**3GPP TSG-RAN WG4 Meeting # 98-e R4-210xxxx**

**Electronic Meeting, Jan. 25-Feb. 5, 2021**

**Agenda item:** 9.18.1

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [98e][117] NR\_SAR\_PC2\_interB\_SUL\_2BUL

**Document for:** Information

# Introduction

In the last RAN4#97e meeting, the SAR schemes for UE power class 2 NR inter-band CA and SUL configurations were discussed and a WF of R4-2016851 was approved with the following candidate options for SAR schemes:

* *Duty Cycle based solutions*
	+ *Option 1: Report the duty cycle capability per band combination (CTC, Intel, ZTE, Huawei, Apple)*
		- *Main issue commented by companies：Unequal responses for the SAR effects in different band frequencies.*
	+ *Option 2: Report the duty cycle capabilities per band (CATT, Xiaomi, ZTE, OPPO, vivo, CMCC)*
		- *Main issue commented by companies: Too many pairs of signalling's, more detailed signalling design and values need to be provided, especially for the reference band.*
* *Blind scheme solution (Ericsson, Verizon, T-Mobile USA)*
	+ *Further discussion on whether to consider (Scell) power dropping behavior due to power prioritization for UL CA and SUL configurations*
* *Other solutions/options are not precluded*

Based on this alignment, companies further study the SAR solutions for CA and SUL. In this meeting, according to the contributions submitted, this email discussion thread will focus on the following aspects:

* Topic#1: PC2 band-combination requirements for example combos
* Topic#2: PC2 SAR solutions
	+ Sub-topic 2-1: For PC2 inter-band CA
	+ Sub-topic 2-2: For PC2 SUL configurations
	+ Sub-topic 2-3: Release independence issue
* Topic#3: Power configuration

Note that the tables for collecting comments for sub-topic issues are arranged just below each issue.... and the tables for collecting comments for CR/TP are still kept at the original position.

# Topic #1: PC2 band-combination requirements for example combos

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2101109 | Xiaomi, ZTE Corporation | **Observation 1: No need to consider harmonic and IMD issues for PC2 band combination CA\_n41-n79.****Observation 2: Cross band isolation issue shall be re-evaluated for those PC2 cases that one band can support 26dBm if simultaneous Rx/Tx is supported for CA\_n41-n79.****Proposal 1: It is proposed to define the MSD requirements due to cross band isolation as shown in table 3 for CA\_n41-n79 high power UE.**Table 3: the proposed value for MSD requirements due to cross band isolation for high power UE

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| NR Band / Channel bandwidth of the affected DL band |
| UL band | DL band | 5MHz (dB) | 10MHz (dB) | 15MHz (dB) | 20MHz (dB) | 25MHz (dB) | 30 MHz (dB) | 40 MHz (dB) | 50 MHz (dB) | 60 MHz (dB) | 70MHz(dB) | 80 MHz (dB) | 90 MHz (dB) | 100 MHz (dB) |
| n41 | n79 |  |  |  |  |  |  | 3.1 | 3.1 | 3.1 |  | 3.1 |  | 3.1 |
| n79 | n41 |  | 3.5 | 3.3 | 3.1 |  |  | 2.6 | 2.5 | 2.5 |  | 2.4 | 2.4 | 2.4 |

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## Open issues summary

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

### Sub-topic 1-1: PC2 band-combination requirements

This sub-topic will discuss band-combination requirements for PC2 inter-band CA, i.e. CA\_n41A-n79A

**Issue 1-1-1: Requirements for PC2 CA\_n41A-n79A**

* Proposals
	+ It is proposed to define the MSD requirements due to cross band isolation as shown in table 3 for CA\_n41-n79 high power UE. (R4-2101109)

Table 3: the proposed value for MSD requirements due to cross band isolation for high power UE

|  |
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| NR Band / Channel bandwidth of the affected DL band |
| UL band | DL band | 5MHz (dB) | 10MHz (dB) | 15MHz (dB) | 20MHz (dB) | 25MHz (dB) | 30 MHz (dB) | 40 MHz (dB) | 50 MHz (dB) | 60 MHz (dB) | 70MHz(dB) | 80 MHz (dB) | 90 MHz (dB) | 100 MHz (dB) |
| n41 | n79 |  |  |  |  |  |  | 3.1 | 3.1 | 3.1 |  | 3.1 |  | 3.1 |
| n79 | n41 |  | 3.5 | 3.3 | 3.1 |  |  | 2.6 | 2.5 | 2.5 |  | 2.4 | 2.4 | 2.4 |

* Recommended WF
	+ Collect views on the proposed MSD values, if no comments, the contribution R4-2101109 will be recommended as approved.

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| **Company** | **Comments on Issue 1-1-1: Requirements for PC2 CA\_n41A-n79A** |
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## Companies views’ collection for 1st round

### CRs/TPs comments collection

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| **CR/TP number** | **Comments collection** |
|  | Company A |
| Company B |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:*  |

### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
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# Topic #2: PC2 SAR solutions

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2100100 | CMCC | Proposal: It is proposed to define the SAR solutions for PC2 inter band CA and SUL configurations based on per band. |
| R4-2101101 | Xiaomi | Observation 1: If dutycycle based solution is used, the P-MPR impact on UE configured maximum output power could be decrease.Proposal 1: Besides the default solution, i.e. UE implementation based solution (P-MPR), the dutycycle based solution can be introduced as a capability for PC2 NR inter-band CA UE meeting SAR issue.Observation 2: For option 2, the most important thing is not about which band is selected as reference band but how many reference points and theirs values are used.Observation 3: Option 2a is not only saving signaling but also be more operable in practice compared to option 2b.Proposal 2: For PC2 inter-band CA case, it is proposed option 2a is adoptedProposal 3: For FDD+TDD case, it is proposed to select FDD as reference band by considering the dutycycle for FDD is not so viable and FDD band usually has better coverage due to low frequency. The reference points can be reused from NSA FDD+TDD case. For TDD+TDD case, it is proposed to select Low band as reference band, but how many reference points shall be used can be FFS. |
| R4-2101102 | Xiaomi | Observation 1: If dutycycle based solution is used, the P-MPR impact on UE configured maximum output power could be decrease.Proposal 1: Besides the default solution, i.e. UE implementation based solution (P-MPR), the dutycycle based solution can be introduced as a capability for PC2 NR inter-band CA UE meeting SAR issue.Proposal 2: For PC2 SUL case, it is proposed to report UL duty cycle capabilities based on the duty cycle in NUL band and how many reference points are used can be FFS. |
| R4-2101117 | China Telecom | Proposal 1: Report one total UL duty cycle capability by considering SARratio factor as expressed by the equation 2.DutyNR, x \*( PNR,x/ P26)\*SARratioNR, x + DutyNR, y \*(PNR, y/ P26)\* SARratioNR, y ≤ *Duty threshold …*(2)Proposal 2: Report the *maxUplinkDutyCycle-CA-PC2* as the sequence of *maxUplinkDutyCycle[1,2,3,4]* for power class 2 case [a,b,c,d] correspondingly. * Proposal 2a: The SARratio factor is proposed by equation 3, but no need to report since it could be inherited from the corresponding single band capability.

SARratioNR, x = 50%/DutycycleNR, x SARratioNR, y = 50%/DutycycleNR, y  …(3) |
| R4-2101118 | China Telecom | Proposal 1: Report one total UL duty cycle capability by considering SARratio factor as expressed by the equation 2.Proposal 2: Report the *maxUplinkDutyCycle-SULcombination-PC2* for power class 2 NR SUL configurations.* Proposal 2a: The SARratio factor is proposed by equation 3, but no need to report since it could be inherited from the corresponding single band capability.
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| R4-2101119 | China Telecom | draft CR to 38.101-1 Introduce SAR solution for UE power class 2 NR inter-band CA with 2UL |
| R4-2101120 | China Telecom | draft CR to 38.101-1 Introduce SAR solution for UE power class 2 NR SUL configurations |
| R4-2101726 | Ericsson | We make the followingObservation 1: duty-cycle reporting is not viable for UL CA (and EN-DC)* the ‘actual’ UE output powers on the uplinks also determine the total average output power; the network has limited information about the UE output power on a radio-frame time scale, the PHR is not that frequent, not accounting for any scaling and has limited reporting accuracy
* the measurement of the ‘actual’ duty cycle is ambiguous in the time domain; ”certain evaluation period” has been used for TDD HPUE throughout, but is unknown to the scheduler for its evaluation

andProposal 1: duty cycle reporting should not be specified for UL CA PC2; it is not viable.Instead, we propose thatProposal 2: to facilitate SAR compliance for UL CA PC2 and prevent dropping of SCells, UE-specific absolute or relative power limits (P-Max) could be specified modifying the configured maximum output power per serving cell. Proposal 3: the UE-specific power limits could be used in conjunction with the P-MPR method.Proposal 4: the absolute/relative power limits are set up during the RRC reconfiguration (or modification) of the band combination. The limit to be used by the UE is determined by a MAC-CE or a PDCCH message based on a DCI format, which enables fast adaptation to changing radio conditions temporarily enabling/disabling limits. The method is also applicable for SUL. The following should also be considered:Observation 2: the Pcmax,f,c per serving cell and thus the PHR (always per cell) would be modified by the P-MPR method, but not by any power prioritization for concurrent transmissions according to 38.213. Observation 3: the PCMAX would be modified by the P-MPR method for SAR compliance (long time scale) and thus the power prioritization for concurrent transmissions (slot time scale) according to 38.213.  |
| R4-2101752 | OPPO | *Observation 1: Reporting of combined Band X +Band Y duty cycle capability is a possible way for inter-band UL CA HPUE SAR issues.**Proposal 1: It is proposed to consider reporting a group of combined maxUplinkdutycycle capabilities for inter-band UL CA HPUE SAR issue.* |
| R4-2102190 | ZTE Corporation | Proposal 1. For duty cycle based solutions, report both total duty cycle capability and duty cycle of PCell.If only Option 1 and Option 2 in the WF are considered, for sake of progress, Option 2 is also acceptable for us. |
| R4-2102191 | ZTE Corporation | Proposal 1. For duty cycle based solutions, report both total duty cycle capability and duty cycle of PCell.Proposal 2. Introduce maximum output power table for both PC3 and PC2 SUL in TS38.101-1.For proposal 1, if only Option 1 and Option 2 in the WF are considered, for sake of progress, Option 2 is also acceptable for us. |
| R4-2102287 | Huawei, HiSilicon | *Proposal 1: It is proposed to report the per-BC total UL duty cycle capability as well as SARratio factor for NR HPUE UL CA band combinations.* |
| R4-2102289 | Huawei, HiSilicon | *Proposal 1: It is proposed to report the per-BC total UL duty cycle capability as well as SARratio factor on the PC2 NR band for NR SUL HPUE band combinations.**Proposal 2: PC2 HPUE only falls back maximum output power on TDD band but not SUL band when operating under SUL-TDD band combinations.**Proposal 3: The condition for UE power fallbacks is met when either 1) the network configures 23dbm or less Pmax or 2) the network schedules too many UL resources, under SUL-TDD band combinations operating with 26dbm MOP.* |
| R4-2102712 | vivo | Proposal 1: The solution based on option 2 with detail signaling: 1. Select PCell band as the reference band, UE report duty cycle capability based on PCell band.
2. Select 2 reference points on the reference band (Pcell band);
3. Two pair of reference points are defined: [40%/70%], [20%/35%], UE chooses one pair reference points to report duty cycle. The signalling can be as the following table:

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| UE maxUplinkDutyCycle signaling | Parameter (for another cell) |
| ReferenceDutyCycle70and40 | {maxUplinkDutyCycle1, maxUplinkDutyCycle2} |
| ReferenceDutyCycle35and20 | {maxUplinkDutyCycle1, maxUplinkDutyCycle2} |

1. When the actual uplink transmission time exceed the UE capability, the overall power class fallback and the power reduction on each band and each channel follows the RAN1 power allocation prioritizing order.

Observation: The UE would actually only report one of the two sets of parameters after RACH, this means the signalling overhead is in fact aligned with FDD-TDD EN-DC.Proposal 2: Further analysis for removing upper power limits for PC2 UE with the inter-band NR CA is proposed. |
| R4-2101121 | China Telecom | Proposal 1: It is proposed to consider the example provided in this contribution when specifying into 38.307. |
| R4-2101122 | China Telecom | CR to 38.307 Release independence for UE power class 2 NR inter-band CA and SUL configurations (R15) |
| R4-2101123 | China Telecom | CR to 38.307 Release independence for UE power class 2 NR inter-band CA and SUL configurations (R16) |
| R4-2101124 | China Telecom | CR to 38.307 Release independence for UE power class 2 NR inter-band CA and SUL configurations (R17) |

## Open issues summary

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

### Sub-topic 2-1: For PC2 inter-band CA

This sub-topic will discuss SAR schemes/solutions for PC2 inter-band CA.

**Issue 2-1-1: SAR schemes for PC2 inter-band CA**

* Proposals
	+ Duty Cycle based solutions
		- Option 1: Report the duty cycle capability per band combination
		- Option 2: Report the duty cycle capabilities per band
	+ “blind scheme” solution
		- To facilitate SAR compliance for UL CA PC2 and prevent dropping of SCells, UE-specific absolute or relative power limits (P-Max) could be specified modifying the configured maximum output power per serving cell.
* Recommended WF
	+ Try to merge the options for capabilities reporting for duty cycle solution
	+ Discussion on “blind scheme” solution

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| **Company** | **Comments for Issue 2-1-1: SAR schemes for PC2 inter-band CA** |
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### Sub-topic 2-2: For PC2 SUL configurations

This sub-topic will discuss SAR schemes/solutions for PC2 SUL configurations.

**Issue 2-2-1: SAR schemes for PC2 SUL configurations**

* Proposals
	+ Duty Cycle based solutions
		- Option 1: Report the duty cycle capability per band combination
		- Option 2: Report the duty cycle capabilities per band
	+ “blind scheme” solution
		- To facilitate SAR compliance for UL CA PC2 and prevent dropping of SCells, UE-specific absolute or relative power limits (P-Max) could be specified modifying the configured maximum output power per serving cell.
* Recommended WF
	+ Try to merge the options for capabilities reporting for duty cycle solution
	+ Discussion on “blind scheme” solution

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| **Company** | **Comments for Issue 2-2-1: SAR schemes for PC2 SUL configurations** |
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### Sub-topic 2-3: Release independence issue

**Issue 2-3-1: Release independence issue for NR PC2 inter-band CA and SUL configurations**

* Proposals
	+ It is proposed to agree the CRs R4-2101122, R4-2101123, R4-2101124 for 38.307.
* Recommended WF
	+ Collect the views on the release independence CRs R4-2101122, R4-2101123, R4-2101124. If no comments, the CRs will be recommended as agreed.

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| **Company** | **Comments for Issue 2-3-1: Release independence issue for NR PC2 inter-band CA and SUL configurations** |
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## Companies views’ collection for 1st round

### CRs/TPs comments collection

The following two draft CRs will depend on the progress of SAR schemes discussion.

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| **CR/TP number** | **Comments collection** |
| R4-2101122 |  |
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| R4-2101123 |  |
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| R4-2101124 |  |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary**  |
| **Sub-topic#1** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:*  |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)

*Moderator tries to summarize discussion status for 2nd round and provided recommendation on CRs/TPs/WFs/LSs Status update suggestion*

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| **CR/TP/LS/WF number** | **T-doc Status update recommendation**  |
| XXX | *Based on 2nd round of comments collection, moderator can recommend the next steps such as “agreeable”, “to be revised”* |

# Topic #3: Power configuration

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2100372 | CATT | Observation 1: The impact to current PC3 definition needs to be clarified.Observation 2: How to interpret the power class for inter-band UL CA needs to be clarified.Observation 3: The spec impacts need more discussion such as Pcmax\_H definition and Power class report. |
| R4-2102414 | Qualcomm | The specifications should allow for this possibility by either removing artificial constraints on maximum configured output power or by definition of a new power class to reflect the hardware configuration. The pros and cons of each of these two approaches is listed in this contribution with a proposal that RAN4 should agree which is the most appropriate to follow. |
| R4-2102712 | vivo | Proposal 2: Further analysis for removing upper power limits for PC2 UE with the inter-band NR CA is proposed. |
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## Open issues summary

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

### Sub-topic 3-1: Power configuration

This sub-topic will discuss power configuration for UE equipped with two PA’s.

**Issue 3-1-1: Increasing UE maximum power for UE equipped with two PA’s**

* Proposals on increasing UE maximum power for UE equipped with two PA’s
	+ The specifications should allow higher UE Tx power by
		- Option1: Removing artificial constraints on maximum configured output power
		- Option2: Definition of a new power class to reflect the hardware configuration.
* Recommended WF
	+ Collect views on the proposals.

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| **Company** | **Comments for Issue 3-1-1: Increasing UE maximum power for PC2 inter-band CA** |
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## Companies views’ collection for 1st round

### CRs/TPs comments collection

The following two draft CRs will depend on the progress of SAR schemes discussion.

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| **CR/TP number** | **Comments collection** |
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## Summary for 1st round

### Open issues

*Moderator tries to summarize discussion status for 1st round, list all the identified open issues and tentative agreements or candidate options and suggestion for 2nd round i.e. WF assignment.*

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|  | **Status summary**  |
| **Sub-topic#** | *Tentative agreements:**Candidate options:**Recommendations for 2nd round:*  |

*Recommendations on WF/LS assignment*

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|  | **WF/LS t-doc Title**  | **Assigned Company,****WF or LS lead** |
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### CRs/TPs

*Moderator tries to summarize discussion status for 1st round and provides recommendation on CRs/TPs Status update*

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| **CR/TP number** | **CRs/TPs Status update recommendation**  |
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## Discussion on 2nd round (if applicable)

## Summary on 2nd round (if applicable)