

3GPP TSG-RAN WG4 Meeting #100-e
Electronic Meeting, August 16-27, 2021

R4-2113909

Motivation of 3Tx handheld UE

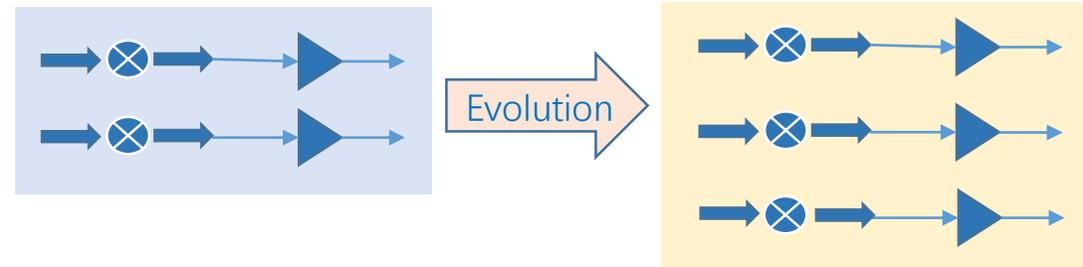
OPPO

Big imbalance b/w UL and DL

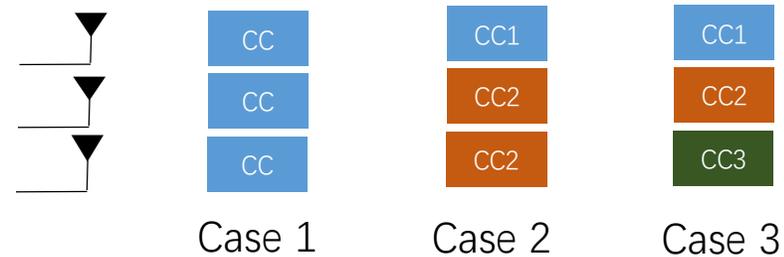
- **UL for handheld UE is limited to 2T and 2CC, max combined capability is 2layer x 2CC (when less than 200MHz contig UL CA)**
 - UL MIMO and CA can't be supported simultaneously other cases, like inter-band CA, non-contig CA, EN-DC
- **DL can reach much higher MIMO and CA capabilities**
 - Now RAN4 supports up to 4 bands in DL CA, and each band can support 8CC in theory, i.e. max CA capability is **32 CC**
 - Up to 4layer MIMO in each CC, i.e. max MIMO capability can achieve **16 layers**
 - **The achievable DL MIMO+CA capability is much higher than UL**
- **Handheld UE UL performance is quite limited and no more can be enhanced if stay with current 2Tx assumption**
 - Max achievable power is 26+26
 - Max MIMO and CA is 2layer+200MHz CC, and no MIMO in non-contig CA and inter-band CA
 - EN-DC is 1T+1T
 - Max concurrent Bands is two

Introduction of 3Tx in handheld UE

- Evolution from current 2Tx to 3Tx
 - 3Tx means 3Tx chain, and 3PAs activated



- Target following 3Tx cases
 - 1 band/cc with 3Tx
 - 2 bands/cc with 3Tx
 - 3 bands/cc with 3Tx



Power enhancement with 3Tx

- **3Tx can support higher than 29dBm total output power** -> RAN4 impact

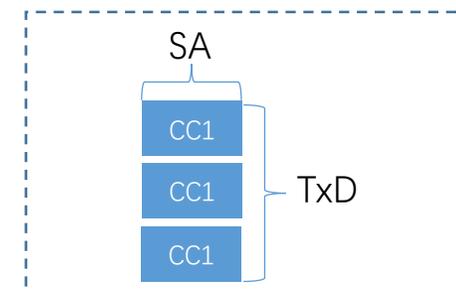
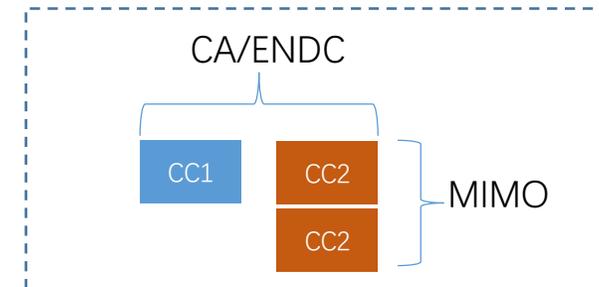
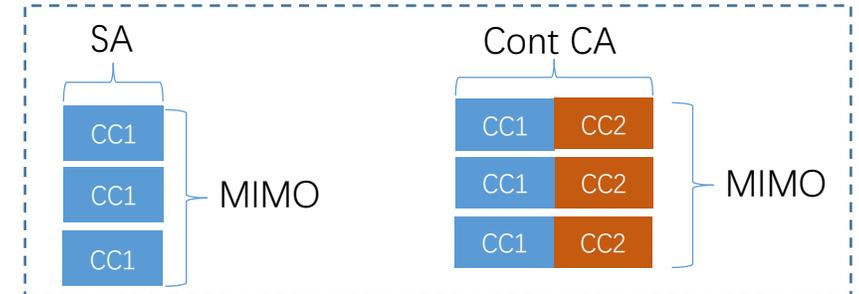
- $3 \times 26 = 30.8\text{dBm}$ -> PC1
- $23 + 2 \times 26 = 30\text{dBm}$ -> PC1.3?
- $3 \times 23 / 23 + 26 = 27.7\text{dBm}$ -> PC1.7?

PC1	PC1.3?	PC1.5	PC1.7?	PC2	PC3	PC5
31	30	29	28	26	23	20

- **Different approaches can be considered to support higher or new power capabilities than current power class**
 - New power class
 - Remove upper limit
 - Power boosting

MIMO enhancement with 3T

- **3 layer MIMO can be supported in 1CC or 2 contig CC**
-> RAN1 and RAN4 impact
 - New 3 ports codebook or reuse 4 ports codebook
- **2 layer MIMO can be supported in non-contig UL CA, inter-band UL CA, or EN-DC at one CC**
->RAN4 impact
 - Similar feature has been introduced in RAN4 Rel-17, i.e. contig UL CA+MIMO up to 200MHz aggregated CBW
 - No impact to RAN1 and RAN2
- **TxD with 3Tx can be supported if necessary**
-> RAN4 impact

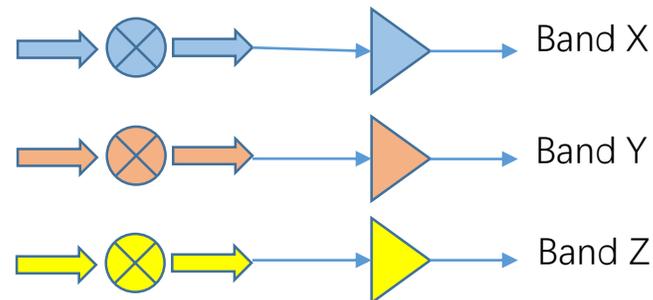


3 bands Tx simultaneously

- **3 bands with 1Tx in each band** concurrent transmission can be supported, e.g. in UL CA or EN-DC

->RAN4 impact

- MPR evaluation with 3PA
- MSD to cover 3 bands harmonics/IMD/cross band isolation, etc.
- 3 bands Tx fall back to 2 bands Tx and 1 band Tx behavior and requirements



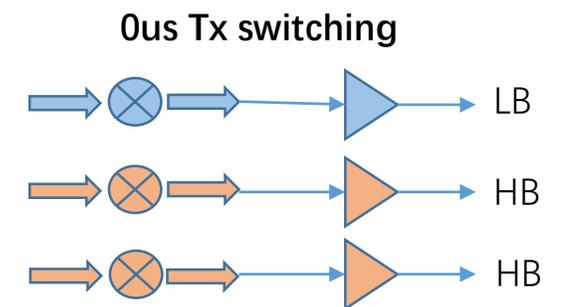
Tx switching transmission enhancement

- With 3Tx, low band and high band concurrent transmission can be achieved
- However, for power consumption/heating reasons Tx switching transmission might still happen, and in such case 0us Tx switching and no DL interruption can be achieved.

->RAN2 and RAN4 impact

- For, switching transmission might still be needed

```
ULTxSwitchingBandPair-r16 ::=          SEQUENCE {  
    bandIndexUL1-r16                    INTEGER (1..maxSimultaneousBands),  
    bandIndexUL2-r16                    INTEGER (1..maxSimultaneousBands),  
    uplinkTxSwitchingPeriod-r16         ENUMERATED {n35us, n140us, n210us},  
    uplinkTxSwitching-DL-Interruption-r16 BIT STRING (SIZE(1..maxSimultaneousBands)) OPTIONAL  
}
```



UE implementation impact

- **RFIC needs to support 3Tx chain with 2LO or 3LO**

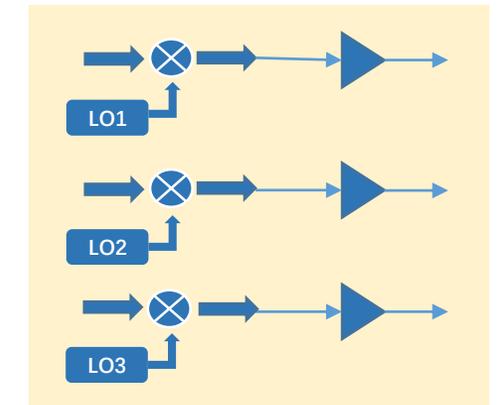
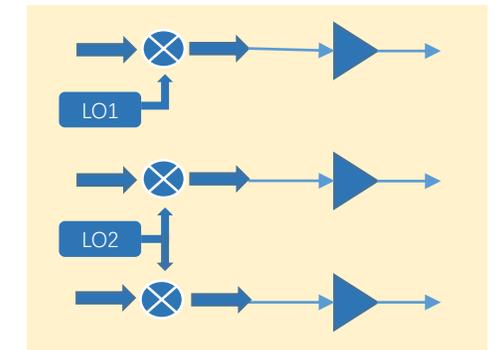
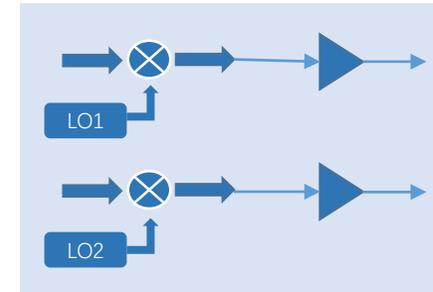
- 3Tx chain+2LO can support up to two frequencies concurrent Tx
 - 3Layer@1CC
 - 1Layer@CC1+2Layer@CC2
- 3Tx chain+3LO can support up to three frequencies concurrent Tx
 - 3Layer@1CC
 - 1Layer@CC1+2Layer@CC2
 - 1Layer@CC1+1Layer@CC2+1Layer@CC3

- **RFFE needs to support 3PA/Ant**

- Current UE supports 1PA for low/mid band, and 2PA for high band, and has two PA power supply (ATP/ET)
- To support 1T CC1+2T CC2 case
 - No more PA is needed, but one more PA power supply needs to be added
- To support 3T@1CC case
 - One more PA is needed for high band, and also PA power supply

- **SAR/heating issues**

- Keep total power to existing PC1.5/PC2/PC3 and reuse SAR solutions
- Introduce higher power class (e.g. PC1) to handheld UE in certain bands with further duty cycle restrictions



Proposal

- Introduce handheld UE with 3Tx in Rel-18 and support following features
 - Higher or new power capabilities
 - 3layer and TxD for single CC, and contiguous UL CA
 - CA/EN-DC +UL MIMO
 - Band A 1T + Band B 2T
 - Non-contiguous UL CA: CC₁ 1T+CC₂ 2T
 - 3 bands or 3CC transmission simultaneously
 - Band A 1T + Band B 1T + Band C 1T
 - Non-contiguous UL CA: CC₁ 1T+CC₂ 1T+CC₃ 1T
 - 0us Tx switching transmission and no DL interruption