3GPP TSG-RAN WG4 Meeting # 95-e R4-2006693

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

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

Title: TP for TR 38.716-02-00: CA\_n5-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\_n5A-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\_n5-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 n5+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\_n5-n77 | n5 | 824 MHz | – | 849 MHz | 869 MHz | – | 894 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 n5+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\_n5A-n77A | CA\_n5A-n77A | n5 | 15 | Yes | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  |  |  |  |  |  |  |  |  |
| 60 |  |  |  |  |  |  |  |  |  |  |  |  |  |
| 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, 5th harmonics and harmonic mixing for CA\_n5A-n77A.

**Table 6.x.1.3-1: Band n5 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** |
| n5 | 824 | 849 | 869 | 894 | 1648 | 1698 | 2472 | 2547 | 3296 | 3396 | 4120 | 4245 |
| n77 | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 13200 | 16800 | 16500 | 21000 |

**Table 6.x.1.3-2: Band n5 and Band n77 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** |
| n5 | 824 | 849 | 869 | 894 | 1738 | 1788 | 2607 | 2682 | 3476 | 3576 | 4345 | 4470 |
| n77 | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 13200 | 16800 | 16500 | 21000 |

In analysis, it could be seen,

* The 4th and 5th harmonic interferences from band n5 UL may fall into band n77 DL frequency range
* The 4nd harmonic mixing products from band n5 may fall into band n77 DL frequency range

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

For US operation, the 4th and 5th harmonic and harmonic mixing products from band n5 to band n77 DL are out of the US C-band frequency range. Therefore, there is no MSD considering the US deployment range (3700-3980MHz) inside the n77 band.

#### 6.x.1.4 ∆TIB and ∆RIB values

For the CA\_n5-n77, the ΔTIB,c and ΔRIB,c values are given in the tables below.

**Table 6.x.1.4-1: ΔTIB,c**

| Inter-band DA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n5-n77 | n5 | 0.6 |
| n77 | 0.8 |

**Table 6.x.1.4-2: ΔRIB,c**

| Inter-band DC Configuration | NR Band | ΔRIB,c [dB] |
| --- | --- | --- |
| CA\_n5-n77 | n5 | 0.2 |
| n77 | 0.5 |

#### 6.x.1.5 REFSENS requirements

For US operation, the 4th and 5th harmonic and harmonic mixing products from band n5 to band n77 DL are out of the US C-band frequency range. Therefore, there is no MSD considering the US deployment range (3700-3980MHz) inside the n77 band.

MSD values for Band n77 due to harmonic of Band n5 for CA\_n5A-n77A are captured in Table 6.x.1.5-1.

**Table 6.x.1.5-1: MSD due to UL harmonic issue for CA\_n5-n77**

|  | 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) | 30 MHz (dB) | 40 MHz  (dB) | 50 MHz  (dB) | 60 MHz  (dB) | 70 MHz (dB) | 80 MHz  (dB) | 90 MHz  (dB) | 100 MHz  (dB) |
| n5 | n774, 5 |  | 10.5 | 8.9 | 7.8 | 7.2 | 6.5 | 5.1 | 4.2 | 3.5 | 2.8 | 2.3 | 2.1 | 1.4 |
| n5 | n776,7 |  | 10.4 | 8.9 | 7.8 | 7.4 | 6.5 | 4.7 | 3.7 | 3 | 2.35 | 1.7 | 1.2 | 0,7 |
|  | NOTE 4: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of the aggressor (lower) band for which the 4th transmitter harmonic is within the downlink transmission bandwidth of a victim (higher) band.  NOTE 5: The requirements should be verified for UL EARFCN 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 6: These requirements apply when there is at least one individual RE within the uplink transmission bandwidth of a low band for which the 5th transmitter harmonic is within the downlink transmission bandwidth of a high band.  NOTE 7: The requirements should be verified for UL NR‑ARFCN of a low band (superscript LB) such that in MHz and  with the carrier frequency of a high band in MHz and  the channel bandwidth configured in the low band. | | | | | | | | | | | | | |

The uplink configuration for reference sensitivity exceptions due to UL harmonic interference for CA\_n5A-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) |
| n5 | n77 | - | 16 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 | 25 |

Sensitivity degradation is allowed for the impact to the received harmonic mixing due to n5 UL to the victim band n77 DL frequency range in the configuration of CA\_n5A-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

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | **MSD due to harmonic exception for the DL band** | | | | | | | | | | | | |
| **UL band** | | **DL band** | **5**  **MHz** | **10**  **MHz** | **15**  **MHz** | **20**  **MHz** | **25**  **MHz** | **40**  **MHz** | **50**  **MHz** | **60**  **MHz** | **70**  **MHz** | **80**  **MHz** | **100**  **MHz** |
| **dB** | **dB** | **dB** | **dB** | **dB** | **dB** | **dB** | **dB** | **dB** | **dB** | **dB** |
| n77 | | n5 | 5.7 | 4.0 | 3.0 | 2.7 |  |  |  |  |  |  |  |

The uplink configuration of the aggressor band n5 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

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL band** | **DL band** | **5 MHz** | **10 MHz** | **15 MHz** | **20 MHz** | **25 MHz** | **40 MHz** | **50 MHz** | **60 MHz** | **70 MHz** | **80 MHz** | **100 MHz** |
| n77 | n5 | 25 | 25 | 20 | 20 |  |  |  |  |  |  |  |

### 

### 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 n5 +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 n5 and Band n77 2 UL bands IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| 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) | 2451 | 3376 | 4124 | 5049 |
| 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) | 2552 | 1602 | 5751 | 7576 |
| 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) | 4948 | 5898 | 7424 | 9249 |
| 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) | 1728 | 753 | 9051 | 11776 |
| 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) | 5772 | 6747 | 10724 | 13449 |
| 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) | 6752 | 4902 | 8248 | 10098 |
| 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) | 15976 | 12351 | 96 | 904 |
| 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) | 14024 | 17649 | 6596 | 7596 |
| 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) | 10952 | 8202 | 4053 | 5928 |
| 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) | 11548 | 14298 | 9072 | 10947 |

There are no IMD products fell in the US C-band frequency range (3700-3980MHz). The IMD issue discussed below is for the band n77, and out of the frequency range of US C-band.

Based on the Table 6.x.2.1-1, it could be seen,

* The 4th order IMD from Band n5 UL may fall into own Rx band frequency range, and 2nd order IMD from Band n77 may fall into own Rx band frequency range.
* The 4th order IMD from Band n5 may fall into band n77 DL frequency range,

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\_n5-n77 | E-UTRA Band 2, 4, 12, 13, 14, 17, 25, 26, 28, 29, 30, 65, 66, 70, 71 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 41 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| 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.  NOTE 3: 15 kHz SCS is assumed when RB is mentioned in the note when channel bandwidth is less than or equal to 50 MHz, lowest SCS is assumed when channel bandwidth is larger than 50 MHz. The transmission bandwidth in terms of RB position and range is not limited to 15 kHz SCS and shall scale with SCS accordingly. | | | | | | | |

#### 6.x.2.2 REFSENs requirements

Table 6.x.2.2-1 lists the MSD required for the dual connectivity configuration due to IMD4. And, the IMD produces are outside of the frequency range of US C-band.

Based on above coexistence study, two-tone 2nd order IMD products may fall into the own Rx Band of Band n77, and two-tone 4th order IMD products may fall into the own Rx Band of Band n5. The n77 is a TDD band hence there is no issue for the case IMD products fall into own RX band. The MSD for IMD4 from band 77 UL to band n5 Rx is shown in Table 6.x.2.2-1 for the dual connectivity configuration.

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

| NR or E-UTRA Band / Channel bandwidth / NRB / MSD | | | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| EN-DC  Configuration | EUTRA or NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  LCRB | DL Fc (MHz) | MSD  (dB) | IMD order |
| CA\_n5A\_n77A | 5 | 844 | 5 | 25 | 889 | 8.3 | IMD4 |
| n77 | 3421 | 10 | 50 | 3421 | N/A | N/A |
| CA\_n5A\_n77A | 5 | 829 | 5 | 25 | 875 | [5.5] | IMD5 |
| n77 | 3600 | 10 | 50 | 3600 | N/A | N/A |

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

**<Start of Text Proposal>**

## **9.x DC\_n5-n77**

### 9.x.1 Operating bands for DC\_n5-n77

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

|  |  |
| --- | --- |
| **NR DC Band** | **NR Band** |
| DC\_n5-n77 | n5, n77 |

### 9.x.2 Configurations for DC\_n5-n77

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

| **NR DC**  **configuration** | **Uplink NR DC**  **configuration** |
| --- | --- |
| DC\_n5A-n77A | DC\_n5A-n77A |
|

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