx/CC will be applied and asks RAN2 to develop relevant signalling* | *Wait for the conclusion of Issue 2-2-5* |