3GPP TSG-RAN WG4 Meeting # 95-e R4-2006690

Electronic Meeting, 25th May – 5th June, 2020

Source: Verizon, Samsung, Mediatek, Qualcomm, Nokia Ericsson

Title: TP for TR 38.716-02-00: CA\_n2-n77

Agenda item: 8.2.2

Document for: Approval

# **Introduction**

In RAN#87-e meeting, the revised WID ” Rel-16 NR Inter-band Carrier Aggregation/Dual Connectivity for 2 bands DL with x bands UL (x=1,2)” [1] was approved. This contribution is a text proposal for TR 38.716-02-00 to include CA\_n2A-n77A CA band combination.

# **Reference**

[1] RP-200168 [RAN 87-e] Revised WID for NR CA\_DC 2 band DL with up to 2 band UL, ZTE

# **Text Proposal**

## **6 Both bands within FR1 Carrier Aggregation: Specific Band Combination Part**

## **<Start of Text Proposal>**6.x CA\_n2-n77

### 6.x.1 Common for 1 band UL and 2 bands UL CA

#### 6.x.1.1 Operating bands for CA

**Table 6.x.1.1-1: CA band combination of band n2+n77**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **NR CA Band** | **NR Band** | **Uplink (UL) band** | | | **Downlink (DL) band** | | | **Duplex**  **mode** |
| **BS receive / UE transmit** | | | **BS transmit / UE receive** | | |
| **FUL\_low – FUL\_high** | | | **FDL\_low – FDL\_high** | | |
| CA\_n2-n77 | n2 | 1850 MHz | – | 1910 MHz | 1930 MHz | – | 1990 MHz | FDD |
| n77 | 3300 MHz | – | 4200 MHz | 3300 MHz | – | 4200 MHz | TDD |

#### 6.x.1.2 Channel bandwidths per operating band for CA

**Table 6.x.1.2-1: Supported NR bandwidths per CA configuration of band n2+n77**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | **CA operating / channel bandwidth** | | | | | | | | | | | | | | | |
| **NR CA Configuration** | **UL CA Configuration** | **Band** | **Subcarrier spacing**  **[kHz]** | **5**  **MHz** | **10**  **MHz** | **15**  **MHz** | **20**  **MHz** | **25**  **MHz** | **30**  **MHz** | **40**  **MHz** | **50**  **MHz** | **60**  **MHz** | **70**  **MHz** | **80**  **MHz** | **90 MHz** | **100 MHz** | **BCS** |
| CA\_n2A-n77A | CA\_n2A-n77A | n2 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 60 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  |
| n77 | 15 |  | Yes | Yes | Yes | Yes | Yes | Yes | Yes |  |  |  |  |  |
| 30 |  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes | Yes |

#### 6.x.1.3 UE co-existence studies

Table 6.x.1.3-1 and Table 6.x.1.3-2 capture the UL 2nd, 3rd, 4th and 5th harmonics and harmonic mixing for CA\_n2A-n77A.

**Table 6.x.1.3-1: Band n2 and Band n77 UL harmonics products**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | **UL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** | **UL Low Band Edge** | **UL High Band Edge** | **UL Low Band Edge** | **UL High Band Edge** | **UL Low Band Edge** | **UL High Band Edge** | **UL Low Band Edge** | **UL High Band Edge** |
| n2 | 1850 | 1910 | 1930 | 1990 | 3700 | 3820 | 5550 | 5730 | 7400 | 7640 | 9250 | 9550 |
| n77 | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 16800 | 16800 | 16500 | 21000 |

**Table 6.x.1.3-2: Band n2 and Band n77 UL harmonic mixing products**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | | **3rd Harmonic** | | **4th Harmonic** | | **5th Harmonic** | |
| **Band** | **UL Low Band Edge** | **UL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** | **DL Low Band Edge** | **DL High Band Edge** |
| n2 | 1850 | 1910 | 1930 | 1990 | 3860 | 3980 | 5790 | 5970 | 7720 | 7960 | 9650 | 9550 |
| n77 | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 13200 | 16800 | 16500 | 21000 |

In analysis, it could be seen,

* The 2nd harmonic interference from band n2 UL may fall into band n77 DL frequency range.
* The 2nd harmonic mixing products from band n2 may fall into band n77 DL frequency range.

The MSD should be considered to mitigate the impact of the interference for this combination.

#### 6.x.1.4 ∆TIB and ∆RIB values

For CA\_n2-n77, the ΔTIB,c and ΔRIB,c values are given in the tables below.

**Table 6.x.1.4-1: ΔTIB,c**

| Inter-band CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n2-n77 | n2 | 0.6 |
| n77 | 0.8 |

**Table 6.x.1.4-2: ΔRIB,c**

| Inter-band CA Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n2-n77 | n2 | 0.2 |
| n77 | 0.5 |

#### 6.x.1.5 REFSENS requirements

MSD values for band n77 due to 2nd harmonic of band n2 in combo CA\_n2A-n77A are captured in Table 6.x.1.5-1.

**Table 6.x.1.5-1: MSD due to harmonic issue for CA\_n2-n77**

| MSD due to harmonic exception for the DL band | | | | | | | | | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| UL band | DL band | 5 MHz  (dB) | 10 MHz  (dB) | 15 MHz  (dB) | 20 MHz  (dB) | 25 MHz  (dB) | 30 MHz (dB) | 40 MHz  (dB) | 50 MHz  (dB) | 60 MHz  (dB) | 70 MHz  (dB) | | 80 MHz  (dB) | 90 MHz  (dB) | 100 MHz  (dB) |
| n2 | n772,13 |  | 23.9 | 22.1 | 20.9 | 19.8 | 19.0 | 17.9 | 16.8 | 16.0 | 15.5 | 14.8 | | 14.3 | 13.8 |
| n773 |  | 1.1 | 0.8 | 0.3 |  |  |  |  |  |  |  | |  |  |
| NOTE 1: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 2nd transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band and a range ∆FHD above and below the edge of this downlink transmission bandwidth. The value ∆FHD depends on the band combination: ∆FHD = 10 MHz for CA\_n1-n77, CA\_n2-n77, CA\_n2-n78, CA\_n3-n77, CA\_n3-n78, CA\_n2-n48, CA\_n25-n78, CA\_n48-n66, CA\_n66-n78  NOTE 2: The requirements should be verified for UL EARFCN or NR ARFCN of the aggressor (lower) band (superscript LB) such that in MHz and  with carrier frequency in the victim (higher) band in MHz and the channel bandwidth configured in the lower band.  NOTE 3: The requirements are only applicable to channel bandwidths no larger than 20 MHz and with a carrier frequency at  MHz offset from  in the victim (higher band) with , whereandare the channel bandwidths configured in the aggressor (lower) and victim (higher) bands in MHz, respectively. | | | | | | | | | | | | | | | |

The uplink configuration for reference sensitivity exceptions due to UL harmonic interference for the combo CA\_n2A-n77A are captured in Table 6.x.1.5-2.

**Table 6.x.1.5-2 Uplink configuration due to UL harmonic interference**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | NR Band / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band | | | | | | | | | | | | |
| UL band | DL band | 5  MHz  (LCRB) | 10 MHz  (LCRB) | 15 MHz  (LCRB) | 20 MHz  (LCRB) | 25 MHz  (LCRB) | 30 MHz  (LCRB) | 40 MHz  (LCRB) | 50 MHz  (LCRB) | 60 MHz  (LCRB) | 70 MHz  (LCRB) | 80 MHz  (LCRB) | 90 MHz  (LCRB) | 100 MHz  (LCRB) |
| n2 | n77 |  | 25 | 36 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 | 50 |

Sensitivity degradation is allowed for the impact to the received harmonic mixing to the victim band n2 DL frequency range in the configuration of CA\_n2A-n77A. Reference sensitivity exceptions are captured in Table 6.x.1.5-3.

Table 6.x.1.5-3: MSD due to receiver harmonic mixing for CA in NR FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | NR Band / Channel bandwidth of the affected DL band / MSD | | | | | | | | | | | | |
| UL band | DL band | 5  MHz  (dB) | 10 MHz  (dB) | 15 MHz  (dB) | 20 MHz  (dB) | 25 MHz  (dB) | 40 MHz  (dB) | 50 MHz  (dB) | 60 MHz  (dB) | 70 MHz  (dB) | 80 MHz  (dB) | 90 MHz  (dB) | 100 MHz  (dB) |
| n77 | n2 | 6.7 | 5.0 | 4.0 | 3.7 |  |  |  |  |  |  |  |  |

The uplink configuration of the aggressor band are captured in Table 6.x.1.5-4.

Table 6.x.1.5-4: Uplink configuration due to receiver harmonic mixing for CA in NR FR1

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | | NR Band / SCS / Channel bandwidth of the affected DL band / UL RB allocation of the agressor band | | | | | | | | | | | | | |
| UL band | DL band | | SCS of UL band  (kHz) | 5 MHz  (LCRB) | 10 MHz  (LCRB) | 15 MHz  (LCRB) | 20 MHz  (LCRB) | 25 MHz  (LCRB) | 40 MHz  (LCRB) | 50 MHz  (LCRB) | 60 MHz  (LCRB) | 70 MHz  (LCRB) | 80 MHz  (LCRB) | 90 MHz  (LCRB) | 100 MHz  (LCRB) |
| n77 | n2 | | 15 | 25 | 50 | 75 | 100 |  |  |  |  |  |  |  |  |

### 6.x.2 Specific for 2 bands UL CA

#### 6.x.2.1 UE co-existence studies

Table 6.x.2.1-1 lists band n2+band n77 2UL CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 6.x.2.1-1: Band n2 and Band n77 2 UL bands IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL frequency (MHz) | 1850 | 1910 | 3300 | 4200 |
| Two tone 2nd order IMD products | fy\_low – fx\_high | fy\_high – fx\_low | fx\_low + fy\_low | fx\_high + fy\_high |
| IMD frequency limits (MHz) | 1390 | 2350 | 5150 | 6110 |
| Two-tone 3rd order IMD products | |2\*fx\_low – fy\_high| | 2\*fx\_high – fy\_low | 2\*fy\_low – fx\_high | 2\*fy\_high – fx\_low |
| IMD frequency limits (MHz) | 500 | 520 | 4690 | 6550 |
| Two-tone 3rd order IMD products | 2\*fx\_low + fy\_low | 2\*fx\_high + fy\_high | 2\*fy\_low + fx\_low | 2\*fy\_high + fx\_high |
| IMD frequency limits (MHz) | 7000 | 8020 | 8450 | 10310 |
| Two-tone 4th order IMD products | |3\*fx\_low – fy\_high| | |3\*fx\_high – fy\_low| | 3\*fy\_low – fx\_high | 3\*fy\_high – fx\_low |
| IMD frequency limits (MHz) | 1350 | 2430 | 7990 | 10750 |
| Two-tone 4th order IMD products | 3\*fx\_low + fy\_low | 3\*fx\_high + fy\_high | 3\*fy\_low + fx\_low | 3\*fy\_high + fx\_high |
| IMD frequency limits (MHz) | 8850 | 9930 | 11750 | 14510 |
| Two-tone 4th order IMD products | |2\*fx\_low – 2\*fy\_high| | |2\*fx\_high – 2\*fy\_low| | 2\*fx\_low + 2\*fy\_low | 2\*fx\_high + 2\*fy\_high |
| IMD frequency limits (MHz) | 4700 | 2780 | 10300 | 12220 |
| Two-tone 5th order IMD products | |fx\_low – 4\*fy\_high| | |fx\_high – 4\*fy\_low| | |fy\_low – 4\*fx\_high| | |fy\_high – 4\*fx\_low| |
| IMD frequency limits (MHz) | 14950 | 11290 | 4340 | 3200 |
| Two-tone 5th order IMD products | |fx\_low + 4\*fy\_low| | |fx\_high + 4\*fy\_high| | |fy\_low + 4\*fx\_low| | |fy\_high + 4\*fx\_high| |
| IMD frequency limits (MHz) | 15050 | 18710 | 10700 | 11840 |
| Two-tone 5th order IMD products | |2\*fx\_low – 3\*fy\_high| | |2\*fx\_high – 3\*fy\_low| | |2\*fy\_low – 3\*fx\_high| | |2\*fy\_high – 3\*fx\_low| |
| IMD frequency limits (MHz) | 8900 | 6080 | 870 | 2850 |
| Two-tone 5th order IMD products | |2\*fx\_low + 3\*fy\_low| | |2\*fx\_high + 3\*fy\_high| | |2\*fy\_low + 3\*fx\_low| | |2\*fy\_high + 3\*fx\_high| |
| IMD frequency limits (MHz) | 13600 | 16420 | 12150 | 14130 |

* The 2nd and 4th order IMD products from band n2 UL and 5th band n77 UL may fall into band their own DL frequency range
* The 4th order IMD of n77 UL may fall into Rx frequency of band n2

The MSD should be considered to mitigate the impact of the interference for this combination.

Table 6.x.2.1-2 lists the protected bands required for the 2UL bands CA configuration.

**Table 6.x.2.1-2: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| NR CA combination | Spurious emission | | | | | | |
| Protected Band | Frequency range (MHz) | | | Maximum Level (dBm) | MBW (MHz) | NOTE |
| CA\_n2-n77 | E-UTRA Band 4, 5, 12, 13, 14, 17, 26, 29, 30, 41, 48, 65, 66, 70, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 2, 25 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| NOTE 2: As exceptions, measurements with a level up to the applicable requirements defined in Table 6.5.3.1-2 are permitted for each assigned NR carrier used in the measurement due to 2nd, 3rd, 4th or 5th harmonic spurious emissions. Due to spreading of the harmonic emission the exception is also allowed for the first 1 MHz frequency range immediately outside the harmonic emission on both sides of the harmonic emission. This results in an overall exception interval centred at the harmonic emission of (2 MHz + N x LCRB x RBsize kHz), where N is 2, 3, 4, 5 for the 2nd, 3rd, 4th or 5th harmonic respectively. The exception is allowed if the measurement bandwidth (MBW) totally or partially overlaps the overall exception interval. | | | | | | | |

#### 6.x.2.2 REFSENs requirements

Table 6.x.2.2-1 lists the MSD required for the dual connectivity configuration due to IMD2.

Based on above coexistence study, two-tone 2nd order IMD products may fall into the own Rx of Band n2, and two-tone 4th order IMD products may fall into the Rx of Band n2. The MSD for IMD2 and IMD4 are,

Table 6.x.2.2-1: MSD due to IMD issue

|  | Operating band/ Channel bandwidth / NRB / Duplex mode | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| CA  Configuration | Operating band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  LCRB | DL Fc (MHz) | MSD  (dB) | Duplex mode | IMD order | |
| CA\_n2A-n77A | n2 | 1855 | 5 | 25 | 1935 | 26 | FDD | IMD24 | |
| 28.75 |
| n77 | 3790 | 10 | 50 | 3790 | N/A | TDD | N/A | |
| n2 | 1885 | 5 | 25 | 1965 | 8.0 | FDD | IMD44 | |
| 10.75 |
| n77 | 3690 | 10 | 50 | 3690 | N/A | TDD | N/A | |
| NOTE 4: This band is subject to IMD5 also which MSD is not specified.  NOTE 5: Applicable only if operation with 4 antenna ports is supported in the band with carrier aggregation configured. | | | | | | | | |

**<Start of Text Proposal>**

## **9 2 bands Dual Connectivity: Specific Band Combination Part**

**<Start of Text Proposal>**

## **9.x DC\_n2-n77**

### 9.x.1 Operating bands for DC\_n2-n77

**Table 9.x.1-1: Inter-band NR DC operating bands**

|  |  |
| --- | --- |
| **NR DC Band** | **NR Band** |
| DC\_n2-n77 | n2, n77 |

### 9.x.2 Configurations for DC\_n2-n77

**Table 9.x.2-1: Inter-band NR DC configurations**

| **NR DC**  **configuration** | **Uplink NR DC**  **configuration** |
| --- | --- |
| DC\_n2A-n77A | DC\_n2A-n77A |
|

**<Start of Text Proposal>**