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R19 NR 3Tx enhancements

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Background

- 3Tx for inter-band UL CA/EN-DC together with low band 4Rx WI was approved in Dec 2022, and in the past half year, both have been **successfully commercialized and become popular in several regions**.
- However, due to little time when it was approved, 3Tx in Rel-18 has only focused on **limited cases in power combinations, band combinations, and UE types.**
- The urgent demands keep showing for the 3Tx in the market which call for the enhancements in Rel-19.

Consideration of R19 enhancements (1)

1. For 3Tx inter-band UL CA/ENDC
   a) UE Types

      In Rel-18, it is targeted for FWA device, and in Rel-19, the **handheld UE** can be enabled.

   b) Power combinations

      In Rel-18 only PC3+PC2 and PC3+PC1.5 were considered to limit the scope. And more power combinations were proposed and interested by many companies. Below two tables shows the **collected interests of new power combinations** from companies before meeting:

Table 1: Power combinations for PC2 in total with 3Tx inter-band UL CA/ENDC

PC2 in total		**band A 1Tx**			
		FDD PC3	FDD PC2	TDD PC3	TDD PC2
band B 2Tx	FDD PC3				
	FDD PC2	R19	R19	R19	R19
	TDD PC3	R18			
	TDD PC2	R18	R19	R18	

Table 2: Power combinations for PC1.5 in total with 3Tx inter-band UL CA/ENDC

PC1.5 in total		**band A 1Tx**			
		FDD PC3	FDD PC2	TDD PC3	TDD PC2
band B 2Tx	FDD PC2	N/A		N/A	
	TDD PC2	N/A		N/A	
	TDD PC1.5	R18	R19	R19	R19

NOTE: Rel-18 power combinations will be inherited for handheld UE also.

Consideration of R19 enhancements (2)

1. For 3Tx inter-band UL CA/ENDC (continue)
   c) Increased high power limit

      In Rel-18, the increased high power limit was excluded to simplify the discussion. And considering UE with **3Tx can transmit higher Tx power by nature**, it will be useful to enable this feature for 3Tx.

2. For single band 3Layer and 3TxD
   a) PA configuration assumptions are:
      - **3x23dBm** with total power class PC2
      - **3x26dBm** with total power class PC1.5 for TDD bands

      3port-codebook will be introduced in Rel-19. The requirements can be defined in RAN4 considering UEs already have the ability in implementation.

   b) Increase UE power high limit feature for single band

      3Tx UE with 3PAs transmit simultaneously in single band can achieve **higher power than single band power class limits**. Enabling the increased high power limit feature for single band would be useful in fully utilize the 3Tx abilities.

Proposed Objectives (1)

Objectives for 3Tx enhancement in R19.

- **Enhancements of 3Tx for single band**
  - Specify UE RF requirements to support 3Tx with **3Layer UL MIMO and TxD**
    - PA configuration assumptions are:
      - 3x23dBm with total power class PC2
      - 3x26dBm with total power class PC1.5 for TDD bands
    - Enable **increase UE power high limit feature** for 3Tx in single band
    - Example bands n77/n78, n1 and n8
- **Enhancements of 3Tx for band combinations with two bands**
  - Specify requirements for 3Tx with inter-band UL CA or EN-DC
    - Introduce band combinations to the CA/ED-DC configuration tables, and inter-band CA/EN-DC MOP tables
    - Specify corresponding MSD requirements if any
  - The 3Tx band combinations considered:
    - In each band only 1CC included
    - Tx capability considered is 1Tx in one band, and 2Tx in the other band

Proposed Objectives (2)

- Enhancements of 3Tx for band combinations with two bands (continue)
  - The following power combinations will be considered
    - **R18 legacy power combinations to be supported by handheld UE**
    - **New power combinations for both handheld UE and FWA devices.**
      - ✓ **CA or EN-DC power class PC2**

PC2 in total		band A 1Tx			
		FDD PC3	FDD PC2	TDD PC3	TDD PC2
band B 2Tx	FDD PC3				
	FDD PC2	R19	R19	R19	R19
	TDD PC3	R19 (inherit R18)			
	TDD PC2	R19 (inherit R18)	R19	R19 (inherit R18)	

      - ✓ **CA or EN-DC power class PC1.5**

PC1.5 in total		band A 1Tx			
		FDD PC3	FDD PC2	TDD PC3	TDD PC2
band B 2Tx	FDD PC2	N/A		N/A	
	TDD PC2	N/A		N/A	
	TDD PC1.5	R19 (inherit R18)	R19	R19	R19

    - **Enable increase UE high power limit feature for 3Tx inter-band CA/EN-DC**