**3GPP TSG-RAN4#97e R4-2014524**

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**Source:** Nokia, Samsung, T-Mobile USA, KDDI

**Title:** TP for TR 38.717-02-01: CA\_n41-n77

**Agenda Item: 10.2.2**

**Document for:** Approval

# 1 Introduction

This is a text proposal to introduce CA\_n41-n77 into TR 38.717.02-01 Rel-17 NR inter-band Carrier Aggregation/Dual connectivity for 2 bands DL with x bands UL (x=1, 2).

# 2 Text proposal

\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*Start of TP\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*\*

## 6.x CA\_n41-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 n41 + n77

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA Band Combination** | **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\_n41-n771 | n41 | 2495 MHz | – | 2690 MHz | 2495 MHz | – | 2690 MHz | TDD |
| n77 | 3300 MHz | – | 4200 MHz | 3300 MHz | – | 4200 MHz | TDD |
| NOTE 1: Applicable for UE supporting inter-band carrier aggregation with mandatory simultaneous Rx/Tx capability. |

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

Table 6.x.1.2-1: Supported bandwidths per CA band combination of band n41+n77

|  |
| --- |
| **NR CA configuration / Bandwidth combination set [MHz]** |
| **NR CA configuration** | **UL configuration** | **NR Band** | **SCS****(kHz)** | **5** | **10** | **15** | **20** | **25** | **30** | **40** | **50** | **60** | **70** | **80** | **90** | **100**  | **Bandwidth combination set** |
| CA\_n41A-n77A | CA\_n41A-n77A | n41 | 15 |  | Yes | Yes | Yes |  | Yes | Yes | Yes |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes |  | 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 |
| CA\_n41(2A)-n77A | CA\_n41A-n77A | n41 | See CA\_n41(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1 in TS 38.101-1 | 0 |
| 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 |
| CA\_n41C-n77A | CA\_n41A-n77ACA\_n41C | n41 | See CA\_n41C Bandwidth Combination Set 0 in Table 5.5A.1-1 in TS 38.101-1 | 0 |
| 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 |
| CA\_n41A-n77(2A) | CA\_n41A-n77A | n41 | 15 |  | Yes | Yes | Yes |  | Yes | Yes | Yes |  |  |  |  |  | 0 |
| 30 |  | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes |
| 60 |  | Yes | Yes | Yes |  | Yes | Yes | Yes | Yes |  | Yes | Yes | Yes |
| n77 | See CA\_n77(2A) Bandwidth Combination Set 1 in Table 5.5A.2-1 in TS 38.101-1 |

#### 6.x.1.3 Co-existence studies

Table 6.x.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_n41-n77.

**Table** **6.x.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | **3rd Harmonic** | **4th 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** |
| **n41** | 2496 | 2690 | 2496 | 2690 | 4992 | 5380 | 7488 | 8070 | 9984 | 10760 |
| **n77** | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 13200 | 16800 |

Based on above table no harmonics occur.

**Table 6.x.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **2nd Harmonic** | **3rd Harmonic** | **4th 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** |
| **n41** | 2496 | 2690 | 2496 | 2690 | 4992 | 5380 | 7488 | 8070 | 9984 | 10760 |
| **n77** | 3300 | 4200 | 3300 | 4200 | 6600 | 8400 | 9900 | 12600 | 13200 | 16800 |

Based on above table 2nd UL harmonic of n77 is same as n41 DL 3rd harmonic.

#### 6.x.1.4 ∆TIB and ∆RIB values

For CA\_n41-n77, it is proposed to re-use the ΔTIB,c and ΔRIB values from CA\_n41-n78.

Table 6.x.1.4-1: ΔTIB,c

| Inter-band CA Configuration | NR Band | ΔTIB,c [dB] |
| --- | --- | --- |
| CA\_n41-n771 | n41 | 0.3 |
| n77 | 0.8 |
| NOTE 1: The requirements only apply when the sub-frame and Tx-Rx timings are synchronized between the component carriers. In the absence of synchronization, the requirements are not within scope of these specifications. |

Table 6.x.1.4-2: ΔRIB

| Inter-band CA Configuration | NR Band | ΔRIB [dB] |
| --- | --- | --- |
| CA\_n41-n771 | n77 | 0.5 |
| NOTE 1: The requirements only apply when the sub-frame and Tx-Rx timings are synchronized between the component carriers. In the absence of synchronization, the requirements are not within scope of these specifications. |

#### 6.x.1.5 REFSENs requirements

No additional requirements are necessary.

#### 6.x.1.6 OOB blocking exception requirements

There is no OOB exception for the CA combination.

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

#### 6.x.2.1 Maximum output power for inter-band CA

**Table 6.x.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB)  |
| CA\_n41A-n77A | 23 | +2/-32 |
| NOTE 2: 2 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 |

#### 6.x.2.2 UE co-existence

Table 6.x.2.2-1 gives IMD interference analysis for CA\_ n41-n77 with 2 ULs.

**Table 6.x.2.2-1: Harmonic and IMD analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | **fy\_high** |
| UL frequency (MHz) | 2496 | 2690 | 3300 | 4200 |
| Two tone 2nd order IMD products | |fy\_low - fx\_high| | |fy\_high - fx\_low| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 610 | 1704 | 5796 | 6890 |
| 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) | 792 | 2080 | 3910 | 5904 |
| 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) | 8292 | 9580 | 9096 | 11090 |
| 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) | 3288 | 4770 | 7210 | 10104 |
| 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) | 10788 | 12270 | 12396 | 15290 |
| 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) | 3408 | 1220 | 11592 | 13780 |
| 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) | 14304 | 10510 | 7460 | 5784 |
| 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) | 15696 | 19490 | 13284 | 14960 |
| 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) | 7608 | 4520 | 1470 | 912 |
| 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) | 14892 | 17980 | 14088 | 16470 |

Based on the table 6.x.2.2-1, there is 3rd and 4th order IMD are an issue for n77, however IMD3 cannot interfere own downlink channel even it hits the band.

Table 6.x.2.2-2 lists the protected bands required for the 2UL bands CA configuration.

**Table 6.x.2.2-2: Protected bands for the 2UL bands CA configuration**

|  |  |
| --- | --- |
| **UL NR CA Configuration** | **Spurious emission**  |
| **Protected band** | **Frequency range (MHz)** | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n41-n77 | E-UTRA Band 1, 2, 3, 4, 5, 8, 10, 11, 12, 13, 14, 17, 18, 19, 20, 21, 24, 25, 26, 27, 28, 29, 30, 34, 39, 40, 44, 45, 50, 51, 53, 65, 66, 70, 71, 73, 74, 85,  | FDL\_low | - | FDL\_high | -50 | 1 |  |
| Frequency range | 1884.5 |  | 1915.7 | -41 | 0.3 | 8 |
| NOTE 1: FDL\_low and FDL\_high refer to each frequency band specified in Table 5.2-1 in TS 38.101-1 or Table 5.5-1 in TS 36.x01NOTE 8: Applicable when co-existence with PHS system operating in 1884.5 - 1915.7 MHz. |

#### 6.x.2.3 REFSENS requirements

There is MSD defined for CA\_41A-78A due to cross band isolation, it is proposed to define same requirement for CA\_41A-77A.

Table 7.3A.6-1: Reference sensitivity exceptions (MSD) due to cross band isolation for NR CA FR1

|  |
| --- |
| NR Band / Channel bandwidth of the affected DL band |
| UL band | DL band | 5MHz (dB) | 10MHz (dB) | 15MHz (dB) | 20MHz (dB) | 25MHz (dB) | 30 MHz (dB) | 40 MHz (dB) | 50 MHz (dB) | 60 MHz (dB) | 70MHz(dB) | 80 MHz (dB) | 90 MHz (dB) | 100 MHz (dB) |
| n41 | n77 |  | 8.3 | 8.3 | 8.3 | 7.3 | 6.5 | 6.3 | 5.3 | 4.5 | 4.3 | 4.0 | 3.9 | 3.8 |

Table 7.3A.6.2: Uplink configuration for reference sensitivity exceptions due to cross band isolation for NR CA FR1

|  |
| --- |
| NR Band / SCS / Channel bandwidth of the affected DL band |
| UL band | DL band | SCS of UL band (kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30 MHz | 40 MHz | 50 MHz | 60 MHz | 70MHz | 80 MHz | 90 MHz | 100 MHz |
| n41 | n77 | 15 |  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |

There is also harmonic receiver mixing issue that needs MSD.

Table 7.3A.4-4: Reference sensitivity exceptions due to harmonic mixing for CA in NR FR1

|  |
| --- |
| NR Band / Channel bandwidth of the affected DL band |
| UL band | DL band | 5 MHz(dB) | 10 MHz(dB) | 15 MHz(dB) | 20 MHz(dB) | 25 MHz(dB) | 30MHz(dB) | 40 MHz(dB) | 50 MHz(dB) | 60 MHz(dB) | 70MHz(dB) | 80 MHz(dB) | 90 MHz(dB) | 100 MHz(dB) |
| n77 | 412 | 10.4 | 10.4 | 10.4 | 10.4 |  | 10.4 | 10.4 | 10.4 | 10.4 |  | 10.4 | 10.4 | 10.4 |
| NOTE 2: The requirements should be verified for UL NR-ARFCN of the aggressor (high) band (superscript HB) such that in MHz and  with carrier frequency in the victim (lower) band in MHz and  the channel bandwidth configured in the higher band. |

Table 7.3A.4-4a: Uplink configuration for reference sensitivity exceptions due to receiver harmonic mixing for CA in NR FR1

|  |
| --- |
| NR Band / SCS / Channel bandwidth of the affected DL band |
| UL band | DL band | SCS(kHz) | 5 MHz | 10 MHz | 15 MHz | 20 MHz | 25 MHz | 30MHz | 40 MHz | 50 MHz | 60 MHz | 70MHz | 80 MHz | 90 MHz | 100 MHz |
| n77 | 41 | 15 | 12 | 25 | 36 | 50 |  | 50 | 50 | 50 | 50 |  | 50 | 50 | 50 |
| NOTE 1: The UL configuration applies regardless of the channel bandwidth of the UL band unless the UL resource blocks exceed that specified in Table 7.3.2-3 for the uplink bandwidth in which case the allocation according to Table 7.3.2-3 applies. |

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