3GPP TSG-RAN WG4 Meeting #110-bis R4-2404157

Changsha, China, 15th – 19th April 2024

Title: TP for TR38.899: adding UL CA\_n77(2A) to HP-NRCA n28-n77, n41-n77 and n77-n79

Source: Softbank

Agenda Item: 5.17.2

Document for: Approval

# **Introduction**

This contribution is a text proposal for TR38.899[8] to add UL CA\_n77(2A) to the following HP-NRCA combinations.

* CA\_n77(2A)-n79A
* CA\_n77(3A)-n79A
* CA\_n28A-n77(3A) \*1
* CA\_n41A-n77(2A)

\*1: CA\_n28A-n77(2A) with UL CA\_n77(2A) is already defined in the current specification.

# **Reference**

[3] 3GPP TS 38.101-1 " NR; User Equipment (UE) radio transmission and reception; Part 1: Range 1 Standalone; (Release 18)", v18.5.0.

[5] 3GPP TR38.717-02-01 “Rel-17 NR inter-band Carrier Aggregation/Dual connectivity for 2 bands DL with x bands UL (x=1, 2) (Release 17)”, v17.0.0

[8] 3GPP TR38.899 “High power UE for FR1 NR inter-band CA/DC or NR SUL band combination with y (1<y<=6) bands DL and x (x=1, 2) bands UL and power class m (m<3) and high power on TDD band(s); (Release 18)”, v0.8.0

[9] 3GPP TR38.718-02-01 “Rel-18 NR Inter-band Carrier Aggregation/Dual Connectivity for2 bands DL with x bands UL (x=1,2) (Release 18)”, v0.10.0

[10] 3GPP TR38.841 “High power User Equipment (UE) (power class 2) for NR inter-band Carrier Aggregation with 2 bands downlink and x bands uplink (x =1,2); (Release 17)”, v17.0.0

# **Text Proposal**

# **-- Start of TP –**

**-- Unaffected parts omitted –**

5.5 CA\_n77-n79

5.5.1 Configurations

The minimum requirements apply only when there is non-simultaneous Rx/Tx operation between n77-n79 NR carriers. This restriction applies also for these carriers when applicable NR CA configuration is part of a higher order configuration. These are shown in Table 5.2A.2.1-1 of TS 38.101-1 [3].

**Table 5.5.1-1: NR CA configurations and bandwidth combinations sets defined for inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or**  **single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n77A-n79A | n77A8,9, n79A8,9  CA\_n77A-n79A8 | n77 | 10, 15, 20, 40, 50, 60, 80, 90, 100 | 0 |
| n79 | 40, 50, 60, 80, 100 |
| CA\_n77(2A)-n79A | n77A8,9, n79A8,9  CA\_n77(2A)**8**, 12  CA\_n77A-n79A8 | n77 | CA\_n77(2A)\_BCS1 | 0 |
| n79 | 40, 50, 60, 80, 100 |
| CA\_n77(3A)-n79A | n77A8,9, n79A8,9  CA\_n77(2A)**8**,12  CA\_n77A-n79A8 | n77 | CA\_n77(3A)\_BCS1 | 0 |
| n79 | 40, 50, 60, 80, 100 |
| NOTE 8: Power Class 2 is allowed for this uplink combination or single uplink carrier in this downlink/uplink combination  NOTE 9: Power Class 1.5 is allowed for this single uplink carrier in this downlink/uplink combination  NOTE 12: UL configurations are for non simultaneous Rx/Tx operation. | | | | |

5.5.2 Maximum output power

**Table 5.5.2-1 UE Power Class 2 for uplink inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Uplink CA configuration** | **Power class 2 cases for CA\_nX-nY** | **CA power class** | **Carrier X power class** | **Carrier Y power class** |
| CA\_n77-n79 | Case a | 26dBm | 23dBm | 23dBm |
| Case b | 26dBm | 23dBm | 26dBm |
| Case c | 26dBm | 26dBm | 23dBm |
| Case d | 26dBm | 26dBm | 26dBm |

5.5.3 REFSENS requirements

Analysis of REFSENS exceptions or MSD requirements is needed due to higher power uplink. For PC3 CA\_n77-n79 with single uplink, the co-existence study is provided in TR 37.865-01-01 [4]. For PC2 CA\_n77-n79 with UL CA\_n77-n79, the co-existence study is provided in TR38.717-02-01[5]. For PC2 and PC1.5 CA\_n77-n79 with single uplink, the co-existence study is provided in TR 37.865-01-01[4]. Analysis is based on these studies.

Additionally, analysis of REFSENS exceptions or MSD requirements is needed due to now added CA\_n77(2A) UL for PC2.

5.5.3.0 Power class 2 case a, b, c and d

Considering both n77 and n79 are TDD bands and synchronous operation for CA\_n77-n79 is assumed, no MSD is needed for dual UL of CA\_n77-n79.

CA\_n77(2A) UL for CA\_n77(2A)-n79A DL and CA\_n77(3A)-n79A DL are already defined for PC3. PC2 is also defined for CA\_n77(2A)-n79A DL and CA\_n77(3A)-n79A DL but not yet for CA\_n77(2A) UL. However, non-simultaneous Rx-Tx operation for CA\_n77-n79 is assumed, therefore no MSD is needed for CA\_n77(2A) UL.

5.5.3.1 Power class 2 for single uplink n77

Based on above,

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n79.

- the 2nd, 3rd, 4th, and 5th order harmonic mixing do not fall into Rx frequencies of n79.

Therefore, there is no MSD issue for this CA configuration.

5.5.3.2 Power class 2 for single uplink n79

Based on above,

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n77.

- the 2nd, 3rd, 4th, and 5th order harmonic mixing do not fall into Rx frequencies of n77.

Therefore, there is no MSD issue for this CA configuration.

5.5.3.3 Power class 1.5 for single uplink n77

Based on above,

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n79.

- the 2nd, 3rd, 4th, and 5th order harmonic mixing do not fall into Rx frequencies of n79.

Therefore, there is no MSD issue for this CA configuration.

5.5.3.4 Power class 1.5 for single uplink n79

Based on above,

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n77.

- the 2nd, 3rd, 4th, and 5th order harmonic mixing do not fall into Rx frequencies of n77.

Therefore, there is no MSD issue for this CA configuration.

**-- Unaffected parts omitted –**

5.11 CA\_n28-n77

5.11.1 Configurations

**Table 5.11.1-1: NR CA configurations and bandwidth combinations sets defined for inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or**  **single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n28A-n77A | n778,9  CA\_n28A-n77A8 | n28 | 5, 10, 15, 20 | 0 |
| n77 | 10, 15, 20, 40, 50, 60, 80, 90, 100 |
| CA\_n28A-n77(2A) | n778,9  CA\_n77(2A)8  CA\_n28A-n77A8 | n28 | 5, 10, 15, 20 | 0 |
| n77 | CA\_n77(2A)\_BCS0 |
| CA\_n28A-n77(3A) | n778,9  CA\_n77(2A) **8**  CA\_n28A-n77A8 | n28 | 5, 10 | 0 |
| n77 | CA\_n77(3A)\_BCS0 |
| NOTE 8: Power Class 2 is allowed for this uplink combination or single uplink carrier in this downlink/uplink combination  NOTE 9: Power Class 1.5 is allowed for this single uplink carrier in this downlink/uplink combination | | | | |

5.11.2 Maximum output power

**Table 5.11.2-1 UE Power Class 2 for uplink inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Uplink CA configuration** | **Power class 2 cases for CA\_nX-nY or (CA\_nC)** | **CA power class** | **Carrier X power class** | **Carrier Y power class** |
| CA\_n28-n77 | Case a | 26dBm | 23dBm | 23dBm |
| Case b | 26dBm | 23dBm | 26dBm |
| CA\_n77(2A) | Case a | 26dBm | 23dBm | 23dBm |
|  | Case b | 26dBm | 23dBm | 26dBm |

5.11.3 REFSENS requirements

Analysis of REFSENS exceptions or MSD requirements is needed due to higher power uplink.

5.11.3.1 Power class 2 case a, b

For UL CA\_n28A-n77A, based on calculation, IMD5 of dual UL falls into n28 DL, the MSD exception is defined as below.

For UL CA\_n77(2A), based on calculation, IMD 2, 4, 6, 7 and 8 of dual n77 UL falls into n28 DL. Possible problematic cases are

- IMD2: For IMD2 to fall on n28, carriers in n77 would need to exceed 600 MHz spacing which is not allowed in current specification [3].

- IMD4

- IMD6: Considered to be covered by lower even order case of IMD4. A note should be added to clarify that IMD6 is present but the corresponding MSD does not need to be specified (e.g. NOTE X as in Table below).

- IMD7: For IMD7 to fall on n28, carriers in n77 would need to exceed 600 MHz spacing which is not allowed in current specification [3].

- IMD8: Considered to be covered by lower even order case of IMD4

The MSD exception is defined as below.

**Table 5.11.3-1: 2DL/2UL inter-band Reference sensitivity QPSK PREFSENS and uplink/downlink configurations for PC2 CA**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | | | | | | | | **Source of IMD** |
| **NR CA**  **Configuration** | **NR band** | **UL Fc  (MHz)** | **UL/DL BW  (MHz)** | **UL  CLRB** | **DL Fc (MHz)** | **MSD  (dB)** | **Duplex mode** |  |
| CA\_n28-n77 | n28 | 705.5 | 5 | 25 | 760.5 | 19.2 | FDD | IMD5 |
|  | n77 | 3582.5 | 10 | 50 | 3582.5 | N/A | TDD | N/A |
|  | n28 | N/A | N/A | N/A | N/A | N/A | FDD | IMD27 |
|  | n7712 | N/A | N/A | N/A | N/A | N/A | TDD | N/A |
|  | n28 | 725 | 5 | 25 | 780 | 18.5 | FDD | IMD4X |
|  | n7712 | 3510 | 10 | 1 RBSTART=25 | 3510 | N/A | TDD | N/A |
|  |  | 3900 | 10 | 1 RBSTART=25 | 3900 | N/A | TDD | N/A |
| NOTE 7: In current release the maximum separation bandwidth class is 600MHz, therefore, no IMD2 MSD requirement apply for this CA configuration when two uplink sub blocks are assigned within CA\_77(2A).  NOTE 12: This band supports intra-band non-contiguous uplink configuration.  NOTE X: This band is subject to IMD6 also which MSD is not specified. | | | | | | | | |

5.11.3.2 Power class 2 for single uplink n77

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n77.

- the 5th order harmonic mixing falls into Rx frequencies of n28.

Therefore, MSD issue due to harmonic mixing from PC2 n77 UL falling into n28 DL should be defined, the value is reused from CA\_n28-n78.

**Table 5.11.3.2-1: Reference sensitivity exceptions and uplink/downlink configurations due to harmonic mixing from a PC2 aggressor NR UL band for NR DL CA FR1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n77 | n28 | 5 | 15 | 25 (RBstart=0) | 5 | 31 | NOTE 1 | UL1/DL5 |
| n77 | n28 | 30 | 15 | 160 (RBstart=0) | 30 | 11.7 | NOTE 1 | UL1/DL5 |

5.11.3.3 Power class 1.5 for single uplink n77

- the 2nd, 3rd, 4th, and 5th order harmonic do not fall into Rx frequencies of n77.

- the 5th order harmonic mixing falls into Rx frequencies of n28.

Therefore, MSD issue due to harmonic mixing from PC1.5 n77 UL falling into n28 DL should be defined,.

**Table 5.11.3.3-1: Reference sensitivity exceptions and uplink/downlink configurations due to harmonic mixing from a PC1.5 aggressor NR UL band for NR DL CA FR1**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **UL BW** | **SCS of UL band** | **UL RB Allocation** | **DL BW** | **MSD** | **UL/DL fc condition** | **UL/DL harmonic order** |
| **(MHz)** | **(kHz)** | **LCRB** | **(MHz)** | **(dB)** |
| n77 | n28 | 5 | 15 | 25 (RBstart=0) | 5 | 34 | NOTE 1 | UL1/DL5 |
| n77 | n28 | 30 | 15 | 160 (RBstart=0) | 30 | 14.7 | NOTE 1 | UL1/DL5 |

5.11.4 ∆TIB and ∆RIB values

There is no change by comparing to the values for PC3 CA.

**-- Unaffected parts omitted –**

5.x CA\_n41-n77, UL CA\_n77(2A)

5.x.1 Configurations

**Table 5.x.1-1: NR CA configurations and bandwidth combinations sets defined for inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or**  **single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n41A-n77(2A) | n418,9  n778,9  **CA\_n77(2A)8**  CA\_n41A-n77A8 | n41 | 10, 15, 20, 30, 40, 50, 60, 70, 80, 90, 100 | 0 |
| n77 | CA\_n77(2A)\_BCS1 |
|  | n418,9  n778,9  CA\_n41A-n77A8 | n41 | n41 channel bandwidth in Table5.3.5-1 | 4 and 5 |
| n77 | CA\_n77(2A)\_BCS4 and 5 |
| NOTE 8: Power Class 2 is allowed for this uplink combination or single uplink carrier in this downlink/uplink combination  NOTE 9: Power Class 1.5 is allowed for this single uplink carrier in this downlink/uplink combination | | | | |

5.x.2 Maximum output power

**Table 5.x.2-1 UE Power Class 2 for uplink inter-band CA (two bands)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Uplink CA configuration** | **Power class 2 cases for CA\_nX-nY** | **CA power class** | **Carrier X power class** | **Carrier Y power class** |
| CA\_n41-n77 | Case a | 26dBm | 23dBm | 23dBm |
| Case b | 26dBm | 23dBm | 26dBm |
| Case c | 26dBm | 26dBm | 23dBm |
| Case d | 26dBm | 26dBm | 26dBm |

5.x.3 REFSENS requirements

Analysis of REFSENS exceptions or MSD requirements is needed due to higher power uplink. For PC3 CA\_n41-n77 with single uplink and UL CA\_n41-n77, the co-existence study is provided in TR38.717-02-01[5]. For PC3 CA\_n41-n77 with UL CA\_n77(2A), the co-existence study is provided in TR38.718-02-01[9]. For PC2 and PC1.5 CA\_n41-n77 with single uplink, the co-existence study is provided in TR 38.841[10]. Analysis is based on these studies.

For UL CA\_n77(2A), IMD3, IMD5 and IMD7 fall into n41 downlink. IMD5 test point was chosen instead of IMD3, as for IMD3 to fall on n41 the frequency separation would need to be over 600 MHz which is not allowed based on clause 5.3A.5 of 38.101-1.

For PC3 CA\_n41-n77 with UL CA\_n77(2A), analysis of REFSENS exceptions is already defined in the Table 7.3A.5-1a of TS38.101-1[3] as follows.

**Table 5.x.3-1 2DL/2UL inter-band Reference sensitivity QPSK PREFSENS and uplink/downlink configurations for PC3 CA**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | | | | | | | | **Source of IMD** |
| **NR CA band combination** | **NR band** | **UL Fc  (MHz)** | **UL/DL BW  (MHz)** | **UL  LCRB** | **DL Fc (MHz)** | **MSD  (dB)** | **Duplex mode** |  |
| CA\_n41-n77 | n41 | N/A | 10 | N/A | 2565 | 17 | TDD | IMD516 |
| n7712 | 3485 | 10 | 1 (RBSTART=25) | 3485 | N/A | TDD | N/A |
|  | 3945 | 10 | 1 (RBSTART=25) | 3945 |  |  |  |
| NOTE 12: This band supports intra-band non-contiguous uplink configuration.  NOTE 16: This band is subject to IMD7 also which MSD is not specified. | | | | | | | | |

MSD for PC2 UL CA is calculated from MSD for PC3 as follows:

If the input signal increases by 3dB, the IMD5 increases by 3\*5=15dB.

The proposed value for PC2 UL CA MSD can be found in Table 5.x.3-2.

**Table 5.x.3-2 2DL/2UL inter-band Reference sensitivity QPSK PREFSENS and uplink/downlink configurations for PC2 CA**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Band / Channel bandwidth / NRB / Duplex mode** | | | | | | | | **Source of IMD** |
| **NR CA band combination** | **NR band** | **UL Fc  (MHz)** | **UL/DL BW  (MHz)** | **UL  LCRB** | **DL Fc (MHz)** | **MSD  (dB)** | **Duplex mode** |  |
| CA\_n41-n77 | n41 | N/A | 10 | N/A | 2565 | 32 | TDD | IMD516 |
| n7712 | 3485 | 10 | 1 (RBSTART=25) | 3485 | N/A | TDD | N/A |
|  | 3945 | 10 | 1 (RBSTART=25) | 3945 |  |  |  |
| NOTE 12: This band supports intra-band non-contiguous uplink configuration.  NOTE 16: This band is subject to IMD7 also which MSD is not specified. | | | | | | | | |

5.x.4 ∆TIB and ∆RIB values

There is no change by comparing to the values for PC3 CA.

**-- Unaffected parts omitted –**

**-- End of TP –**