**3GPP TSG-RAN WG4 Meeting # 111 Rev-R4-2407911**

**Fukuoka, Japan, May 20 – May 24, 2024**

**Source:** China Unicom

**Title:** TP for TR 38.896 to add PC2 for n26

**Agenda item:** 6.19.2

**Document for:** Approval

# 1. Introduction

A text proposal for TR 38.896 to add PC2 for n26 including RSD requirements based on the WF in [1] and the A-MPR based on the WF in [2].

# 2. Text Proposal

---Start of changes---

## 5.x NR band n26

### 5.x.1 UE maximum output power

**Table 5.x.1-1: UE output power for PC2**

|  |  |  |
| --- | --- | --- |
| NR  band | Class 2 (dBm) | Tolerance (dB) |
| n26 | 26 | +2/-33 |
| NOTE 3: Refers to the transmission bandwidths confined within FUL\_low and FUL\_low + 4 MHz or FUL\_high – 4 MHz and FUL\_high, the maximum output power requirement is relaxed by reducing the lower tolerance limit by 1.5 dB. | | |

### 5.x.2 A-MPR requirements

Based on discussions for A-MPR for PC2 on NR band n26, the NS\_12, NS\_13, NS\_14, NS\_15 need to be studied.

#### 5.x.2.1 A-MPR simulation results from Huawei (R4-2402214)

Simulations are performed under the agreed assumptions. The results are obtained for NS\_12 to NS\_15 based on 1Tx PC2 PA model, which are shown in Table 1 below. The figures in the 2nd column show the differences in the A-MPR simulation results between PC2 and PC3, and the figures in the 3rd column plot only the PC2 A-MPR, **for which 0dB is assigned if A-MPR ≤ PC2 MPR**.

Table 1: A-MPR simulation results for NS\_12

|  |  |  |
| --- | --- | --- |
| **BW** | **DIFF A-MPR (PC2-PC3)** | **PC2 A-MPR** |
| 10MHz |  |  |
|  |  |  |
| 5MHz |  |  |
|  |  |  |
| 3MHz |  |  |
|  |  |  |

Table 2: A-MPR simulation results for NS\_13

|  |  |  |
| --- | --- | --- |
| **BW** | **DIFF A-MPR (PC2-PC3)** | **PC2 A-MPR** |
| 5MHz |  |  |
|  |  |  |
| 3MHz |  |  |
|  |  |  |

Table 3: A-MPR simulation results for NS\_14

|  |  |  |
| --- | --- | --- |
| **BW** | **DIFF A-MPR (PC2-PC3)** | **PC2 A-MPR** |
| 20MHz |  |  |
|  |  |  |
| 15MHz |  |  |
|  |  |  |
| 10MHz |  |  |
|  |  |  |

Table 4: A-MPR simulation results for NS\_15

|  |  |  |
| --- | --- | --- |
| **BW** | **DIFF A-MPR (PC2-PC3)** | **PC2 A-MPR** |
| 5MHz |  |  |
|  |  |  |
| 10MHz |  |  |
|  |  |  |
| 20MHz |  |  |
|  |  |  |

#### 5.x.2.2 A-MPR simulation results from Apple (R4-2315374, R4-2407067)

The simulation results for NS\_12 are provided below. The difference between PC3 and the proposal for PC2 is visualised by red colour and indicating the delta A-MPR. The proposals have a maximum delta of 3dB to max(MPR, A-MPR) of PC3.

Below the A-MPR values and the difference to PC3 is shown. While all modulations require additional power back-off there does not seem need for further back-off with 256QAM.

Table 1: A-MPR regions for NS\_12

|  |  |  |  |
| --- | --- | --- | --- |
| Channel BW | RBStart\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | ≤1.8 | >0 | A1 |
|  | >1.8 | >1.08 | A2 |
| 10MHz | ≤3.6 | >0 | A1 |
|  | >3.6, ≤5.04 |  | A2 |

Table 2: A-MPR for NS\_12

|  |  |  |
| --- | --- | --- |
| Modulation/Waveform | A1 | A2 |
|  | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 5 +2.5 | 3.0 |
| DFT-s-OFDM QPSK | ≤ 5 +2.5 | 3.0 |
| DFT-s-OFDM 16 QAM | ≤ 5.5 +2 | 3.0 |
| DFT-s-OFDM 64 QAM | ≤ 5.5 +2 | 3.0 |
| DFT-s-OFDM 256 QAM | ≤ 9.5 | 4.5 |
| CP-OFDM QPSK | ≤ 7 +1.5 | 4.5 |
| CP-OFDM 16 QAM | ≤ 7 +1.5 | 4.5 |
| CP-OFDM 64 QAM | ≤ 7 +1.5 | 4.5 |
| CP-OFDM 256 QAM | ≤ 9.5 | 6.5 |

|  |  |
| --- | --- |
|  |  |
|  |  |

The simulation results for NS\_13 are provided below. The difference between PC3 and the proposal for PC2 is visualised by red colour and indicating the delta A-MPR. The proposals have a maximum delta of 3dB to max(MPR, A-MPR) of PC3.

Table 3: A-MPR regions for NS\_13

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Frequency, Fc, MHz | RBStart\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 819.5 ≤ Fc < 821.5 | ≤1.44 | <1.08 | A1 |
|  |  | ≤1.44 | ≥1.08 | A2 |
|  |  | >1.44 | ≥1.8 | A3 |
| 5MHz | Fc ≥ 821.5 | ≤0.54 | <1.08 | A1 |
|  |  |  | ≥3.24 | A3 |
|  |  |  | <3.24, ≥2.52 | A4 |

Table 4: A-MPR for NS\_13

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 |
|  | Outer/Inner | Outer/Inner | Outer | Outer |
| DFT-s-OFDM PI/2 BPSK | ≤ 3.5 +1.0 | ≤ 4.5 +2 | ≤ 3 +1.0 | ≤ 3 |
| DFT-s-OFDM QPSK | ≤ 3.5 +1.0 | ≤ 4.5 +2 | ≤ 3 +1.0 | ≤ 3 |
| DFT-s-OFDM 16 QAM | ≤ 3.5 +1.0 | ≤ 5 +1.5 | ≤ 3 +1.0 | ≤ 3 |
| DFT-s-OFDM 64 QAM | ≤ 4.5 | ≤ 5 +1.5 | ≤ 3 +1.0 | ≤ 3 |
| DFT-s-OFDM 256 QAM | ≤ 8 | ≤ 6 +1 |  |  |
| CP-OFDM QPSK | ≤ 5 +1.0 | ≤ 6.5 +1.0 | ≤ 4.5 +1.0 | ≤ 4.5 |
| CP-OFDM 16 QAM | ≤ 5 +1.0 | ≤ 6.5 +1.0 | ≤ 4.5 +1.0 | ≤ 4.5 |
| CP-OFDM 64 QAM | ≤ 6 | ≤ 6.5 +1.0 | ≤ 4.5 +1.0 | ≤ 4.5 |
| CP-OFDM 256 QAM | ≤ 8 | ≤ 8 |  |  |

|  |  |
| --- | --- |
|  |  |
|  |  |

The simulation results for NS\_14 are provided below. The difference between PC3 and the proposal for PC2 is visualised by red colour and indicating the delta A-MPR. The proposals have a maximum delta of 3dB to max(MPR, A-MPR) of PC3. A-MPR regions A1/A3 allow increased power back-off for edge allocations and smaller allocations close to channel edge. The proposed A-MPR is on the higher side as edge allocation performance is typically highly dependent on BB implementation with WOLA and other factors influencing the actual power back-off need.

Table 5: A-MPR regions for NS\_14

|  |  |  |  |
| --- | --- | --- | --- |
| Channel BW | RBStart\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 10MHz | ≤0.18 | <1.08 | A1 |
|  | ≥0 | ≥9 | A2 |
|  | ≥0 | ≥8.64, <9 | A4 |
| 15MHz | ≤1.8 | <1.8 | A1 |
|  | ≥0 | ≥9 | A2 |
|  | ≤1.8 | ≥1.8, <3.6e6 | A4 |
|  | ≥0 | ≥8.64, <9 | A4 |
| 20MHz | ≤3.42 | <1.8 | A3 |
|  | ≥0 | ≥9 | A2 |
|  | ≤3.42 | ≥1.8, <3.6e6 | A4 |
|  | ≥0 | ≥8.64, <9 | A4 |

Table 6: A-MPR for NS\_14

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 |
|  | Outer/Inner | Outer | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 3 +1.5 | ≤ 2 +1.5 | ≤ 3 +1.5 | ≤ 3 |
| DFT-s-OFDM QPSK | ≤ 3 +1.5 | ≤ 2 +1.5 | ≤ 3 +1.5 | ≤ 3 |
| DFT-s-OFDM 16 QAM | ≤ 3 +1.5 | ≤ 2 +1.5 | ≤ 3 +1.5 | ≤ 3 |
| DFT-s-OFDM 64 QAM | ≤ 3 +1.5 |  | ≤ 3 +1.5 | ≤ 3 |
| DFT-s-OFDM 256 QAM |  |  | ≤ 8 | ≤ 4.5 |
| CP-OFDM QPSK | ≤ 5 +1.5 | ≤ 4 +1.0 | ≤ 5 +1.5 | ≤ 3 |
| CP-OFDM 16 QAM | ≤ 5 +1.5 | ≤ 4 +1.0 | ≤ 5 +1.5 | ≤ 3 |
| CP-OFDM 64 QAM | ≤ 6 +0.5 | ≤ 5.0 | ≤ 6 +0.5 | ≤ 3.5 |
| CP-OFDM 256 QAM | ≤ 8 |  | ≤ 8 | ≤ 6.5 |

|  |  |
| --- | --- |
|  |  |
|  |  |
|  |  |

On NS\_15 for n26 (R4-2407067)

In previous meetings there was strong concern that the A-MPR values of the initial proposals might not be sufficient with respect to physical implementation. High power back-off faces issues such as supply voltage changes and power consumption optimisations which are not reflected by a fixed bias simulation. Therefore, companies were asked to further check on the proposed A-MPR values.

We followed the request and did additional analysis based on measurements and found that there is indeed demand for adjusting the starting point from WF [R4-2406573, “WF on A-MPR for FDD HPUE”, China Unicom, 3GPP TSG-RAN WG4 Meeting # 110-bis ]. With respect to the measurement based evaluation, full or almost fully allocated channels require an A-MPR increase close to 3dB. Those allocations are all located inside regions linked to A1. The proposal for the updated set of A-MPR values can be found in Table 1. The RB allocation regions do not require updates and can be keept according to the starting point. Those regions can be found in Table 2.

The delta A-MPR between PC3 and the proposal for PC2 is marked with red colour. The new A-MPR set ‘A5’ is designed such that there is a maximum delta of 3dB for inner allocations between PC3 and PC2.

Table 1: A-MPR for NS\_15 (PC2)

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Modulation/Waveform | A1 | A2 | A3 | A4 | A5 |
|  | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner | Outer/Inner |
| DFT-s-OFDM PI/2 BPSK | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM QPSK | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 16 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 64 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 4 +3 | ≤ 9 +1.5 | ≤ 3 |
| DFT-s-OFDM 256 QAM | ≤ 9 +3 | ≤ 5 +1.5 | ≤ 9 | ≤ 13.5 | ≤ 4.5 |
| CP-OFDM QPSK | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 16 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 64 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 4 +3 | ≤ 10.5 +1.5 | ≤ 4.5 |
| CP-OFDM 256 QAM | ≤ 10.5 +3 | ≤ 6.5 +1.5 | ≤ 9 | ≤ 13.5 | ≤ 6.5 |

Table 2: A-MPR regions for NS\_15 (PC2)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Channel BW | Carrier Frequency, Fc, MHz | RBend\*12\*SCS (MHz) | LCRB\*12\*SCS (MHz) | A-MPR |
| 5MHz | 840.5 < Fc ≤ 846.5 | ≥3.24 | >0 | A1 |
|  |  | <3.24, ≥2.52 | ≥1.44 | A2 |
|  |  | <0.9 | ≤0.36 | A3 |
|  |  | <2.53, ≥1.8 | ≥1.44 | A5 |
|  |  | <1.08 | >0.36, ≤0.72 | A5 |
| 10MHz | 840 < Fc ≤ 844 | ≥5.76 | >1.08 | A1 |
|  |  | ≥5.76 | ≤1.08 | A4 |
|  |  | <5.76, ≥4.14 | ≥2.7 | A2 |
|  |  | <2.52 | ≤0.36 | A3 |
|  |  | <4.14, ≥1.8 | ≥2.52 | A5 |
|  |  | <2.52 | >0.36, ≤0.72 | A5 |
|  | 835 < Fc ≤ 840 | ≥7.2 | >0 | A1 |
|  |  | <7.2, ≥5.22 | ≥4.32 | A2 |
|  |  | <1.08 | ≤0.36 | A3 |
|  |  | <7.2, ≥5.22 | <4.32, ≥3.24 | A5 |
|  |  | <1.44 | >0.36, ≤0.72 | A5 |
| 15MHz | 837.5 < Fc ≤ 841.5 | ≥9.36 | >1.08 | A1 |
|  |  | ≥9.36 | ≤1.08 | A4 |
|  |  | <9.36, ≥4.68 | ≥3.6 | A2 |
|  |  | <3.96 | ≤0.36 | A3 |
|  |  | <4.68, ≥1.8 | ≥2.52 | A5 |
|  |  | <3.96 | >0.36, ≤1.08 | A5 |
|  | 831.5 < Fc ≤ 837.5 | ≥10.8 | >1.08 | A1 |
|  |  | ≥10.8 | ≤1.08 | A4 |
|  |  | <10.8, ≥6.48 | ≥3.6 | A2 |
|  |  | <2.7 | ≤0.36 | A3 |
|  |  | <2.7 | >0.36, ≤0.72 | A5 |
|  | Fc ≤ 831.5 | ≥13.14 | >0 | A1 |
|  |  | <13.14, ≥7.92 | ≥3.6 | A2 |
|  |  | <0.72 | ≤0.36 | A3 |
|  |  | <1.08 | >0.36, ≤0.72 | A5 |
| 20MHz | 835 < Fc ≤ 839 | ≥12.24 | >1.08 | A1 |
|  |  | ≥12.24 | ≤1.08 | A4 |
|  |  | <12.24, ≥8.46 | ≥5.4 | A2 |
|  |  | <5.58 | ≤0.36 | A3 |
|  |  | < 8.46, ≥1.8 | ≥3.6 | A5 |
|  |  | <6.12 | >0.36, ≤1.08 | A5 |
|  |  | <12.24, ≥8.46 | < 5.4, ≥3.6 | A5 |
|  | Fc ≤ 835 | ≥13.68 | >1.08 | A1 |
|  |  | ≥13.68 | ≤1.08 | A4 |
|  |  | <13.68, ≥8.46 | ≥5.4 | A2 |
|  |  | <4.32 | ≤0.36 | A3 |
|  |  | <4.68 | >0.36, ≤1.08 | A5 |











### 5.x.3 Reference sensitivity requirements

For PC2 single band n26, both 1Tx and 2Tx requirements are considered. Therefore, for the Reference Sensitivity Degradation requirements, not supporting Tx diversity (i.e. 1Tx) and supporting Tx diversity (i.e. 2Tx) are needed to be defined.

For PC2 single band n26 not supporting Tx diversity (i.e. 1Tx), the Reference Sensitivity Degradation from PC3 to PC2 are defined in Table:

**Table 5.x.3-1: Reference Sensitivity Degradation from PC3 to PC2 for FDD bands for UE not supporting Tx Diversity**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | Source | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) | 25  MHz (dB) | 30 MHz (dB) | 35 MHz (dB) | 40  MHz (dB) | 45 MHz (dB) | 50  MHz (dB) |
| n26 | Skyworks(R4-2300652) | 0.3 | 0.5 | 0.8 | 1.7 | 2.1 | 2.4 |  |  |  |  |
| Apple(R4-2300362) | 0 | 0.9 | 0.7 | 1.3 | 1.7 | 2.2 | N/A | N/A | N/A | N/A |
| Huawei, HiSilicon(R4- 2300715) | 1.0 | 1.0 | 1.0 | 2.9 | 3.3 | 3.6 | - | - | - | - |
| Murata(R4-2305393) | 0.5 | 0.5 | 0.5 | 2.9 | 3.1 | 3.1 | - | - | - | - |
| Average | | 0.5 | 0.7 | 0.8 | 2.2 | 2.6 | 2.8 |  |  |  |  |

**Table 5.x.3-2: Reference Sensitivity Degradation from PC3 to PC2 for FDD bands for UE supporting Tx Diversity**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating Band | Source | 5  MHz (dB) | 10  MHz (dB) | 15  MHz (dB) | 20  MHz (dB) | 25  MHz (dB) | 30 MHz (dB) | 35 MHz (dB) | 40  MHz (dB) | 45 MHz (dB) | 50  MHz (dB) |
| n26 | Skyworks(R4-2300652) | 0.9 | 1.2 | 1.7 | 4.4 | 5.5 | 6.2 |  |  |  |  |
| Apple(R4-2305364) | 0.5 | 0.5 | 0.5 | 5.0 | 6.7 | 7.5 | N/A | N/A | N/A | N/A |
| Huawei, HiSilicon(R4- 2300715) | 2.6 | 2.4 | 2.3 | 5.6 | 6.3 | 6.8 | - | - | - | - |
| Murata(R4-2305393) | 1.4 | 1.7 | 2.2 | 5.8 | 6.3 | 6.6 | - | - | - | - |
| MediaTek(R4-2302353) | 0 | 0 | 0.5 | 5.1 | 5.6 | 5.6 |  |  |  |  |
| Average | | 1.1 | 1.2 | 1.4 | 5.2 | 6.1 | 6.5 |  |  |  |  |

---End of changes---

# References

[1] R4-2306544: WF on FDD HPUE Basket WIs; China Unicom RAN4#106bis-e

[2] R4-2406573: WF on A-MPR for FDD PC2 HPUE; China Unicom RAN4#110-bis