**3GPP TSG-RAN WG4 Meeting # 99-e R4-21xxxxx**

**Electronic Meeting, May. 19-27, 2021**

**Agenda item:** 8.35.1

**Source:** Moderator (China Telecom)

**Title:** Email discussion summary for [99-e][126] NR\_SAR\_PC2\_interB\_SUL\_2BUL

**Document for:** Information

# Introduction

In the last RAN4#98bis-e meeting, the SAR solutions for UE power class 2 NR inter-band CA and SUL configurations were discussed and a WF of R4-2105341 was approved with the following candidate options for SAR solutions:

* *Duty Cycle based solutions*
	+ *Report the total duty cycle capability per band combination with SARratio factor consideration and not need to report SARratio*
		- *The Dutycycle threshold calculation procedure is based on formula (1), which is to be specified in the spec.*

*DutyNR, x \*( PNR,x/ P26)\*SARratioNR, x + DutyNR, y \*(PNR, y/ P26)\* [SARratioNR, y ] ≤ Duty threshold (1)*

* + - *How to define the SARratio will be further discussed, considering but not limit to the following options*
			* *Option 1: The SARratio calculation formula (2) could be a reference*

*[Formula (2): SARratioNR, x = 50%/DutycycleNR, x   ; SARratioNR, y = 50%/DutycycleNR, y]*

* + - * *Option 2: Depend on UE implementation*
* *“Blind scheme” solution can be discussed further*

Based on this alignment and according to the contributions submitted, this discussion summary will focus on the following topics:

* Topic#1: PC2 SAR solutions
	+ Sub-topic 1-1: Dutycycle solution for CA and SUL
	+ Sub-topic 1-2: Blind scheme solution
	+ Sub-topic 1-3: R17 power class report
* Topic#2: Increasing UE maximum power high limit

Note that the tables for collecting comments for sub-topic issues are arranged just below each issue...

# Topic #1: PC2 SAR solutions

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2108805 | Nokia, Nokia Shanghai Bell | Observation 1: * The following formula will generate inconsistency between the reported total duty cycle for uplink inter band CA by UE and the total(*actual*) duty cycle to be scheduled.
	+ DutyNR, x \*( PNR,x/ P26)\*SARratioNR, x + DutyNR, y \*(PNR, y/ P26)\* [SARratioNR, y ] ≤ *Duty threshold* (1)
	+ SARratioNR, x = 50%/DutycycleNR, x   ; SARratioNR, y = 50%/DutycycleNR, y

Observation 2: * With respect to the formulas (1) and (2), whatever DutycycleNR, x and DutycycleNR, y are, UE vendors can set the total(*actual*) duty cycle considering DutycycleNR, x and DutycycleNR, y by adjusting *Duty threshold*.

Proposal: In case duty cycle method is adopted, the formula should be as follows.* DutyNR, x \*( PNR,x/ P26) + DutyNR, y \*(PNR, y/ P26)\* SARratioNR ≤ *Duty threshold*
	+ The definition of SARratioNR is FFS. Possible candidates are DutycycleNR, x /DutycycleNR, y or reported by UE together with *Duty threshold.*
 |
| R4-2109676 | vivo | Observation: The max duty cycle per band *maxUplinkDutyCycle-PC2-FR1* is specified. And the factor impacted SAR is already considered per band. Proposal 1: To reuse the SA signal band SAR solution and save signaling overhead, SARratioNR = 50%/ *maxUplinkDutyCycle-PC2-FR1* and the default value is 1 when some of bands don’t support PC2 or the *maxUplinkDutyCycle-PC2-FR1* is not reported.Proposal 2: Considering more than 2 UL band CA are supported in the future, the square bracket in formula (1) is proposed to removed.Proposal 3: Considering the UE implementation flexibility, the candidate values for total duty cycle can be listed as {n50, n60, n70, n80, n90, n100, full\_duty}, 50% is proposed as default.  |
| R4-2109975 | Ericsson | We make the followingObservation 1: duty-cycle reporting is not viable for UL CA (neither for 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
* from a SAR perspective, there is no reason for a UE to fall back to UL CA PC3 in case the output power for one of the bands is significantly lower than the power class of the band, even though the duty cycle in this band is 100%.

and propose thatProposal 1: duty cycle reporting should not be specified for UL CA PC2; it is not viable. It poses constraints on scheduling that trigger unnecessary fallbacks to PC3.Observation 2: consideration of meaningful SAR ratio indicated the UE capability does not appear feasible. Moreover, it is not the task of the BS scheduler to ensure SAR compliance, it is a UE liability. P-MPR can always be used for SAR compliance. Does the SAR ratio override the P-MPR?Proposal 2: UE-specific absolute/relative power limits should be specified for modification of the configured maximum output power per serving cell to facilitate SAR compliance and UE heat management for UL CA PC2 and reduce the risk of dropping of SCells. Hit two birds with one stone.The P-MPR method is the default in case the power limits are absent.Proposal 3: the UE-specific power limits can be used in conjunction with the P-MPR method.The above method is also applicable for SUL.  |
| [R4-2110049](file:///E%3A%5C01%20%E6%A0%87%E5%87%86%5C14%20HPUE%5C02%20UL_interCA%5CRAN4_99_e%5CDocs%5CR4-2110049.zip) | China Telecom | Proposal 1: Report one capability with one sequence of maxUplinkDutyCycle values to apply for power class 2 case a, b, c, d for inter-band CA * Proposal 1a: The sequence could be defined as: maxUplinkDutyCycle - {n50, n60, n70, n80, n90, n100, full\_duty}
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| [R4-2110050](file:///E%3A%5C01%20%E6%A0%87%E5%87%86%5C14%20HPUE%5C02%20UL_interCA%5CRAN4_99_e%5CDocs%5CR4-2110050.zip) | China Telecom | Proposal 1: Report one capability with one sequence of maxUplinkDutyCycle values to apply for power class 2 case a, b for SUL configurations. * Proposal 1a: The sequence could be defined as: maxUplinkDutyCycle - {n50, n60, n70, n80, n90, n100, full\_duty}
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| R4-2110192 | Xiaomi | Proposal 1: It is proposed the mapping of power class configuration and dutycycle signalling sequence shown in table 2 shall be specified for high power UE inter-band UL CA and SULProposal 2: SARratio factor should be known for both BS and UE. If it is not reported, the SARratio calculation formula should be specified in the spec.Proposal 3: When the inter-band UL scheduling exceeds the UE overall maximum duty cycle capability by checking the equation (1), the traditional approach that fall back to PC3 shall be applied. |
| R4-2110438 | ZTE Corporation | Proposal: [Formula (2): SARratioNR, x = 50%/DutycycleNR, x ; SARratioNR, y = 50%/DutycycleNR, y] is selected, i.e. Option 1. |
| R4-2110830 | OPPO | *Observation 1: Without SAR ratio reported, it is impossible for the NW to consider the SAR difference between bands.**Observation 2: SAR ratio can be reported directly or calculated indirectly by formula.**Proposal 1: It is proposed to either report the SAR ratio to facilitate NW schedule the duty cycle between bands or calculate the SAR ratio by formula.**Proposal 2: It is proposed to consider SAR ratio {0.5, 0.7, 1.5, 2} and default value 1 if absent for direct reporting.* |
| R4-2110831 | OPPO | Observation 1: The power capability of bands with TxD might be different between under single band and under inter-band CAObservation 2: With TxD capability introduced, NW is able to understand the power class difference between single band and under CA mode.Proposal 1: It is proposed to not introduce new power class capability in Rel-16, and rely on the TxD capability to distinguish UE power class capability in single band and CA mode. |

## 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: Dutycycle solution for CA and SUL

**Issue 1-1-1: Dutycycle threshold calculation procedure**

**Question:** How to specify the SARratio in dutycycle threshold calculation formula (1) to the spec?

**Option1:** DutyNR, x \*( PNR,x/ P26)\*SARratioNR, x + DutyNR, y \*(PNR, y/ P26)\* SARratioNR, y  ≤ Duty threshold

**Option2:** DutyNR, x \*( PNR,x/ P26) + DutyNR, y \*(PNR, y/ P26) \*SARratioNR ≤ Duty threshold

**Recommended WF:** Collect views on these two options.

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| **Company** | **Comments on Issue 1-1-1: Dutycycle threshold calculation procedure**  |
| Nokia | Option 2 |
| Xiaomi | Option 2 or option 3 |
| China Telecom | Option 1Regarding option 2, the meaning of the parameter of *Duty threshold* is not explicit, actually it contains dutycycle capability of band NRx, if we transform option 1 to option 2. Also, if 3UL HPUE is proposed in future, option2 cannot be well compatible. |
| OPPO | Option 2. In our understanding, the SARratio in option 2 means the Band Y comparing to Band X, so when 3 bands introduced, then the band Z will compare to Band X and get SARratioZ |
| ZTE | Option 1 For option 2, one simple question, can SARratioNR be also applied to the DutyNR, x \*( PNR,x/ P26)? |
| Ericsson | This exercise if difficult since the actual UE power is not accounted for and the averaging length not specified. Can the network use the reported total duty threshold to assume that the UE has ‘higher’ “average” power capability? What would be the fallback behavior given this? |
| Apple | Either Option 1 or Option 2 is fine as long as they are mathematically correct and consistent with the definition for each parameter. What is the definition of P26? If the band is an FDD band, do we still use P26 in the formula? |
| Vivo | Option 1. the meaning and range of parameter of duty threshold in option 2 is unclear. |
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**Issue 1-1-2: SARratio calculation procedure**

**Question:** How to specify the SARratio calculation formula (2) to the spec?

**Option 1:** SARratioNR, x = 50%/DutycycleNR, x   ; SARratioNR, y = 50%/DutycycleNR, y

**Option 2:** SARratioNR = DutycycleNR, x /DutycycleNR, y

**Option 3:** Depend on UE reporting (which is in conflict with the WF of R4-2105341)

**Recommended WF:** Collect views on the options.

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| **Company** | **Comments on Issue 1-1-2: SARratio calculation procedure** |
| Nokia | Option 2 or 3 |
| Xiaomi | Option 1 or 2 |
| China Telecom | Option 1 |
| OPPO | Option 2 or 3. And if use either option 1 or 2, it needs to consider the case that the band X is PC3 in SA singe band then how to get dutycycle x ? |
| ZTE | Option 1, but it depend on the outcomes of issue 1-1-1. |
| CHTTL | As Issue 1-1-1 and Issue 1-1-2 are actually linked together. One clarification question for option 2 that how to determine which band is x and which band is y. The result will be reciprocal ex: 3/2 🡪 2/3 if the x and y band is exchanged. |
| Apple | Option 1 or Option 2 |
| Vivo | Option 1.  |
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**Issue 1-1-3: Total dutycycle capability**

**Question:** How to report the total dutycycle capability?

**Option 1:** Report only one total dutycycle capability independent of power class cases

**Option 2:** Report total dutycycle capabilities based on power class cases

**Recommended WF:** Collect views on these two options.

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| **Company** | **Comments on Issue 1-1-3: Total dutycycle capability** |
| Nokia | It would be great if UE vendors could share possible impact of each case on UL duty cycle. If we can see some tendency, we can reduce the number of signalling. |
| Xiaomi | Option 1. The total dutycle capability is derived based on the CA UE power class (i.e. 26dBm). The power configuration only affects which power parameter is selected in the equation for each bands. |
| China Telecom | Option 1 or 2.Option 1 will save the signaling, option 2 could solve the TxD issue raised by some companies.Maybe the signaling including two elements could be a compromise, one is config 1 considering TxD for 23+23 case, the other one is config 2 without considering TxD for the other PC2 cases.  |
| OPPO | Option 1. |
| ZTE | Option 1. The formulation can be applied for all the 4 cases, so one sequence of maxUplinkDutyCycle would be enough. |
| Apple | What is the definition of total duty cycle capability and its relation to per-band duty cycle capability? |
| Vivo | Option 1, the total duty cycle capability is based on MOP 26dBm, independent of the detail cases.  |

### Sub-topic 1-2: Blind scheme solution

**Proposals for blind scheme (**R4-2109975**):**

**Proposal 2:** UE-specific absolute/relative power limits should be specified for modification of the configured maximum output power per serving cell to facilitate SAR compliance and UE heat management for UL CA PC2 and reduce the risk of dropping of SCells. Hit two birds with one stone.

**Proposal 3:** the UE-specific power limits can be used in conjunction with the P-MPR method.

The above method is also applicable for SUL.

**Recommended WF:** Collect views on the proposals

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| **Company** | **Comments on Sub-topic 1-2: Blind scheme solution** |
| Qualcomm | We do not accept either proposal 2 or proposal 3. We are not convinced of the blind scheme as an approach to facilitate SAR compliance and UE heat management. These are fundamentally quantities that are known only to the UE and particular for any UE, so any approach that does not take UE capability reporting into consideration can be sub-optimal at best. If the answer is to use in conjunction with P-MPR to take into consideration the UE performance, then it is not clear what additional benefit the UE-specific power limits enable. |
| Huawei | It’s not clear how the proposed scheme(s) can work. As the proponent has pointed out, the network does not have prompt and accurate information on UE transmit power. The effect of setting UE-specific power limit is questionable, plus the signaling overhead. |
| Ericsson | To Qualcomm: by configuring the limits such that the average output power does not exceed 23 dBm. The same principle as other HPUE methods but without the downside of the duty-cycle method as there are no scheduling restrictions and unnecessary fallback to PC3. Is the SAR ratio above preferred? We recognize that the UE can always use P-MPR for SAR if e.g. triggered by proximity sensors. The same for all power classes.The benefits? Predictability for the network. The method is not blind! Power prioritization can be controlled by the network. Testability. The “downside” with the corresponding solution for EN-DC PC2 with the “slow” RRC reconfiguration for removing the PLTE limit now remedied by MAC-CE signaling to disable/enable limits as needed when the radio conditions change.The proprietary P-MPR method is blind. The network can only estimate its behaviour by making UL measurements. But we prefer it to the duty-cycle method.To Huawei: hope the above answers the questions. We do not understand the concern on signaling overhead. The MAC-CE would not be sent frequently. No worse than a TA update (also a MAC-CE).  |
| Vivo | We do not prefer to either of them. |
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### Sub-topic 1-3: R17 power class report

**Proposals for R17 power class report:**

**Proposal 1:** It is proposed to not introduce new power class capability in Rel-16, and rely on the TxD capability to distinguish UE power class capability in single band and CA mode.

**Recommended WF:** Collect views on the proposal

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| **Company** | **Comments on Sub-topic 1-3: R17 power class report** |
| Nokia | It’s OK but we need to make sure that TxD PC does not change regardless of being used mode such that CA or single band operation. |
| Qualcomm | We don’t see the value of accommodating a 23+23 PC2 in the single band, but 23 only when configured for CA. This means that when the UE is configured for CA, the power in the CC is reduced by 3 dB which will hurt coverage. So while we agree not to introduce the new power class capability in R16, we don’t see the need to make any other adjustment to the specs either.  |
| Huawei | The proposal might work if the network is sure that the UE is equipped with only two PC3 PAs. In this case, either PC2 on a single band or PC2 for CA are implemented by two PAs. The underlying assumption may not always be true. Hypothetically speaking, one UE implementation may utilise three 23 dBm PAs. So it could report PC2 for both band X and band Y as well as PC2 for CA\_X-Y potentially with 23+26dBm/26+23dBm power configuration. Therefore we still think some form of explicit signaling would be beneficial, especially when we’re discussing increase of max power limit in topic #2.To Qualcomm:The 23+23 is a valid power configuration for PC2 CA. And according to the R16 power control rules, the total output power of PC2 CA is capped at 26 dBm at any symbol period. If both UL are transmitting, the max output power on individual bands is reduced anyway, regardless of whether TxD is used or not. |
| Xiaomi | Support this proposal |
| Skyworks | This aspect must be decided in conjunction with the increased maximum power aspect as it is not clear that TxDiv signaling is sufficient depending on the number of PAs and their individual capability. A complete signaling solution need to be understood. |
| OPPO | Support Proposal 1. The proposal here considers the typical implementation with TxD, i.e. PC3+PC3 to achieve PC2 in Band X, then when it comes to inter-band CA, this band X can only support PC3 rather than PC2. So the combination of PC2 and TxD can be used to determine the power capability in single band and CA. Regarding the three PA case, it is understood that UE might be in 23 or 26 in CA, to solve this ambiguity then with the approach above the power class of each band under CA will be PC3, i.e. PC2 Band X alone, PC2 Band Y alone, PC2 Band X+Y with PC3 in Band X and Band Y. It still works even not perfect.And for clarification of the intended explicit signaling, is it static power class reporting or dynamic reporting?  |
| Qualcomm | We still don’t agree with this idea of degrading the per carrier power class when CA is configured. I understand Huawei’s point about power control limiting the total power (a limitation that I’ve been trying to overcome); however, in the case where UL allocation for a slot is only scheduled on one of the CC’s, that CC should be able to reach 26 dBm for coverage since this is the coveraged enabled when CA is not configured for that one CC. It should not fallback to max 23 dBm after CA configuration. |
| Apple | Question for clarification, for PC2 inter-band UL CA, do we allow each UL to transmit more than 23dBm (assuming TDD bands) when both ULs are transmitting simultaneously? If not, why is it important to know whether the power capability is 23dBm or 26dBm under CA?  |

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

# Topic #2: Increasing UE maximum power high limit

## Companies’ contributions summary

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| **T-doc number** | **Company** | **Proposals / Observations/Abstracts** |
| R4-2108806 | Nokia, Nokia Shanghai Bell | Observation 1: If removing PPowerClass,CA from PCMAX\_H, there is a backward compatibility issue. Because gNBs would consider the UEs supporting the default PC for the uplink inter-band CA. Hence, the gNBs cannot distinguish legacy UEs without this feature, i.e., PC3 and new UEs with it.Observation 2: The backward compatibility issue in the Observation 1 can be resolved by introducing a new capability.Observation 3: If removing PPowerClass,CA from PCMAX\_H and if it means PPowerClass,CA is not reported, PCMAX\_H cannot reflect UE’s real ability and/or the meaning of PC may be ambiguous.Observation 4: If removing PPowerClass,CA from PCMAX\_H and if it means PPowerClass,CA is not reported, PCMAX\_L does not hold true.Observation 5: For a UE with this new feature, by replacing pPowerClass,CA with ∑ pPowerClass,c , the UE can be handled as if the UE has a new power class without introducing it. And this can be applied to any combinations of power classes within a band combination such that 23dBm+26dBm, 23dBm+29dBm, 26dBm+29dBm etc.Observation 6: The introduction of new power classes is not suitable to the original purpose of this discussion.Observation 7: The introduction of power boosting is making the specification more complicated than any other listed options. Observation 8: For possible impact on regulations, there is nothing new to be discussed. The same principle of PC2/1.5 UEs applies to the UEs with this new feature. That is, if the IE P-Max as defined in TS 38.331 is provided and set to the maximum output power of the default power class or lower, shall apply all requirements for the default power class to the supported power class and set the configured transmitted power as specified in clause 6.2A.4.Observation 9: A new signalling is needed for each method. Removing PPowerClass,CA from PCMAX\_H or replacing PPowerClass,CA with the sum of PPowerClass,c can offer more versatility than an introduction of a new PC, since the latter requires extra PCs in the future if RAN4 introduces 23dBm+26dBm for MR-DC or 23dBm+29dBm, 26dBm+29dBm for not only CA but also MR-DC etc in the future.Observation 10: For SAR, there is nothing particular to address for this new feature. The same SAR method for normal PC2 uplink inter band CA can be reused and the value for maxUplinkDutyCycle can be discussed . By the time the SAR method for PC2 uplink inter band CA is completed, P-MPR can be used.Observation 11: For MPR/A-MPR, we can reuse the existing requirements. For MSD, re-evaluation is needed for MSD due to intermodulation interference and that due to cross band isolation.Proposal 1: Focus on increasing UE maximum power high limit for NR uplink inter band CA under this WI and revise the WID to accommodate this topic in the objective accordingly.Proposal 2: For a UE with this new feature, select replacing pPowerClass,CA with ∑ pPowerClass,c |
| R4-2109173 | Mediatek India Technology Pvt. | Observation 1: Since an excess maximum output power has the possibility to interfere to other channels or other systems and a small maximum output power decreases the coverage area, power-tolerance test is needed.Observation 2: Regarding options of defining new power class or power boosting, power-tolerance test issue of 27.8dBm can be solved by referring to original methods/tables in TS [38.521](https://www.3gpp.org/ftp/Specs/archive/38_series/38.521-1/38521-1-h00.zip) for modification. Regarding other options of increase of maximum output power, no clear clarification yet for power-tolerance range. Proposal 1: Regarding increase of maximum output power, RAN4 has to clarify CA maximum power and power-tolerance range with adopted methodologies/options to increase maximum power. The question needs discussion in RAN4 first. Observation 3: In WF[1], possible impacts by increasing UE maximum power high limit need to be solved before agreeing to enable increase of maximum output power.Proposal 2: Need to solve possible impacts in Table 1 for increasing UE maximum power high limit before agreeing to enable it. If there are new issues/impacts, they are not precluded for discussion. Table 1

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| Possible impact to regulations | Possible impact to 3GPP specifications | Possible need for signaling | Possible impact to SAR and whether existing mechanisms such as duty cycle need to be enhanced | Possible impact to SAR and whether existing mechanisms such as duty cycle need to be enhanced | Possible impact on RAN4 requirements, such as MPR, emissions, coexistence | Possible impact to measurement and test |

Proposal 3: Since PC2 for FDD bands need more discussion for study and convergence, CA of FDD(23dBm) + TDD(26dBm) can be first reference case for discussion/evaluation.  |
| R4-2109976 | Ericsson | For inter-band UL CA, we propose thatProposal 1: define an new power class for inter-band combinations supporting a total UE power greater than 26 dBm (Option 2). The only new power class needed is “23 + 26” dBm, PC1.5 already exists for band combinations.Observation 1: operators can set a UE-specific limit (PNR) of the total output power per cell group configured for each UE should there be any regulary requirements applying in the geographical region of operation.Observation 2: Option 2 does not imply any new signaling and can be specified in 38.101-1.There is an impact on SAR, the total average output power can increase. Duty-cycle reporting would be affected, but should not be specified at any rate.Observation 3: a higher BC power class implies higher total power, UE heat management and facilitation of SAR compliance more challenging. Observation 4: for inter-band CA, MSD requirements would be impacted by the higher power class.The latter was essentially the only consequence when increasing the power capability of EN-DC band combinations aside from the duty-cycle reporting. |
| R4-2111298 | Huawei, HiSilicon | Proposal 1: Define Band Combination (BC) only power classes to signal the max total power limit as well as PA configuration.Proposal 2: FFS possible impact of increasing the max output power limit.Proposal 3: RAN4 prioritises the work on inter-band combinations.Proposal 4: Discuss the topic in a dedicated SI in Rel-18. |
| R4-2111501 | Apple | Observation 1: One potential issue with PC2 inter-band UL CA is when UL SCell is deactivated, the UE would not be able to maintain PC2 power capability if its per band capability is only PC3.Observation 2: Per-band requirements can very well be applied for inter-band UL CA without the need for defining the composite power class provided the thermal and SAR issues can be mitigated, just like that for FR1-FR2 UL CA.Observation 3: Inter-band UL CA power class is only needed when a UE would like to confine its own total maximum output power to less than the sum of its per-band power capability. Otherwise, per-band power capability should be sufficient.Proposal 1: Introduce a new CA power class where the requirements would be based on per-band power capability to enable NR inter-band UL CA to fully utilize each constituent band power capability.Proposal 2: There is no need to further define separate MSD requirements with different UL CA power compositions other than PC2 and PC3 to enable NR inter-band UL CA to fully utilize each constituent band power capability. |

## 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: Increasing UE maximum power high limit

**Issue 2-1-1: How to increase UE maximum power high limit**

**Option 1:** Remove PPowerClass constraint from PCMAX\_H

**Option 2:** Replace PPowerClass with sum or modified sum in both PCMAX\_H and PCMAX\_L

**Option 3:** Define a new power class

**Option 4:** Consider power boosting approach

**Recommended WF:** Collect views for the options

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| **Company** | **Comments on Issue 2-1-1: How to increase UE maximum power high limit** |
| **Nokia** | Option 2. Otherwise we need to define new power classes not only for uplink inter band CA, intra band cont, non-cont CA, EN-DC, NR-DC etc… |
| Qualcomm | Our preference is option 1 or option 2. |
| Huawei | Our preference is option 3, but option 3 may have different meaning under different companies’ proposals. In our proposal, the new power class is defined for band combination only. In essence it’s a new signaling for indicating the max total power as well as CA power configuration.We’re also open to discuss other options. So far, option 1 may not be compatible with the power control rules; option 2 would reduce the flexibility of UE implementation and might result in incorrect power sum for power classes via TxD or dual-PA architecture. Option 4 may complicate the power control. |
| Xiaomi | Option 3 or 4. Since some requirements such as MOP, MSD and uplink dutycycle capability depends on the total UE power class. |
| Skyworks | In our understanding , if the new power class option (option 3) is based on each band power class signaling there is no fundamental difference with option 2. In this case the power class only designates the possible implementations and combined signaling:23+23, 23+26, 26+26, 20+20, 20+23, 20+26…Regarding the increase max power, all the two UL (even 3UL if one band uses intra-band UL CA) MSD will increase. This does mean that new MSD test point are needed as they can already tested with the “normal 23+23dBm” PC2 requirement, but signaling is needed so that NW is aware that these MSD will be higher for the UEs that will have the increased power capabilityHow the increased max power affects the duty cycle management and threshold should be further studied |
| OPPO | Option 4.  |
| **ZTE** | Our preference is option 1, also we can accept option 4.  |
| CHTTL | Our preference is option 3… based on the regulator’s aspect.In some regulation, there is restriction on the conducted maximun output power, for power class 2 UE 🡪 maximum 26dBm, for power class 3 UE 🡪 maximum 23dBm. So other options might not be acceptable from this point of view, cuz it will be difficult to tell the regulator that okay… this UE is power class 2, but in some case the power might exceeed 26dBm? |
| Ericsson | Option 1 is impossible, then the upper limit of PCMAX at which the UE should start prioritizing power would be unspecified.Option 2 would lead to a conflict with the power class for the band combination, the network assumes this is PC3 if the BC power class is not present (replaced by a “sum”)***powerClass, powerClass-v1610***Indicates power class the UE supports when operating according to this band combination. If the field is absent, the UE supports the default power class [PC3]. If this power class is higher than the power class that the UE supports on the individual bands of this band combination (*ue-PowerClass* in *BandNR*), the latter determines maximum TX power available in each band [in the proposed cases it would be assumed to be lower if *powerClass* absent]. The UE sets the power class parameter only in band combinations that are applicable as specified in TS 38.101-1 [2] and TS 38.101-3 [4]. This capability is not applicable to IAB-MT.Option 3 straightforward: PC2 and PC1.5 (26 + 26) already exists for a band combination, just add a field for 23 + 26… why not PC1.7? Option 4 also works, then the UE indicates a “delta” w r t an existing PC for the band combination, similar to boosting for TX switching. Option 3 preferred. |
| Qualcomm | For CHTTL, can you share the regulation? It seem strange to me that regulations would refer to 3GPP defined power classes and impose limits based on that. They usually just limit the total output power or EIRP. For regulatory compliance, Pemax can be signaled if needed. |
| Apple | Option 3: Define a new power class where the requirements are based on per-band capability. The concept is similar to Option 2. However, for Option 2, if no CA power class is signaled to the network, would the network still assume the CA is PC3 (default power class)?  |
| Samsung | Option 3 for the UL CA is more preferred now since we see some potential issues if the current Pcmax bounds are changed.  |
| Vivo | We prefer to option 3, option 2 can also be considered. |

**Issue 2-1-2: WI scope for increasing UE maximum power high limit**

**Option 1:** Focus on increasing UE maximum power high limit for NR uplink inter band CA under this WI and revise the WID to accommodate this topic in the objective accordingly.

**Option 2:** Discuss the topic in a dedicated SI in Rel-18.

**Recommended WF:** Collect views for the options

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| --- | --- |
| **Company** | **Comments on Issue 2-1-2: WI scope for increasing UE maximum power high limit** |
| **Nokia** | Uplink inter band CA as far as we discuss this feature under this WI |
| Qualcomm | Option 1 |
| Huawei | Our preference is option 2, but we’re also open to see other views. |
| ZTE | Option 1 |
| Ericsson | Changing the power class of the band combination a straightforward amendment that would work with the “blind scheme” and presumably the P-MPR method without changes to the specification. |
| Apple | Option 1 or Option 2 if Option 1 cannot be concluded in Rel-17 |
| **Samsung** | We prefer Option 1 focusing on this WI as much as possible |
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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 2-1: Increasing UE maximum power high limit | **Companies standpoints for options for Issue 2-1-1: How to increase UE maximum power high limit:****Option 1:** Remove PPowerClass constraint from PCMAX\_H* Qualcomm, ZTE

**Option 2:** Replace PPowerClass with sum or modified sum in both PCMAX\_H and PCMAX\_L * Nokia, Qualcomm, vivo

**Option 2a:** Define a new power class where the requirements are based on per-band power capability (no need to further define separate MSD requirements)* [Apple, vivo]

**Option 3:** Define a new power class per band-combination* [Huawei, Xiaomi, CHTTL, Ericsson, vivo, Samsung]

**Option 4:** Consider power boosting approach* Xiaomi, OPPO, ZTE, Ericsson
 |
|  | **Companies standpoints for options for Issue 2-1-2: WI scope for increasing UE maximum power high limit****Option 1:** Focus on increasing UE maximum power high limit for NR uplink inter band CA under this WI and revise the WID to accommodate this topic in the objective accordingly.* Nokia, Qualcomm, ZTE, Apple, Samsung

**Option 2:** Discuss the topic in a dedicated SI in Rel-18.* Huawei, Apple
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*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 for 2nd round