3GPP TSG-RAN WG4 Meeting #111 R4-2408613

Fukuoka, Japan, May 20th – 24th, 2024

**Agenda item:** 10.10.3

**Source:** Moderator (Intel Corporation)

**Title:** Topic summary for [111][132] NR\_FR1\_5MHz\_BW\_Ph2

**Document for:** Information

# Introduction

Rel-19 WI on **NR channel BW less than 5MHz for FR1 evolution** (RP-240832) was approved in RAN#103 with the following objectives:

|  |
| --- |
| 4 Objective4.1 Objective of SI or Core part WI or Testing part WI* Define common co-located and non-co-located inter-band NR CA/DC UE RF requirements with 3MHz CBW in the one band and 5MHz or 10MHz CBW in the other band
	+ Example band combination: CA/DC of 3MHz in band n100 and 5MHz or 10MHz in band n101
* Define RRM requirements for inter-band CA and DC for combinations introduced in RF part

Note: other band combinations than example band combinations can be specified in basket WIs after the above generic requirements are specified.4.2 Objective of Performance part WINOTE: Leave empty if the WI proposal does not contain a RAN performance part.* Specify necessary performance requirements (RAN4)
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The discussion took place in the previous meetings with the following approved documents:

* **RAN4 #110bis (April 2024)**
	+ R4-2406623 WF on RF requirements for less than 5MHz band combinations
	+ R4-2406624 WF on clarification of multiple carrier operation for n100/n101

This summary handles the tdoc submitted for AI 10.10 for the Rel-19 NR\_FR1\_5MHz\_BW\_Ph2 WI and addresses the following Topics:

* **Topic #1: UE RF requirements for inter-band NR CA/DC with 3MHz CBW**

The following tdocs are handled in this summary document:

|  |  |  |  |
| --- | --- | --- | --- |
| **TDoc** | **Title** | **Source** | **Agenda item** |
| [**R4-2407028**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407028.zip) | Clarification of WID RP-240832 - NR\_FR1\_5MHz\_BW\_Ph2 | Union Inter. Chemins de Fer | 10.10.1 |
| [**R4-2407439**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407439.zip) | UE RF requirements for inter-band NR CA/DC with 3MHz CBW | Nokia | 10.10.2 |
| [**R4-2407548**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407548.zip) | Further discussion on UE RF requirements for inter-band NR CA/DC with 3MHz CBW | CATT | 10.10.2 |
| [**R4-2407549**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407549.zip) | draftCR for inter-band NR CA&DC with 3MHz CBW (System parameter part) | CATT | 10.10.2 |
| [**R4-2407991**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407991.zip) | Discussion for UE RF requirements for inter-band NR CA/DC with 3MHz CBW | LG Electronics France | 10.10.2 |
| [**R4-2408480**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408480.zip) | Discussion on the RF requirements for Rel-19 less than 5MHz work item for TN phase 2 | Intel Corporation | 10.10.2 |
| [**R4-2408797**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408797.zip) | Discussion on UE RF requirements for inter-band NR CADC with 3MHz CBW | ZTE Corporation, Sanechips | 10.10.2 |
| [**R4-2408798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408798.zip) | draftCR for TS 38.101-1: Introduction of inter-band NR CA/DC with less than 5MHz CBW | ZTE Corporation, Sanechips | 10.10.2 |
| [**R4-2408814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408814.zip) | draft CR to TS 38.101-1: Introduction of CA\_n100-n101 | Qualcomm Inc. | 10.10.2 |
| [**R4-2408815**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408815.zip) | Scell bandwidth and sync raster | Qualcomm Inc. | 10.10.2 |
| [**R4-2409153**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409153.zip) | Remaining RF requirements for CA\_n100-n101 and DC\_n100-n101 with 3MHz CBW | Huawei, HiSilicon | 10.10.2 |

# Topic #1: UE RF requirements for inter-band NR CA/DC with 3MHz CBW

## Companies’ contributions summary

|  |  |  |
| --- | --- | --- |
| **T-doc number** | **Company** | **Proposals / Observations** |
| [**R4-2407028**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407028.zip) | Union Inter. Chemins de Fer | **Observation 1**: The support of 5MHz CBW (5MHz n100: 20 and 25RB cases) in bands n100 and n101 has been left out of the current WID.**Observation 2**: UIC – Railways have a clear need for the support of CA/DC in both less than 5MHz CBW and 5MHz CBW.**Proposal 1**: Agree to include in WID RP-240832 CA/DC support for 5MHz CBW (both 20RB and 25RB). |
| [**R4-2407439**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407439.zip) | Nokia | **Proposal 1:** To specify ΔTIB,c for CA\_n100-n101 and NR DC\_n100-n101 as 0.3 dB for both bands.**Proposal 2:** Not to specify MSD for CA\_n100-n101 and NR DC\_n100-n101. |
| [**R4-2407548**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407548.zip) | CATT | **Proposal 1:** RAN4 not to define PC1 inter-band CA/DC for the band combination CA\_n100A-n101A until receiving approval from RAN plenary.**Proposal 2:** RAN4 not to introduce a new UE capability to support NR CA/DC with less than 5MHz CBW and support of 12/20 RB transmission bandwidth.**Proposal 3:** RAN4 to specify the requirement ΔTIB,c according to sufficient inputs and evaluation from vendors.**Proposal 4:** RAN4 not to specify the requirement MSD for the band combination CA\_n100A-n101A. |
| [**R4-2407549**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407549.zip) | CATT | Draft CR to TS 38.101-1 (Clause 5). |
| [**R4-2407991**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407991.zip) | LG Electronics France | **Proposal 1**: Revisit the PC1 issue pending RAN decision.**Proposal 2**: No need to specify the MSD requirements for CA n100-n101, but if other band combinations for BW less than 5 MHz have the MSD issues, it can be discussed in the future basket WI. |
| [**R4-2408480**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408480.zip) | Intel Corporation | **Observation 1:** 5MHz is supported together with 3MHz as channel bandwidth for band n100 for single carrier operations and requirements.**Proposal 1:** Send an LS to RANP to clarify in the WID that 5MHz support needs to be included together with 3MHz for CA/DC\_n100-n101 for band n100.**Proposal 2:** Specify support of 5MHz channel bandwidth together with 3MHz for band n100 in CA\_n100-n101 and DC\_n100-n101 in the UE RF specifications.**Proposal 3:** No new signalling indication is required in the RF scope of this item.**Observation 2:** potential enhancements on the network signalling for better UE mobility performance in SCell addition or other related operations can be discussed in RRM room starting from August 2024.**Proposal 4:** Use the basket items to be approved in June RANP to accommodate new requests from interested parties and specify the combo-specific requirements.**Proposal 5:** Work item rapporteur is to provide a Big Draft CR for all the UE RF requirements and the group tries to endorse the Big Draft CR in every WG meeting in Q3-Q4 2024. |
| [**R4-2408797**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408797.zip) | ZTE Corporation, Sanechips | **Proposal 1:** Whether to support PC1 inter-band CA/DC combinations needs input from operators.**Proposal 2:** Whether to introduce new UE capability and/or other RRC signalling to support NR CA/DC with less than 5MHz CBW and support of 12 or 20 RB transmission bandwidth needs to wait for RRM requirements for CA.**Proposal 3:** For inter-band CA\_n100-n101, no MSD issue needs to be discussed. |
| [**R4-2408798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408798.zip) | ZTE Corporation, Sanechips | Draft CR to TS 38.101-1 (Clauses 5 and 6). |
| [**R4-2408814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408814.zip) | Qualcomm Inc. | Draft CR to TS 38.101-1 (Clauses 5 and 6). |
| [**R4-2408815**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408815.zip) | Qualcomm Inc. | **Observation 1:** Current RAN1 specifications specify a cell with SSB/CORESET0 for less than 5MHz are associated with the new sync raster points.**Observation 2:** If SCell with less than 5MHz is not required to be in the new sync raster points, current specification is unclear on the transmission bandwidths when the cell is not a Pcell.**Proposal 1:** Require less than 5 MHz SCell to be associated with the new sync raster points for less than 5MHz, similar as PCell. |
| [**R4-2409153**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2409153.zip) | Huawei, HiSilicon | **Proposal 1:** As ECC considered PC1 on n100 and n101, it is better to ask RANP to include PC1 Cab-radio UE NR CA/DC communications with the following configurations, in the WID.

|  |
| --- |
|  PC1 NR CA/DC TX output power |
| PC1 on FDD band n100 | PC3 on TDD band n101 |
| 31 dBm | 23 dBm |
| Note: the maximum output power on the two bands are limited to 31dBm. |

**Proposal 2:** No UE capability of signaling is needed, as non-colocated inter-band CA is supported since Rel 15 and it was agreed to specify RF requirements agnostic of transmission bandwidth configurations for 3 MHz.**Proposal 3:** ΔTIB,c of CA\_n100-n101:**Proposal 4:** Spurious emissions for UE co-existence for CA\_n100-n101**Proposal 5:** No IMD or harmonic related MSD is needed. Moreover as the two bands are 1 GHZ away from each other no MSD for cross band leakage is needed, neither. |

## Open issues summary

*Before Meeting, moderators shall summarize list of open issues, candidate options and possible WF (if applicable) based on companies’ contributions.*

### Issue 1-1: Support of 5MHz CBW in band n100

* RAN4 #110bis agreements
	+ 5MHz bandwidth can be added for n100 in the band combination after RAN plenary agrees to add it in the WID
* Proposals
	+ Proposal 1: Agree to include in WID RP-240832 CA/DC support for 5MHz CBW (both 20RB and 25RB). (UIC)
	+ Proposal 2: Send an LS to RANP to clarify in the WID that 5MHz support needs to be included together with 3MHz for CA/DC\_n100-n101 for band n100. (Intel)
	+ Proposal 3: Specify support of 5MHz channel bandwidth together with 3MHz for band n100 in CA\_n100-n101 and DC\_n100-n101 in the UE RF specifications. (Intel)
* Recommended WF
	+ Further discuss in the meeting whether RAN4 shall agree and send LS to include in WID RP-240832 CA/DC support for 5MHz CBW (both 20RB and 25RB) for band n100.

Qualcomm: Do we need send LS to RAN plenary?

Huawei: Not against. Send LS to PC1 to inform them.

Agreement:

* In RAN4 common understanding, the support of 5MHz CBW on band n100 and 5MHz/10MHz on n101 in the band combination with band n100 and n101 can be included in Rel-19 WID.

### Issue 1-2: ΔTIB,c

* RAN4 #110bis agreements
	+ ΔTIB,c is FFS
		- Option 1: ΔTIB,c = [0.3] dB
		- Other option are not precluded
* Candidate options
	+ Option 1: ΔTIB,c = 0.3 dB for CA\_n100-n101 and NR DC\_n100-n101 (Nokia, Huawei, Qualcomm, ZTE)

|  |  |
| --- | --- |
| Inter-band CA combination | ΔTIB,c for NR bands (dB) |
| Component band in order of bands in configuration |
| CA\_n100-n101 | 0.3 | 0.3 |

* + Option 2: RAN4 to specify the requirement ΔTIB,c according to sufficient inputs and evaluation from vendors. (CATT)
* Recommended WF
	+ Option 1

Agreement:

* + ΔTIB,c = 0.3 dB for CA\_n100-n101 and NR DC\_n100-n101

|  |  |
| --- | --- |
| Inter-band CA combination | ΔTIB,c for NR bands (dB) |
| Component band in order of bands in configuration |
| CA\_n100-n101 | 0.3 | 0.3 |

### Issue 1-3: MSD requirements

* RAN4 #110bis agreements
	+ FFS on MSD requirements
* Proposals
	+ Proposal 1: Not to specify MSD for CA\_n100-n101 and NR DC\_n100-n101. (Nokia).
	+ Proposal 2: RAN4 not to specify the requirement MSD for the band combination CA\_n100A-n101A. (CATT)
	+ Proposal 3: No need to specify the MSD requirements for CA n100-n101, but if other band combinations for BW less than 5 MHz have the MSD issues, it can be discussed in the future basket WI. (LGE)
	+ Proposal 4: For inter-band CA\_n100-n101, no MSD issue needs to be discussed. (ZTE)
	+ Proposal 5: No IMD or harmonic related MSD is needed. Moreover as the two bands are 1 GHZ away from each other no MSD for cross band leakage is needed, neither. (Huawei)
* Candidate options
	+ Option 1: Do not specify MSD requirements for CA\_n100-n101 and NR DC\_n100-n101
* Recommended WF
	+ Do not specify MSD requirements for CA\_n100-n101 and NR DC\_n100-n101
	+ MSD requirements for other band combinations for BW less than 5 MHz can be discussed in the basket WI(s)

Agreement

* Do not specify MSD requirements for CA\_n100-n101 and NR DC\_n100-n101
* MSD requirements for other band combinations for BW less than 5 MHz can be discussed in the basket WI(s)

### Issue 1-4: Spurious emissions for UE co-existence

* Candidate options
	+ Option 1: Spurious emissions for UE co-existence for CA\_n100-n101 (Huawei, QC, ZTE)

|  |  |
| --- | --- |
| NR CA combination | Spurious emission |
|  | Protected Band | Frequency range (MHz) | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_n100-n101 | Frequency range | 758 | - | 788 | -50 | 1 |  |

* Recommended WF
	+ Option 1

Agreement:

* + Spurious emissions for UE co-existence for CA\_n100-n101

|  |  |
| --- | --- |
| NR CA combination | Spurious emission |
|  | Protected Band | Frequency range (MHz) | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_n100-n101 | Frequency range | 758 | - | 788 | -50 | 1 |  |

### Issue 1-5: Power class for UL inter-band CA

* Background
	+ PC3 and PC1 have been specified for band n100 and n101
	+ The WID does not explicitly provide information on target PC
	+ RAN4 #110bis agreements
		- Define PC3 inter-band CA/DC combinations
		- FFS on whether to define PC1 inter-band CA/DC combinations
* Proposals
	+ Proposal 1: RAN4 not to define PC1 inter-band CA/DC for the band combination CA\_n100A-n101A until receiving approval from RAN plenary (CATT)
	+ Proposal 2: Revisit the PC1 issue pending RAN decision. (LGE)
	+ Proposal 3: Whether to support PC1 inter-band CA/DC combinations needs input from operators. (ZTE)
	+ Proposal 4: As ECC considered PC1 on n100 and n101, it is better to ask RANP to include PC1 Cab-radio UE NR CA/DC communications with the following configurations, in the WID (Huawei)

|  |
| --- |
|  PC1 NR CA/DC TX output power |
| PC1 on FDD band n100 | PC3 on TDD band n101 |
| 31 dBm | 23 dBm |
| Note: the maximum output power on the two bands are limited to 31dBm. |

* Candidate options
	+ Option 1: Further discuss whether to define PC1 inter-band CA/DC for the band combination CA\_n100A-n101A in RANP.
	+ Option 2: RAN4 to recommend RANP to include PC1 cab-radio UE NR CA/DC communications in the WI scope with the following configurations

|  |
| --- |
|  PC1 NR CA/DC TX output power |
| PC1 on FDD band n100 | PC3 on TDD band n101 |
| 31 dBm | 23 dBm |
| Note: the maximum output power on the two bands are limited to 31dBm. |

* Recommended WF
	+ Further discuss in the meeting

LGE: this can be discussed in RAN.

Moderator: from WID, it does not mention any power class. Then power class can be decided in WG.

UIC: original proposal is to have 31dBm.

Huawei: We are also OK to have 31dBm. We are fine to go to RAN plenary.

Qualcomm: This is the first PC1 band combination CA. The spec is fully complete. Some solution may be different from other device type closed to human. It is better to clarify whether the common requirements are needed in RAN.

CATT: we are not against to have this work. Our concern is that we need follow the proper procedure to clarify it in RAN.

### Issue 1-6: UE capability and network signalling

* RAN4 #110bis agreements
	+ FFS whether to introduce new UE capability and/or other RRC signalling to support NR CA/DC with less than 5MHz CBW and support of 12 or 20 RB transmission bandwidth
* Proposals
	+ Proposal 1: RAN4 not to introduce a new UE capability to support NR CA/DC with less than 5MHz CBW and support of 12/20 RB transmission bandwidth. (CATT)
	+ Proposal 2: No new signalling indication is required in the RF scope of this item. (Intel)
	+ Proposal 3: Potential enhancements on the network signalling for better UE mobility performance in SCell addition or other related operations can be discussed in RRM room starting from August 2024. (Intel)
	+ Proposal 4: Whether to introduce new UE capability and/or other RRC signalling to support NR CA/DC with less than 5MHz CBW and support of 12 or 20 RB transmission bandwidth needs to wait for RRM requirements for CA. (ZTE)
	+ Proposal 5: No UE capability of signaling is needed, as non-colocated inter-band CA is supported since Rel-15 and it was agreed to specify RF requirements agnostic of transmission bandwidth configurations for 3 MHz.
* Recommended WF
	+ Do not to introduce a new UE capability signalling to support NR CA/DC with less than 5MHz CBW and support of 12/20 RB transmission bandwidth within RF work scope.
	+ Further potential enhancements can be further discussed in the RRM session.

Qualcomm: UE should be aware of the RBs less than 5MHz will be used. 12 and 20 RB configurations only be operated in the low-end of 900MHz.

Moderator: last meeting we discussed different type of capabilities. There is nothing new from UE capability. The question is whether to have new signalling. UE needs be aware about the transmission bandwidth.

Qualcomm: we are OK to further discuss it in RRM. We need discuss with the spectrum holder.

CATT: we support the WF to avoid UE to detect the normal bandwidth is used or not.

Huawei: Sync raster is defined for single carrier case. For single carrier case, we do not specify the raster explicitly. Why can UE use that capability for this purpose? UE will inform network whether it is capable for CA. The capability can be used for single carrier.

Moderator: No suggestion to change the signalling capability. UE should be aware of this SCell bandwidth with 12 and 20RB. There is different way how to do it. You can do it during SCell addition or fix the sync raster.

Qualcomm: We are OK not need to change of signalling. We need information of bandwidth on the SCell.

Agreement:

* Do not to introduce a new UE capability signalling to support NR CA/DC with less than 5MHz CBW and support of 12/20 RB transmission bandwidth within RF work scope.
* Further potential enhancements can be further discussed for SCell with less than 5MHz.

### Issue 1-7: Sync raster applicability for Scell with < 5MHz CBW

* Proposals
	+ Proposal #1: Require less than 5 MHz SCell to be associated with the new sync raster points for less than 5MHz, similar as PCell. (QC)
* Recommended WF
	+ Discuss in the meeting

Intel: why do we need information of bandwidth when SCell is added.

ZTE: same question. RAN1 spec mentions that core set #0 is associated with the new sync raster.

CATT: Fine with the proposal. Technically, without this association it means that the cell will not be discovered by other UEs as a Pcell.

Qualcomm: If not doing it, the old raster will be overlapped with the new sync raster, which causes the great confusion for even legacy UEs. It is beneficial for overall deployment.

Nokia: Our understanding is that the problem happens only when gNB sends the incorrect information.

Ericsson: Want to be sure that the scenario is related only to n100/101.

Apple: Why is the sync raster so important for Scell? PCell has already indicated all the information to UE. Even for the normal case, we have such restriction that SCell should be based on sync raster.

Intel: This association harms the deployment flexibility. If operators are fine, we are fine to discuss it.

CATT: to Apple, if the Cell less 5MHz is deployed on the normal sync raster, the legacy UE can connect the cell. Otherwise, UEs will waste the energy.

Apple: It can be SCell for some UEs and PCell for other UEs. Not all the Cells should be on the sync raster. SCell should not be always on the sync raster.

Qualcomm: It is not general proposal for all the bands. It is just for special case for CA combination.

UIC: we use 12 and 20 RBs in the low end of the band.

Apple: We are talking about the SCell addition. UE has all the information. gNB can put UE on the sync raster or not. I do not see the technique reason why we need such restriction.

Nokia: We should limit the scope to 12 RB and 20 RB for band n100.

Intel: from our perspective, we try to have more generic standard solution which can be used for other cases. We suggest to have more discussions. We do not get the enough information why we need it.

Huawei: we need specify 12 RB for 3MHz and 20 RBs for 5MHz.

Rakuton: For most issues, we would like to apply the generic solution for 3MHz for other bands.

### Issue 1-8: CR handling

* Proposals
	+ Proposal 1: Work item rapporteur is to provide a Big Draft CR for all the UE RF requirements and the group tries to endorse the Big Draft CR in every WG meeting in Q3-Q4 2024. (Intel)
* Draft CR list

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| --- | --- | --- |
| **TDoc** | **Title** | **Source** |
| [**R4-2407549**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2407549.zip) | draftCR for inter-band NR CA&DC with 3MHz CBW (System parameter part) | CATT |
| [**R4-2408798**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408798.zip) | draftCR for TS 38.101-1: Introduction of inter-band NR CA/DC with less than 5MHz CBW | ZTE Corporation, Sanechips |
| [**R4-2408814**](https://www.3gpp.org/ftp/TSG_RAN/WG4_Radio/TSGR4_111/Docs/R4-2408814.zip) | draft CR to TS 38.101-1: Introduction of CA\_n100-n101 | Qualcomm Inc. |

* Recommended WF
	+ Further discuss timelines to endorse draft CRs
	+ If agreeable to endorse CRs in RAN4 #111, then discuss individual CRs