**3GPP TSG-RAN WG4 Meeting #111 R4-24xxxxx**

**Fukuoka, Japan, 20th May – 24th May 2024**

**Source:** Ericsson, Telstra

**Title:** TP for 38.718-02-01 adding UL CA\_n26(2A) and UL CA\_n78C to CA\_n26-n78

**Agenda item:** 6.10.2

**Document for:** Approval

# 1. Introduction

This contribution is a text proposal for 38.718-02-01 adding UL CA\_n26(2A) and UL CA\_n78C to CA\_n26-n78.

# 2. Text Proposal

# ---Start of changes---

## 5.4 CA\_n26-n78

#### 5.4.1 Common for 1 band UL and 2 bands UL CA

##### 5.4.1.1 Operating bands for CA

Table 5.4.1.1-1: CA band combination of band n26 and n78

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 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 | | |
| n26 | 814 MHz | – | 849 MHz | 859 MHz | – | 894 MHz | FDD |
| n78 | 3300 MHz | – | 3800 MHz | 3300 MHz | – | 3800 MHz | TDD |

##### 5.4.1.2 Channel bandwidths per operating band for CA

Yellow marks in Table 5.4.1.2-1 indicated the configurations added compared to TS 38.101-1 18.5.0.

Table 5.4.1.2-1: Supported bandwidths per CA band combination of band n26+n78

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| NR CA configuration | Uplink CA configuration or single uplink carrier | NR Band | Channel bandwidth (MHz) | Bandwidth combination set |
| CA\_n26A-n78A | CA\_n26A-n78A | n26 | 5, 10, 15, 20 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
| CA\_n26(2A)-n78A | CA\_n26(2A)  CA\_n26A-n78A | n26 | CA\_n26(2A)\_BCS0 | 0 |
|  |  | n78 | 10, 15, 20, 25, 30, 40, 50, 60, 70, 80, 90, 100 |  |
| CA\_n26A-n78(2A) | CA\_n26A-n78A | n26 | 5, 10, 15, 20, 25, 30 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS0 |  |
| CA\_n26A-n78C | CA\_n78C CA\_n26A-n78A | n26 | 5, 10, 15, 20 | 0 |
|  |  | n78 | CA\_n78C\_BCS0 |  |
| CA\_n26(2A)-n78(2A) | CA\_n26(2A)  CA\_n26A-n78A | n26 | CA\_n26(2A)\_BCS0 | 0 |
|  |  | n78 | CA\_n78(2A)\_BCS0 |  |
| CA\_n26(2A)-n78C | CA\_n78C CA\_n26A-n78A CA\_n26(2A) | n26 | CA\_n26(2A)\_BCS0 | 0 |
|  |  | n78 | CA\_n78C\_BCS0 |  |

##### 5.4.1.3 UE co-existence studies

Table 5.4.1.3-1/2 summarizes frequency ranges where harmonics and/or harmonics mixing occur for CA\_ n26-n78.

**Table 5.4.1.3-1: Impact of UL/DL Harmonic**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **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 |
| n26 | 814 | 849 | 859 | 894 | 1628 | 1698 | 2442 | 2547 | 3256 | 3396 | 4070 | 4245 |
| n78 | 3300 | 3800 | 3300 | 3800 | 6600 | 7600 | 9900 | 11400 | 13200 | 15200 | 16500 | 19000 |

**Table 5.4.1.3-2: Impact of UL/DL Harmonic mixing**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  | **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 |
| n26 | 814 | 849 | 859 | 894 | 1718 | 1788 | 2577 | 2682 | 3436 | 3576 | 4295 | 4470 |
| n78 | 3300 | 3800 | 3300 | 3800 | 6600 | 7600 | 9900 | 11400 | 13200 | 15200 | 16500 | 19000 |

In Table 5.4.1.3-3, up to 9th order IMD ranges for 2CCs on intra-band CA\_n26(2A) are listed. As can be seen in Table 5.4.1.3-3, there are IMD4 impact from UL CA\_n26(2A) into DL band n78. However, no MSD is needed since this is already covered by the 4th harmonic MSD defined for CA\_n26-n78.

Table 5.4.1.3-3: Co-existence studies for intra-band UL CA\_n26(2A)

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Configuration | Channel  BW | Minimum  Channel  separation | Maximum  Instantaneous UL BW | Minimum  frequency | Maximum  frequency | (MHz) |
| Data | 3+3, 10+10 | 0 | 20 | 814 | 849 | - |
| CC location | fU1L | fU2L | fU3L | fU1H | fU2H | fU3H |
| Frequency | 814 | 817 | 834 | 849 | 846 | 829 |
| 2nd | I fU1L - fU2L I | I fU1L - fU3L I | fU1L + fU2L | fU1H + fU2H | - | - |
| Interference ranges | 3 | 20 | 1631 | 1695 | - | - |
| 3rd | 2\*fU1L - fU3L | 2\*fU1H - fU3H | 2\*fU1L + fU2L | 2\*fU1H + fU2H | - | - |
| Interference ranges | 811 | 864 | 2445 | 2544 | - | - |
| 4th | I 2\*fU1L - 2\*fU2L I | I 2\*fU1H - 2\*fU3H I | 3\*fU1L - fU3L | 3\*fU1H - fU3H | 3\*fU1L + fU2L | 3\*fU1H + fU2H |
| Interference ranges | 6 | 40 | 1608 | 1718 | 3259 | 3393 |
| 5th | I 3\*fU1L - 2\*fU3L I | I 3\*fU1H-2\*fU3H I | 4\*fU1L - fU3L | 4\*fU1H - fU3H | 4\*fU1L + fU2L | 4\*fU1H + fU2H |
| Interference ranges | 774 | 889 | 2422 | 2567 | 4073 | 4242 |
| 6th | I 3\*fU1L - 3\*fU2L I | I 3\*fU1H-3\*fU3H I | 4\*fU1L - 2\*fU3L | 4\*fU1H - 2\*fU3H | 5\*fU1L - fU3L | 5\*fU1H - fU3H |
| Interference ranges | 9 | 60 | 1588 | 1598 | 3236 | 3416 |
| 7th | I 4\*fU1L - 3\*fU3L I | I 4\*fU1H-3\*fU3H I | 5\*fU1L - 2\*fU3L | 5\*fU1H - 2\*fU3H | 6\*fU1L - fU3L | 6\*fU1H - fU3H |
| Interference ranges | 754 | 909 | 2402 | 2577 | 4050 | 4265 |
| 9th | I 5\*fU1L - 4\*fU3L I | I 5\*fU1H-4\*fU3H I | 6\*fU1L - 3\*fU3L | 6\*fU1H - 3\*fU3H | 7\*fU1L - 2\*fU3L | 7\*fU1H - 2\*fU3H |
| Interference ranges | 734 | 929 | 2382 | 2607 | 4030 | 4285 |

In Table 5.4.1.3-4, up to 7th order IMD ranges for 2CCs on intra-band CA\_n78C are listed. It can be seen that there are no co-existence issues caused by CA\_n78C impact band n26 DL.

Table 5.4.1.3-4: Co-existence studies for Uplink Intra-Band Contiguous CA

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Configuration | Channel BW | Minimum channel separation | Maximum channel separation | Minimum frequency | Maximum frequency |  |
| Data | 10 | 10 | 200 | 3300 | 3800 | - |
| CC location | fU1L | fU2L | fU3L | fU1H | fU2H | fU3H |
| Frequency | 3300 | 3320 | 3500 | 3800 | 3780 | 3600 |
| 2nd order IMD products | IfU1L-fU2LI | IfU1L-fU3LI | fU1L + fU2L | fU1H+fU2H |  |  |
| Interference ranges | 20 | 200 | 6620 | 7580 |  |  |
| 3rd order IMD products | 2\*fU1L-fU3L | 2\*fU1H-fU3H | 2\*fU1L + fU2L | 2\*fU1H + fU2H |  |  |
| Interference ranges | 3100 | 4000 | 9920 | 11380 |  |  |
| 4th order IMD products | I2\*fU1L-2\*fU2LI | I2\*fU1H-2\*fU3HI | 3\*fU1L-fU3L | 3\*fU1H-fU3H | 3\*fU1L+fU2L | 3\*fU1H+fU2H |
| Interference ranges | 40 | 400 | 6400 | 7800 | 13220 | 15180 |
| 5th order IMD products | I3\*fU1L-2\*fU3LI | I3\*fU1H-2\*fU3HI | 4\*fU1L-fU3L | 4\*fU1H-fU3H | 4\*fU1L+fU2L | 4\*fU1H+fU2H |
| Interference ranges | 2900 | 4200 | 9700 | 11600 | 16520 | 18980 |
| 6th order IMD products | I3\*fU1L-3\*fU2LI | I3\*fU1H-3\*fU3HI | 4\*fU1L-2\*fU3L | 4\*fU1H-2\*fU3H | 5\*fU1L-fU3L | 5\*fU1H-fU3H |
| Interference ranges | 60 | 600 | 6200 | 8000 | 13000 | 15400 |
| 7th order IMD products | I4\*fU1L-3\*fU3LI | I4\*fU1H-3\*fU3HI | 5\*fU1L-2\*fU3L | 5\*fU1H-2\*fU3H | 6\*fU1L-fU3L | 6\*fU1H-fU3H |
| Interference ranges | 2700 | 4400 | 9500 | 11800 | 16300 | 19200 |

##### 5.4.1.4 ∆TIB and ∆RIB values

For CA\_n26-n78, the ΔTIB,c and ΔRIB,c values are same as for DC\_26\_n78 and are given in the tables below.

**Table 5.4.1.4-1: ΔTIB,c**

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔTIB,c for NR bands (dB)9 | |
| Component band in order of bands in configuration10 | |
| CA\_n26-n78 | 0.3 | 0.8 |
| NOTE 9: “-” denotes ΔTIB,c = 0.  NOTE 10: 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 5.4.1.4-2: ΔRIB,c**

|  |  |  |
| --- | --- | --- |
| Inter-band CA combination | ΔRIB,c for NR bands (dB)8 | |
| Component band in order of bands in configuration9 | |
| CA\_n26-n78 | - | 0.5 |
| NOTE 8: “-” denotes ΔRIB,c = 0.  NOTE 9: 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. | | |

##### 5.4.1.5 REFSENS requirements

As can be seen in the co-existence studies in 5.4.1.3 there are 4th harmonics issues to DL n78. Values are reused from DC\_26\_n78 and CA\_n20-n78.

Table 5.4.1.5-1: Reference sensitivity exceptions due to UL harmonic for NR 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)** |
| n26 | n78 | 5 | 15 | 16 (Rbstart=0) | 10 | 10.8 | NOTE 4 | UL4/DL1  direct-hit |
| n26 | n78 | 5 | 15 | 25 (Rbstart=0) | 100 | 1.4 | NOTE 4 | UL4/DL1  direct-hit |
| NOTE 4: 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. | | | | | | | | |

##### 5.4.1.6 OOB blocking exception requirements

Since band n28 is a low band and n78 is a wide band, the OOBB exception is needed.

Table 5.4.1.6-1: CA band combination with exceptions allowed

|  |
| --- |
| CA band combination |
| CA\_n26-n78 |

#### 5.4.2 Specific for 2 bands UL CA

##### 5.4.2.1 Maximum output power for inter-band CA

**Table 5.4.2.1-1: UE Power Class for uplink inter-band CA**

|  |  |  |
| --- | --- | --- |
| Uplink CA Configuration | Class 3 (dBm) | Tolerance (dB) |
| CA\_n26A-n78A | 23 | +2/-3 |

##### 5.4.2.2 UE co-existence studies

Table 5.4.2.2-1 lists Band n26 + Band n78 2UL bands CA 2nd, 3rd, 4th and 5th order IMD for the UE-to-UE coexistence analysis.

**Table 5.4.2.2-1: Band n26 and Band n78 UL harmonics and IMD products**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **UE UL carriers** | **f1\_low** | **f1\_high** | **f2\_low** | **f2\_high** |
| UL frequencies (MHz) | 814 | 849 | 3300 | 3800 |
| 2nd order IMD products | |fy\_high – fx\_low| | |fy\_low – fx\_high| | |fy\_low + fx\_low| | |fy\_high + fx\_high| |
| IMD frequency limits (MHz) | 2986 | 2451 | 4114 | 4649 |
| 3rd order IMD products | |fy\_high – 2\*fx\_low| | |fy\_low – 2\*fx\_high| | |2\*fy\_low – fx\_high| | |2\*fy\_high – fx\_low| |
| IMD frequency limits (MHz) | 2172 | 1602 | 5751 | 6786 |
| 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) | 4928 | 5498 | 7414 | 8449 |
| 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) | 5972 | 4902 | 8228 | 9298 |
| 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) | 1358 | 753 | 9051 | 10586 |
| Two-tone 4th order IMD products | |3\*fx\_low +1\* fy\_low| | |3\*fx\_high +1\* fy\_high| | |3\*fy\_low + 1\*fx\_low| | |3\*fy\_high + 1\*fx\_high| |
| IMD frequency limits (MHz) | 5742 | 6347 | 10714 | 12249 |
| 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) | 14386 | 12351 | 96 | 544 |
| 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) | 14014 | 16049 | 6556 | 7196 |
| 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) | 9772 | 8202 | 4053 | 5158 |
| 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) | 11528 | 13098 | 9042 | 10147 |

Based on the table above it can be seen that IMD4 may affect own Rx frequencies of band n26.

**Table 5.4.2.2-2: 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\_n26-n78 | E-UTRA Band 1, 3, 5, 11, 18, 19, 21, 26, 34, 39, 40, 65, 74 | FDL\_low | - | FDL\_high | -50 | 1 |  |
| E-UTRA Band 41 | FDL\_low | - | FDL\_high | -50 | 1 | 2 |
| Frequency range | 703 | - | 799 | -50 | 1 |  |
| Frequency range | 799 | - | 803 | -40 | 1 | 4 |
| Frequency range | 945 | - | 960 | -50 | 1 |  |
| 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 180kHz), 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: Applicable when co-existence with PHS system operating in 1884.5 -1915.7 MHz  NOTE 4: These requirements also apply for the frequency ranges that are less than FOOB (MHz) in Table 6.5.3.1-1 from the edge of the channel bandwidth. | | | | | | | |

##### 5.4.2.3 REFSENS requirements

Based on the co-existence studies the following MSD need to be defined. Values are reused from DC\_26\_n77.

**Table 5.4.2.3-1: MSD due to IMD issue**

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Operating 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\_n26-n78 | n26 | 836.5 | 5 | 25 | 881.5 | 11.1 | FDD | IMD4 |
| n78 | 3391 | 10 | 50 | 3391 | N/A | TDD | N/A |

---End of changes---

# Reference

[1] R4-2405246 TR38.718-02-01 v0.11.0: Rel-18 NR Inter-band Carrier Aggregation/Dual Connectivity for 2 bands DL with x bands UL (x=1,2), ZTE Corporation