**3GPP TSG-RAN WG4 Meeting # 112 R4-2411934**

**Maastricht, Netherlands, Aug.19th – 23th, 2024**

Source: ZTE Corporation, Sanchips

Title: TP for TR38.719-02-01\_CA\_n3A-n104A

Agenda Item: 7.3.3

Document for: Approval

# **Introduction**

CA\_n3A-n104A\_BCS0 was requested and included in the new R19 basket WID[1], Hence, we provide a TP to TR38.719-02-01 to introduce intra-band UL CA\_n3A-n104A.

# **Reference**

[1] RP-241674, New WID: Rel-19 NR Carrier Aggregation (CA)/Dual Connectivity (DC) for x bands DL with y bands UL (x<7, y<3) and Supplementary Uplink (SUL) band combinations/CA band combinations with a single SUL or two SUL cells, Ericsson, ZTE, Huawei

[2] TR38.719-02-01,Rel-19 NR Inter-band Carrier Aggregation/Dual Connectivity for 2 bands DL with x bands UL (x=1,2)

# Text Proposal

**----- Start of TP -----**

## 5.x CA\_n3-n104

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

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

Table 5.x.1.1-1: CA band combination of band n3+n104

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **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** |
| n3 | 1710 MHz | **-** | 1785 MHz | 1805 MHz | **-** | 1880 MHz | FDD |
| n104 | 6425 MHz | **-** | 7125 MHz | 6425 MHz | **-** | 7125 MHz | TDD |

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

Table 5.x.1.2-1: Supported bandwidths per CA band combination of band n3+n104

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **NR CA configuration** | **Uplink CA configuration or single uplink carrier** | **NR Band** | **Channel bandwidth (MHz)** | **Bandwidth combination set** |
| CA\_n3A-n104A | CA\_n3A-n104A | n3 | 5, 10, 15, 20, 25, 30, 35, 40, 45, 50 | 0 |
|  |  | n104 | 20, 30, 40, 50, 60, 70, 80, 90, 100 |  |

#### 5.x.1.3 UE co-existence studies for 1 band UL

Table 5.x.1.3-1 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_n3-n104.

**Table 5.x.1.3-1 UL/DL harmonics/harmonic mixing analysis**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **UL/DL** | | **n3** | **UL12** | **UL2** | **UL33** | **UL4** | **UL5** |  |
| **harmonics** | | **fLow** | 1710 | 3420 | 5130 | 6840 | 8550 | **MSD type** |
| **n104** | **fLow** | **fHigh** | 1785 | 3570 | 5355 | 7140 | 8925 |  |
| **DL1** | 6425 | 7125 | N/A | - | - | D | - | **UL harmonic** |
| **DL23** | 12850 | 14250 | - | N/A | - | N/A | N/A | **Harmonic mixing** |
| **DL34** | 19275 | 21375 | - | - | N/A | - | N/A |
| **DL4** | 25700 | 28500 | - | N/A | N/A | N/A | N/A |
| **DL54** | 32125 | 35625 | - | - | N/A | N/A | N/A |
| **Analysis** | | | Direct hit n3 UL4 / n104 DL1, and no near miss n3 ULx / n104 DLy (5MHz) | | | | | |
| **UL/DL** | | **n104** | **UL14** | **UL2** | **UL33** | **UL4** | **UL5** | **MSD type** |
| **harmonics** | | **fLow** | 6425 | 12850 | 19275 | 25700 | 32125 |
| **n3** | **fLow** | **fHigh** | 7125 | 14250 | 21375 | 28500 | 35625 |
| **DL1** | 1805 | 1880 | N/A | - | - | - | - | **UL harmonic** |
| **DL23** | 3610 | 3760 | - | N/A | - | N/A | N/A | **Harmonic mixing** |
| **DL34** | 5415 | 5640 | - | - | N/A | - | N/A |
| **DL4** | 7220 | 7520 | - | N/A | N/A | N/A | N/A |
| **DL54** | 9025 | 9400 | - | - | N/A | N/A | N/A |
| **Analysis** | | | Neither direct hit n104 ULx / n1 DLy nor Near miss n104 ULx / n3 DLy (20MHz) | | | | | |
| Note 1: ULx means UL xth harmonic frequency, and DLy means DL yth harmonic frequency range Note 2: When a collision is detected with an overlap >0Hz between the ULx with DLy frequency ranges, the ULx/DLy cell is marked “D” for direct hit.  When the gap between ULx and DLy frequency range is from 0Hz to x\*MinULCBW, the ULx/DLy cell is marked “N” for Near miss. Note 3: UL3/DL2 harmonic mixing direct hit case for PC3/5 only apply for DL>3GHz Note 4: For harmonic mixing, near-miss cases only apply for UL1 and odd DLy orders. | | | | | | | | |

Table 5.x.1.3-2 summarizes frequency ranges where cross band isolation may occur for CA\_n3-n104.

**Table 5.x.1.3-2: Cross-band isolation** **analysis**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Bands** | **n3** | | **n104** | |
| **Frequency limit** | **flow** | **fhigh** | **flow** | **fhigh** |
| **fUL (MHz)** | 1710 | 1785 | 6425 | 7125 |
| **fDL (MHz)** | 1805 | 1880 | 6425 | 7125 |
| **UL CBW (MHz)2** | Minimum CBW | Maximum CBW | Minimum CBW | Maximum CBW |
| 5 | 50 | 20 | 100 |
| **ACLR1 range** | fxULlow-maxULCBWx | fxULhigh+maxULCBWx | fyULlow-maxULCBWy | fyULhigh+maxULCBWy |
| **ACLR1 (MHz)** | 1660 | 1835 | 6325 | 7225 |
| **ACLR2 range** | fxULlow-2\*maxULCBWx | fxULhigh+2\*maxULCBWx | fyULlow-2\*maxULCBWy | fyULhigh+2\*maxULCBWy |
| **ACLR2 (MHz)** | 1610 | 1885 | 6225 | 7325 |
| **ACLR3 range** | fxULlow-3\*maxULCBWx | fxULhigh+3\*maxULCBWx | fyULlow-3\*maxULCBWy | fyULhigh+3\*maxULCBWy |
| **ACLR3 (MHz)** | 1560 | 1935 | 6125 | 7425 |
| **ACLR4 range** | fxULlow-4\*maxULCBWx | fxULhigh+4\*maxULCBWx | fyULlow-4\*maxULCBWy | fyULhigh+4\*maxULCBWy |
| **ACLR4 (MHz)** | 1510 | 1985 | 6025 | 7525 |
| **ACLR5 range1** | fxULlow-5\*maxULCBWx | fxULhigh+5\*maxULCBWx | fyULlow-5\*maxULCBWy | fyULhigh+5\*maxULCBWy |
| **ACLR5 (MHz)** | 1460 | 2035 | 5925 | 7625 |
| **Analysis** | There are no cross-band isolation problem for n3 UL to n104 DL up to ACLR 5 according to the calculation. Moreover, n3 and n104 are not the same or adjacent band group as described in table A.1, so there is no need to check >ACLR5 MSD. | | There are no cross-band isolation problem for n104 UL to n3 DL up to ACLR 5 according to the calculation. Moreover, n3 and n104 are not the same or adjacent band group as described in table A.1, so there is no need to check >ACLR5 MSD. | |
| Note 1: Even if there is no overlap up to ACLR5, MSD beyond the ACLR5 range should be evaluated further if: -The UL aggressor band and DL aggressor band are part of the same or adjacent band group as described in table A.1. -If the DL band is above the UL band, it’s lower frequency edge must be below the UL lowest 2nd harmonic frequency -As an indicative threshold, if >45dB UL rejection at the DL band frequency can be guaranteed, assuming a -130dBm/Hz TX noise floor level, the transmitter noise floor related MSD should be negligible Note 2: The maximum UL channel bandwidth of the BCS (noted maxULCBW) is used to calculate the band ACLR ranges while the minimum DL channel bandwidth of the BCS (noted minDLCBW) is used for the DL band victim channel bandwidth. | | | | |
|

#### 5.x.1.4 ∆TIB,c and ∆RIB,c values

For CA\_n3-n104, it is proposed to use n3-n102 ΔTIB,c and ΔRIB,c requirements, which are given in the tables below.

Table 5.x.1.4-1: ΔTIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔTIB,c for NR bands (dB)\* | |
| Component band in order of bands in configuration\*\* | |
| CA\_n3-n104 | 0.3 | 0.8 |
| NOTE \*: “-” denotes ΔTIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n3 the band order from left to right is n1 and n3. | | |

Table 5.x.1.4-2: ΔRIB,c

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔRIB,c for NR bands (dB)\* | |
| Component band in order of bands in configuration\*\* | |
| CA\_n3-n104 | - | 0.5 |
| NOTE \*: “-” denotes ΔRIB,c = 0.  NOTE \*\*: The component band order in the configuration should be listed by the order of NR bands, such as for CA\_n1-n77 the band order from left to right is n1 and n77. | | |

#### 5.x.1.5 REFSENS requirements

Considering the n3 is mid band and n104 is ultra-band, here we use the full separate antenna RF architecture assumption for the MSD derivation. The MSD for H4 caused by n3 UL falls into n104 DL are proposed in the table 5.x.1.5-1:

Table 5.x.1.5-1: Reference sensitivity exceptions and uplink/downlink configurations due to UL harmonic from a PC3 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) |
| n3 | n104 | 5 | 15 | 25 (RBstart=0) | 20 | 14.5 | NOTE 4 | UL4/DL1  direct-hit |
|  |  |  |  |  |  |  |  |  |
| NOTE 4: The requirements should be verified for UL 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. | | | | | | | | |

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

No OOB blocking issues for CA\_n3-n104.

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

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

**Table 5.x.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Power Class 3 (dBm) | Tolerance (dB) |
| CA\_n3A-n104A | 23 | +2/-3 |

#### 5.x.2.2 UE co-existence studies for 2 bands UL

Table 5.x.2.2-1 lists Band n3 + Band n104 2 bands UL CA(2CC) 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.x.2.2-1:** **Band nX and Band nY for 2CC UL IMD products**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **UE UL carriers** | **fx\_low** | **fx\_high** | **fy\_low** | | **fy\_high** |
| **UL frequency** | **1710** | **1785** | **6425** | | **7125** |
| 2nd order IMD products | |fy\_low-fx\_high| | |fy\_high-fx\_low| | |fy\_low+fx\_low| | | |fy\_high+fx\_high| |
| IMD frequency limits (MHz) | 4640 -- 5415 | | | 8135 -- 8910 | |
| 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) | 3705 -- 2855 | | | 11065 -- 12540 | |
| 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) | 9845 -- 10695 | | | 14560 -- 16035 | |
| Two-tone 4th order IMD products | |3\*fx\_low –1\* fy\_high| | |3\*fx\_high – 1\*fy\_low| | |3\*fy\_low – 1\*fx\_high| | | |3\*fy\_high – 1\*fx\_low| |
| IMD frequency limits (MHz) | 1995 -- 1070 | | | 17490 -- 19665 | |
| Two-tone 4th order IMD products | |2\*fx\_low –2\* fy\_high| | |2\*fx\_high – 2\*fy\_low| |  | |  |
| IMD frequency limits (MHz) | 10830 -- 9280 | |  | |  |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high+1\*y\_high| | |3\*fy\_low + 1\*fx\_low| | | |3\*fy\_high+1\*fx\_high| |
| IMD frequency limits (MHz) | 11555 -- 12480 | | | 20985 -- 23160 | |
| Two-tone 4th order IMD products | |2\*fx\_low +2\* fy\_low| | |2\*fx\_high +2\*y\_high| |  | |  |
| IMD frequency limits (MHz) | 16270 -- 17820 | |  | |  |
| 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) | 26790 -- 23915 | | | 715 -- 285 | |
| 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) | 17955 -- 15705 | | | 7495 -- 9120 | |
| 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) | 27410 -- 30285 | | | 13265 -- 14265 | |
| Two-tone 5th order IMD products | |2\*fx\_low + 3\*fy\_low| | |2\*fx\_high + \*fy\_high| | |2\*fy\_low + 3\*fx\_low| | | |2\*fy\_high + \*fx\_high| |
| IMD frequency limits (MHz) | 22695 -- 24945 | | | 17980 -- 19605 | |
| NOTE : For each IMD item, when two bound values before taking absolute have different signs, the relevant IMD range shall be set such that (1) the lower bound is 0 and (2) the upper bound is the bigger value of the two after taking absolute. The lowest even order and lowest odd order IMD MSDs shall be considered. | | | | | |

Based on Table 5.x.2.2-1, 4th order IMD may also fall into Rx frequencies of bands n3.

Table 5.x.2.2-3 lists the protected bands required for the 2UL bands CA configuration.

**Table 5.x.2.2-3: Protected bands for the 2UL bands CA configuration**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **NR CA Configuration** | **Spurious emission** | | | | | | |
| **Protected band** | **Frequency range (MHz)** | | | **Maximum Level (dBm)** | **MBW (MHz)** | **NOTE** |
| CA\_n3-n104 | Frequency range | 1884.5 | - | 1915.7 | -41 | 0.3 | 3 |
| NOTE 3: Applicable when co-existence with PHS system operating | | | | | | | |

#### 5.x.2.3 REFSENS requirements

Based on the co-existence studies there is a need to define IMD4 MSD values, which is proposed in table 5.x.2.3-1:

Table 5.x.2.3-1: 2DL/2UL inter-band Reference sensitivity QPSK PREFSENS and uplink/downlink configurations

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Band / Channel bandwidth / NRB / Duplex mode | | | | | | | | Source of IMD |
| NR CA band combination | NR band | UL Fc  (MHz) | UL/DL BW  (MHz) | UL  CLRB | DL Fc (MHz) | MSD  (dB) | Duplex mode |  |
| CA\_n3-n104 | n3 | 1750 | 5 | 25 | 1845 | 10.7 | FDD | IMD4 |
|  | n104 | 7100 | 20 | 50 | 7100 | N/A | TDD | N/A |

**----- End of TP -----**