3GPP TSG-RAN WG2 #103 Tdoc R2-18xxxxx

Gothenburg, Sweden, August 20th – 24th 2018

Agenda Item: x.x.x.x

Source: Ericsson

Title: Email discussion report: Power Class and P-max

Document for: Discussion, Decision

# 1 Introduction

In this email discussion RAN2 is supposed to “*reach a common understand of the power class related signalling as required by RAN1 and RAN4 agreements, and to progress the CR*”. The intended outcome is a report and a set of CRs to the next meeting.

The deadline for the discussion is Thursday 2018-08-02.

# 2 Discussion

## 2.1 Background

At the AH1807 meeting, the discussion was based on the following paper:

* R2-1810384 E234/E235 Power Class and P-max Ericsson discussion Rel-15

Several agreements have been reached:

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| => The per-UE power is clarified to be just for FR1 (call it per-UE-FR1)=> Make the change backward compatible. (Changes to INMs may be non-backwards compatible)=> The change to the NR side should go into the SA CR, and the LTE side should go into the EN-DC CR.=> UE capability and INM aspects can be progressed offline |

During the AH meeting we provided corresponding CRs for LTE and NR RRC that reflect the agreements:

* R2-1810858 Power class and P-max, CR to 38.331 Ericsson, RAN2-102-AH Montreal
* R2-1810934 Power class and P-max, CR to 36.331 Ericsson, RAN2-102-AH Montreal

As seen above, RAN2 agreed (based on RAN4’s input) that the per-UE power class should be applicable to serving cells on FR1 only. Furthermore, the existing inter-node signalling for conveying the per-cell-group values p-NR and p-LTE stated also explicitly that it is applicable only for serving cells in FR1. We therefore adjusted also the corresponding Uu signalling by renaming p-NR to p-NR-FR1 and p-LTE to p-LTE-FR1 (change “2” in the 38.331 CR).

## 2.2 Discussion

At the presentation of the above-mentioned CRs questions were raised whether it is really intended by RAN4 to apply the power restrictions only to FR1 or whether they should also apply to FR2. And if the latter, the question was whether separate signalling parameters would be required for FR2 or whether one parameter would apply to all serving cells (irrespective whether FR1 or FR2). To resolve these open issues and to finalize the CRs we would hence appreciate companies views... **preferably after consulting their RAN4 colleagues**.

### 2.2.1 Configuring maximum power in DL signalling

**Q1.1) Do the p-Max fields in dedicated signalling (p-NR, p-LTE, p-UE) and in inter-node signalling apply only to serving cells operating on FR1 or also to serving cells operating on FR2?**

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| Company | Comment |
| Sprint | RAN4 only requested p-Max for FR1. From R2-1806639:P-Max for EN-DC and NR CA is also necessary to limit the total transmission power for some potential use cases such as 10 dBm in a hospital.* *P-Max for EN-DC and NR CA in FR1 is introduced for some power limited use cases.*

PEMAX (which is what RAN4 calls p-Max) appears in 38.101-1:PCMAX\_L,f,c ≤ PCMAX,f,c ≤ PCMAX\_H,f,c with PCMAX\_L,f,c = MIN {PEMAX,c– ∆TC,c, (PPowerClass – ΔPPowerClass) – MAX(MPRc + A-MPRc+ ΔTIB,c + ∆TC,c +∆TRxSRS, P-MPRc) }PCMAX\_H,f,c = MIN {PEMAX,c, PPowerClass – ΔPPowerClass }But not in 38.101-2 (FR2 spec):The configured UE maximum output power PCMAX,f,c for carrier *f* of a serving cell *c* shall be set such that the corresponding measured peak EIRP PUMAX,f,c is within the following boundsPPowerclass – MPRf,c – P-MPRf,c – T(MPRf,c + P-MPRf,c) ≤ PUMAX,f,c ≤ EIRPmaxwhile the corresponding measured total radiated power PTMAX,f,c is bounded byPTMAX,f,c ≤ TRPmax |
| Huawei | In our understanding at least in current RAN4 agreements, Pmax is only applied to EN-DC and NR CA for FR1, we suggest currently we only apply this parameter to FR1. if later RAN4 introduces similar thing to FR2, we can introduce another parameter for FR2 as even this applies to both FR1 and FR2, the specific value might be different for FR1 and FR2. |
| T-Mobile USA | These apply to both FR1 and FR2 |
| NTT DOCOMO | RAN4 LS (R2-1806639) stated that *P-Max for EN-DC and NR CA in FR1 is introduced for some power limited use cases*. As the serving cell level power limitation is already supported regardless of FR1/FR2 as in LTE (called P-Max), we understand the RAN4 intention such that “P-Max for EN-DC and NR CA in FR1” is the power limitation per UE in FR1. RAN4 has agreed this per-UE power limitation for FR1 only. RAN4 has not discussed whether the per-UE power limitation is needed for FR2 as well. |

**Q1.2) If they apply only to FR1, do we need additional parameters for FR2?**

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| Company | Comment |
| Sprint | Maybe, but that shouldn’t hold up the addition of p-Max for FR1 as requested by RAN4.  |
| Huawei | As explained above, we are not sure whether same value can be applied to FR1 and FR2 and in this case we prefer to introduce another parameter, however this seems not essential to be introduced right now. As long as we allow future extensions with backward compatible changes, this can be added later until RAN4 has further agreements. |
| NTT DOCOMO | It is better to wait for further input from RAN4. |

**Q1.3) Impact on dynamic power sharing?**

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| Company | Comment |
| Huawei | In previous discussion RAN1 made agreement that the dynamic power sharing is justified by the condition whether P\_lte + P\_nr > X\_total, and RAN4 defined X\_total as UE’s power class. Now if we introduce Pmax for EN-DC and NR CA case (also requested by RAN4), I am not sure whether the previous justification for dynamic power sharing is still valid anymore. It seems the more appropriate way is to define the X\_total as the Pmax used for EN-DC case? We need to check with RAN4 on this point. In addition we need to think about whether this would further affect LTE power control in RAN1 as in my current understanding LTE power control has not taken this into account. |
| NTT DOCOMO | X\_total could be P\_CMAX as in LTE, i.e. min {p-UE, power class}. |

### 2.2.2 Power-Class signalling in UE capabilities

**Q2.1) Do we need an additional powerClass parameter for FR2 in the UE capability?**

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| Company | Comment |
| Ericsson | **No** - It was concluded in the RAN2 AH meeting that the additional power class value in the band combination works anyway only for 2 UL and that hence a single “powerClass” value per band combination is sufficient. The network derives the allowed split among the Uls from the per-band power class. Hence, from signalling point of view, it does not matter whether the two ULs are for FR1 and/or FR2. In other words, the one powerClass parameter introduced in the CR should be sufficient for FR2, too. |
| Sprint | **Not at this time, but maybe Yes in the future – I**t is important to note that powerClass for FR1 and for FR2 are completely independent. Power class for FR1 is in dBm (conducted power), while PowerClass for FR2 is in EIRP (radiated power). From 38.101-3:6.2B.1.5 Inter-band EN-DC including both FR1 and FR2*< OTA requirements >*<Editor’s notes: chapter numbers to be updated.>For inter-band EN-DC of LTE and NR in both FR1 and FR2, the UE shall meet each transmitter power requirement for inter-band EN-DC of LTE and NR in FR1specified in clause 6.2B.1.3 of TS 38.101-3 and for NR in FR2 clause 6.2.1 of TS 38.101-2 independently.For now, there are no CA or EN-DC band combinations with more than one FR2 band. So, per-band Power Class should be sufficient for FR2 bands. If and when CA or EN-DC combinations are added with more than one FR2 band in the uplink, then a UE capability for FR2 power class per band combination might be needed.  |
| Huawei | We think it is fine to have one single powerClass, however it is worth clarifying that this does not mean this powerClass also applies to the band combination for FR1+FR2. As far as we understand from RAN4’s agreement, currently the powerClass only applies for the EN-DC case with FR1 band combination, even there is a combination including both FR1 and FR2, such Pmax is only restricted to FR1 part. For example, if there is a band combination FR1 A + FR1 B + FR2 C, this parameter only considers A+B and Band C is not taken into account. Maybe we need to think about more on the fallback case as well. |
| T-Mobile USA | We agree with Ericsson’s comment. In addition P\_NR applies to both FR1 and FR2 and therefor there is no need for a new FR2 parameter |
| NTT DOCOMO | No. For FR2, we understand that per-band power class (outside band combination) is applied even for NR CA in FR2, as in LTE. This is due to the fact that PA is different for FR1 and FR2. If a UE supports a band combination including FR1 and FR2, UE has two PAs which are isolated each other. |

**Q2.2) Power class for FR2 per band and value range?**

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| Company | Comment |
| Huawei | Currently in ASN.1 the ue-powerclass only addressed PC2 and PC3, however this is only for FR1 case. For FR2 case, at least 4 power classes have been defined in 38.101-2 and in R2-1809442 it is clearly stated that “*necessary number (bit) of power classes for FR2 would be 4 bits since it is expected that there would be several use cases and UE types in FR2. However, the number of bits should be considered also from signalling overhead perspective in RAN2, so the number of bits can be modified appropriately in RAN2 if necessary.*” So I don’t think current RAN2 signaling correctly capture the latest RAN4 agreements and we should define another power class for FR2 per band. |
| NTT DOCOMO | We agree that the RAN4 spec defines 4 power classes in FR2. Since power class 2 and 3 can be reported as shown below, it is enough to add another two power classes as shown below.BandNR ::= SEQUENCE { bandNR FreqBandIndicatorNR, ue-PowerClass ENUMERATED {pc2, pc3} OPTIONAL, ..., [[ ue-PowerClass2 ENUMERATED {pc3, pc4} OPTIONAL ]]} |

### 2.2.3 Inter-Node Message

**Q3.1) Impact on inter-node message?**

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| Company | Comment |
| Huawei | Currently in CG-ConfigInfo there is an IE as below:powerCoordination-FR1 SEQUENCE { p-maxNR P-Max OPTIONAL, p-maxEUTRA P-Max OPTIONAL } These two parameters only addressed the maximum transmission power for EUTRA and NR, but for the new Pmax used across multiple CG for FR1, there is no information exchanged. In this case it would be difficult for the SCG to understand what power is really allowed from the UE side and in our understanding, the new added ***p-UE-FR1*** should also be added in the inter-node message.  |
| NTT DOCOMO | In the power limited scenario, we assume that the limited power is the same for serving cell level and per-UE level. In that sense, NW can set p-maxNR and p-maxEUTRA accordingly. In that sense, p-UE-FR1 is not needed in INM. On the other hand, if there is another case that serving cell level power limitation and per-UE level power limitation is different, p-UE-FR1 might be needed in INM. |

### 2.2.4 Other

**Q4.1) Backwards compatibility**

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| Company | Comment |
| T-Mobile USA | Backward compatibility - Given the aggressive deployment timeline for SA and NSA it is important that the changes be backward compatible.  |
| NTT DOCOMO | Backward compatible change is preferred, except for INM. |

## 2.3 Draft CRs

The above-mentioned CRs that were briefly discussed at the RAN2-AH meeting are also in the Email discussion folder on the FTP server. We will update them based on input provided here. But other companies are also invited to provide their suggestion there directly by adding RIL-comments (like in the ASN.1 review). Please increment the version number of the file.

# Conclusion

In the previous sections we made the following observations:

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Based on the discussion in the previous sections we propose the following:

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# References

1. Tdoc Number, Title, Source, Meeting, Date
2. Spec number, Title, Source, Version, Date