**3GPP TSG-RAN WG4 Meeting #88bis** **R4-1812715**
**Chengdu, China, 8 - 12 Oct, 2018**

# Further discussion of HPUE behavior

OPPO

# Background (1)

- In January RAN4 AH meeting, NR HPUE SAR issue was firstly discussed, since then 5 RAN4 meeting time were put on this topic.
- In February RAN4#86 meeting, how to solve SAR issue was widely discussed but no consensus was reached.
- In April RAN4 #86bis meeting, after a long and difficult discussion between operators and UE vendors, the mechanism of letting UE report the *maxUplinkDutyCycle* capability was agreed and an LS was sent to RAN2 to design the signaling.
- In May RAN4#87, CR of introducing the mechanism to RAN4 spec was agreed but with the "[may]" added to the spec due to concern of mandating UE to do power class fall back was raised by one company at the last minute and no time for further discussion.
- In August RAN4#88, companies' view were collected and with the chair's guidance that an alternative method shall be provided otherwise removing the "[may]" from the spec. In the same meeting, the alternative method "Increase 3dB to MPR" was provided and it was agreed to study the feasibility in the following meeting. Besides, RAN2 completed the signaling design based on the original method in the same meeting.

# Background (2)

- Two option HPUE behaviors when UL duty cycle scheduled by network exceeds *maxUplinkDutyCycle*
  - The existing method is allow UE fall back to power class 3;
  - An alternative method was proposed in RAN4#88:
    - Modify the MPR definition for PC2 to increase by 3 dB when the percentage of uplink symbols exceeds the signaled capability

- WF R4-1811801 was agreed to study the feasibility of the alternative method above.
- Following pages will show some initial findings on the impact of adding 3dB to HPUE MPR.

*Note: In this slides, we call it* $\boldsymbol{MPR_{duty}}$ *to differentiate the MPR caused by UL duty cycle with the existing MPR defined in the spec.*

# Impact to MPR definition

- **HPUE MPR definition was defined to meet OOB emission requirements and it was based on 26dBm output power.**
- When UL duty cycle exceeds UE capability, **$MPR_{duty}$** will be applied to HPUE and the maximum output power changes to 26dBm-$MPR_{duty}$. In this case, original MPR for PC2 need to be revisited.
- When UE apply 3dB $MPR_{duty}$ , the MPR for PC3 would apply.

**Table 6.2.2-2 Maximum power reduction (MPR) for power class 2**

| Modulation | MPR (dB) | | |
|---|---|---|---|
| | Edge RB allocations | Outer RB allocations | Inner RB allocations |
| **DFT-s-OFDM PI/2 BPSK** | ≤ 3.5 | ≤ 0.5 | 0 |
| **DFT-s-OFDM QPSK** | ≤ 3.5 | ≤ 1 | 0 |
| **DFT-s-OFDM 16 QAM** | ≤ 3.5 | ≤ 2 | ≤ 1 |
| **DFT-s-OFDM 64 QAM** | ≤ 3.5 | ≤ 2.5 | |
| **DFT-s-OFDM 256 QAM** | ≤ 4.5 | | |
| **CP-OFDM QPSK** | ≤ 3.5 | ≤ 3 | ≤ 1.5 |
| **CP-OFDM 16 QAM** | ≤ 3.5 | ≤ 3 | ≤ 2 |
| **CP-OFDM 64 QAM** | ≤ 3.5 | | |
| **CP-OFDM 256 QAM** | ≤ 6.5 | | |

**Observation 1:** PC2 MPR definition need to be revisited due to the introduction of $MPR_{duty}$

# Impact to SA Pcmax definition

- **MPR and Power class are included in Pcmax definition in TS38.101-1.**
  - $P_{CMAX_L,f,c} = MIN\ \{P_{EMAX,c} - \Delta T_{C,c},\ (P_{PowerClass} - \Delta P_{PowerClass}) - MAX(MPR_c + A\text{-}MPR_c + \Delta T_{IB,c} + \Delta T_{C,c} + \Delta T_{RxSRS},\ P\text{-}MPR_c)\ \}$
  - $P_{CMAX_H,f,c} = MIN\ \{P_{EMAX,c},\ P_{PowerClass} - \Delta P_{PowerClass}\ \}$

- **3dB $MPR_{duty}$ need to be introduced to $P_{cmax_L}$ and $P_{cmax_H}$.**
- **$\Delta P_{PowerClass}$ definition need to be changed.**

**Observation 2:** Pcmax definition in 38.101-1 need to be changed due to the introduction of $MPR_{duty}$

# Impact to intra-band EN-DC MPR

- **Intra-band ENDC was introduced in the spec for n41.**

| DC configuration | Power class 2 (dBm) | Tolerance (dB) | Power class 3 (dBm) | Tolerance (dB) |
|---|---|---|---|---|
| DC_(n)71B | | | 23 | +2/-3 |
| DC_(n)41AA | 26 | +2/-2[1] | 23 | +2/-2[1] |

| DC configuration | Power class 2 (dBm) | Tolerance (dB) | Power class 3 (dBm) | Tolerance (dB) |
|---|---|---|---|---|
| DC_3A_n3A[(2)] | | | 23 | +2/-3 |
| DC_41A_n41A | 26 | +2/-2[1] | 23 | +2/-2[1] |

- **No MPR has been defined for EN-DC in TS38.101-3. Not clear how to use $MPR_{duty}$ here.**

  - 6.2B.2 UE maximum output power reduction and EN-DC
  - 6.2B.2.1 Intra-band contiguous EN-DC
  - 6.2B.2.2 Intra-band non-contiguous EN-DC
  - 6.2B.2.3 Inter-band EN-DC within FR1

  *< conducted requirements >*

**Observation 3:** Not clear how to use $MPR_{duty}$ for intra-band ENDC HPUE due to no MPR is defined.

# Impact to intra-band EN-DC AMPR

- **For DC_(n)41AA and DC_41A_n41, the mechanism now is only use AMPR to meet NS_04 requirements and no MRP is defined.**

- **With introduction of $MPR_{duty}$, the n41 intra-band contiguous and non-contiguous EN-DC mechanism need to be revisited.**

**- 6.2B.3.1.2 A-MPR for NS_04**

For UEs not supporting dynamic power sharing, with backoff applied independently

$A\text{-}MPR_{E\text{-}UTRA} = MAX(\ A\text{-}MPR_{single,\ E\text{-}UTRA},\ A\text{-}MPR_{IM3}\ )$

$A\text{-}MPR_{NR} = MAX(\ A\text{-}MPR_{single,NR},\ A\text{-}MPR_{IM3}\ )$

For UEs supporting dynamic power sharing , with IM# backoff applied equally to E-UTRA and NR

$A\text{-}MPR_{E\text{-}UTRA} = MAX(\ A\text{-}MPR_{single,E\text{-}UTRA},\ A\text{-}MPR_{IM3}\ )$

$A\text{-}MPR_{NR} = MAX(\ A\text{-}MPR_{single,NR},\ A\text{-}MPR_{IM3})$

**6.2B.3.2 Intra-band non-contiguous EN-DC**

**- 6.2B.3.2.1 A-MPR for NS_04**

For UEs not supporting dynamic power sharing, with backoff applied independently

$A\text{-}MPR_{E\text{-}UTRA} = MAX(\ A\text{-}MPR_{single,\ E\text{-}UTRA},\ A\text{-}MPR_{IM3},\ A\text{-}MPR_{ACLRoverlap}\ )$

$A\text{-}MPR_{NR} = MAX(\ A\text{-}MPR_{single,NR},\ A\text{-}MPR_{IM3},\ A\text{-}MPR_{ACLRoverlap}\ )$

For UEs supporting dynamic power sharing , with IM3 backoff applied equally to E-UTRA and NR

$A\text{-}MPR_{EN\text{-}DC} = MAX(A\text{-}MPR_{single,LTE},\ A\text{-}MPR_{single,NR},\ A\text{-}MPR_{IM3},\ A\text{-}MPR_{ACLRoverlap}\ )$

$A\text{-}MPR_{E\text{-}UTRA} = MAX(\ A\text{-}MPR_{single,E\text{-}UTRA},\ A\text{-}MPR_{EN\text{-}DC}\ )$

$A\text{-}MPR_{NR} = MAX(\ A\text{-}MPR_{single,NR},\ A\text{-}MPR_{EN\text{-}DC}\ )$

- **Observation 4:** The mechanism for DC_(n)41AA and DC_41A_n41 to meet NS_04 requirements needs to be revisited due to no MRP was applied before.

# Impact to inter-band EN-DC HPUE

- **Inter-band ENDC HPUE was proposed in September RAN meeting. How to use MPR for that kinds of UE need to be considered, like equally back off or non equally back off, etc.**

- **The method we defined here need to be forward compatible.**

- **Observation 5:** Forward compatibility need to be considered when we discuss HPUE behaviors.

# Impact to Other groups

- In previous meetings RAN4 has sent two LS to RAN2 on HPUE behavior topic based on RAN4 previous agreements. And RAN2 has implemented RAN4 agreements to RAN2 signaling. The impact to RAN2 signaling design need to be considered.

- **Observation 6:** RAN2 impacts need to be considered.

# Summary

**Based on the initial analysis of 3dB $MPR_{duty}$ impacts the spec, we get the following findings which need to be solved.**

- **Observation 1:** PC2 MPR definition need to be revisited due to the introduction of $MPR_{duty}$
- **Observation 2:** Pcmax definition in 38.101-1 need to be changed due to the introduction of $MPR_{duty}$
- **Observation 3:** Not clear how to use MPRduty in TS38.101-3 due to no MPR is defined.
- **Observation 4:** The mechanism for DC_(n)41AA and DC_41A_n41 to meet NS_04 requirements needs to be revisited due to no MRP was defined before.
- **Observation 5:** Forward compatibility need to be considered when we discuss HPUE behaviors.
- **Observation 6:** RAN2 impacts need to be considered.

# Potential way forward

**Option 1: Keep original method, remove “[may]” from the spec once for all. Making UE power class fall back to PC3 for all the SA and EN-DC HPUEs.**

**Option 2: Adopt the new method, solve the issues at least identified in previous slides within the following two meetings. Further study the feasibility to intra and inter band EN-DC HPUE.**

# Opinion collection before meeting

**Company 1:** It would be helpful if the advocates of “may” try to address these concerns.

**Company 2:** As the initial point of this discussion is to solve SAR concern in HPUE, more simple and straight solution should be preferred.

**Company 3:** There was already some alignment among companies, i.e. clear HPUE behavior needs to be defined within Rel-15 scope by either removing "[may]" or introducing new 3dB MPR. October meeting is a good chance to moving forward on this topic, then we can have one meeting cycle in November to finish the left works.