**3GPP TSG-RAN WG4 Meeting #116 R4-2511850**

Bangalore, India, Aug 25th – 29th, 2025

**Title:** WF on UL CA\_n5-n8

**Agenda Item:** 6.1

**Source:** CATT, Huawei, China Telecom, China Unicom, Anterix

**Document for:** Approval

# **Background**

For carrier aggregation involving a low-low band combination where the UL of one band partially overlaps with the DL of the other band, such as CA\_n5-n8, RAN4 conducted studies in Rel-18 on enhancements for 700/800/900MHz band combinations. The studies concluded that three options are feasible for implementing the CA\_n5-n8 band combination, as detailed in TR 38.872.:

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| *1) Full band n5 and n8 RF filters implementation with option 1 and option2:**- Option 1: Only support 1UL/2DL CA. Single UL in n5**- Option 2: Support both 1UL/2DL and 2UL/2DL CA. Non-concurrent n5 DL and n8 UL**2) Dedicated RF filters implementation with partial frequency range**- Option 3: Support both 1UL/2DL and 2UL/2DL CA. Dedicated filter to allow simultaneous n5 DL and n8 UL without any scheduling restriction on both bands.* |

In Rel-18, only Option 1 was introduced.

Furthermore, RAN4#112bis has reached an agreement to specify Option 2 in Rel-19 [1]:

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| ***<Way forward/Agreement>**** *RAN4 agrees to specify the support of the following implementation architecture in Rel-19 for CA\_n5-n8 (i.e., Option 2)*
	+ *2UL/2DL CA is supported using non-concurrent n5 DL and n8 UL*
	+ *Send LS to RAN2 to complete necessary signalling designs*
* *Stop discussion on Option 3 in Rel-19. If option 3 is discussed in Rel-20 or later, new band numbers are considered.*
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In RAN4#113, RAN4 sent LS [2] to ask RAN2 to define UE capability related to non-simultaneous on (n8UL, n5DL) in the FDD-FDD band combination CA\_n5-n8. And RAN2 replied the LS with further question on the details about the requested capability. RAN4 need to provide sufficient information to RAN2 for reference, including the conclusions and progress in NR\_700800900\_combo\_enh, LTE\_NR\_R19\_Simult\_RxTx and NR\_LBCA\_Sw, to design the capability.

In RAN4#115, a solution was considered for further check on RRM specs or additional requirements of other WG(s), and if identified Option 2 is not considered in Rel-19 [3]:

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| ***<Way forward>:*** *For CA\_n5-n8, further consider the following solution with side conditions to support both 1UL/2DL and 2UL/2DL CA with non-concurrent n5 DL and n8 UL in Rel-19:**Support case 1 and case 2 via RRC reconfiguration.** *Case 1: 2UL/2DL configuration, where NW shall keep all the four carriers activated, allocate resource allocation for a dedicated user only to n5 UL, n8 UL and n8 DL (no n5 DL resource allocation to a dedicated user) and both two bands are collocated.*

* *Case 2: 1UL/2DL configuration*

*Companies are encouraged to study necessity of additional RRM spec or additional requirement(s) of other working groups. If there is impact on RRM or other WGs beyond the introduction of UE capability, the solution is not considered in Rel-19.**Whether new capability is needed or not would be further discussed.* |

In RAN4#116, the solution is further clarified that a UE is able to support 2UL/2DL where scheduling restriction applies on n5-DL and n8-UL, if the UE can make RFFE reconfiguration (Note: not dynamically) within RRC state. The RRC configuration and RFFE configuration are not tied together.

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|  | **RRC configuration** | **RFFE configuration** |
| **Case 1** | 2UL/2DL | * #A: n5-UL: Tx, n5-DL:Rx, n8-DL:Rx
* #B: n5-UL:Tx, n8-UL:Tx, n8-DL:Rx
 |
| **Case 2** | 1UL/2DL (like SDL) | * #A: n5-UL: Tx, n5-DL:Rx, n8-DL:Rx
 |

An example is illustrated without RRM impacts as follows:



Step 1: Access n5 as PCell

Step 2: RRC reconfiguration to Case 2: Add n8 with only n8-DL as SCell 🡪 UL Tx in SCell via n5-UL

* + RFFE configuration is #A: n5-UL: Tx, n5-DL:Rx, n8-DL:Rx

Step 3: RRC reconfiguration to Case 1: PCell remains at n5, reconfigure SCell n8 by adding n8-UL

* + Freedom of RFFE configuration
		- Alt.#1: Not changed, remaining as #A: (n5-UL: Tx, n5-DL:Rx, n8-DL:Rx)
		- Alt#2: Or reconfigured to #B: (n5-UL:Tx, n8-UL:Tx, n8-DL:Rx)

Step 4: When n8-UL needs to be scheduled from Slot #N to Slot #N+m,

* + NW to choose a slot #N-k, where DCI issued to the UE that n8-UL transmission happens at slot #N
		- k is chosen
			* to be large enough so the UE can make successful RFFE reconfiguration to Alt. #2
			* There will be no SSB/PDCCH/CSI-RS on n5-DL to be received by the UE between Slot #N-k and #N
		- m is chosen
			* No SSB/PDCCH/CSI-RS on n5-DL to be received by the UE between Slot #N to #N+m
		- The DCI also schedules n5-UL between Slot#N to #N+m via 1 TB mapping to multiple slots via features:
			* Repetitive (Rel-15)
			* Non-repetitive (Rel-17)

Hence n5-UL transmission during this period is not impacted.

* + UE to complete reconfiguration of RFFE between Slot #N-k and #N (k is chosen to guarantee that no n5-DL reception is required)
	+ UE to make UL transmission at n8-UL at Slot #N until Slot #N+m
	+ Once UE complete n8-UL transmission, reconfigure RFFE from #B to #A immediately
	+ NW do not schedule any PDSCH before Slot #N+m+q
		- q is chosen
			* There is no SSB/PDCCH/CSI-RS on n5-DL to be received by the UE between Slot #N+m and Slot #N+m+q
	+ There is no uplink transmission on n8-UL for the UE between Slot #N+m and Slot #N+m+q

Step 5: Repeat Step 4 if new n8-UL transmission is required.

NOTES:

* PCell is always n5, and n8 always serves as SCell.
* SCell is active
	+ **No SCell activation issue**
* PCell and SCell is collocated, and have the same frame timing
	+ **No UL timing issue**
* Only RFFE Alt.#1 works (i.e., when RRC reconfigured from Case 2 to Case 1, RFFE configuration do not change), otherwise, NW do not configure the UE with 2UL/2DL (scheduling restriction)
* **UE** capability **required**
	+ NW needs to know the UE capability : (1) No RFFE reconfiguration when adding n8-UL to SCell; (2) RFFE reconfigured back to 1UL/2DL when finishing UL transmission on n8-UL.
	+ Besides the UE capability, UE just follows NW instructions, no need for change of behaviors, signaling, etc., and no additional requirements.

In addition to the new UE capability, one statement such as “the UE does not expect concurrent n5-DL reception and n8-UL transmission” may be required, and in which specs to capture this statement is FFS.

Moreover, concerns are also raised on the possible gain from this Option.

**<Agreement>:**

For CA\_n5-n8, specify the solution to support 2UL/2DL CA with scheduling restriction on n5 DL and n8 UL in Rel-19:

* A new UE capability on band combination CA\_n5-n8 is defined to indicate
	+ The UE does not reconfigure RFFE with the addition of n8-UL to Scell, and
	+ RFFE reconfigured back to 1UL/2DL when finishing UL transmission on n8-UL,
	+ where n5 acts as PCell for the band combination
	+ No RRC reconfiguration is required for 2UL/2DL when scheduling restrictions apply
* FFS on
	+ In which specs to capture one statement such as “the UE does not expect concurrent n5-DL reception and n8-UL transmission”
	+ Possible gain from this solution.

# Reference

[1] R4-2417125, “WF on UL CA\_n5-n8”, CATT, China Telecom, Huawei, HiSilicon

[2] R4-2507925, “WF on simultaneous Rx/Tx requirements”, Huawei

[3] R4-2420410, “LS on UE capability for FDD-FDD inter-band CA simultaneous Rx/Tx”, RAN4#113