**3GPP TSG-RAN WG4 Meeting #112 R4-2414277**

**Maastricht, Netherlands, 19-23 Aug, 2024**

**Title:** WF on HPUE for CA in TN

**Agenda Item:** 8.1.3

**Source:** Samsung

**Document for:** Approval

#  1. PC1.5 for intra-band contiguous and non-contiguous UL CA

## 1.1 MPR evaluation methodology and assumption

**Online agreement:**

* MPR and CANS\_04 A-MPR studies for PC1.5 contiguous intra-band ULCA focusses on TxD architecture and may account for PSD imbalance with up to 6dB.
	+ FFS on whether to define the requirements based on equal PSD or PSD imbalance with 6dB
* PC1.5 contiguous intra-band ULCA based on dualPA architecture with two LOs is not specified in R19
* MPR studies for PC1.5 non-contiguous intra-band ULCA focusses on dualPA architecture with two LOs and may account for PSD imbalance with up to 6dB.
	+ FFS on whether to define the requirements based on equal PSD or PSD imbalance with 6dB
* PC1.5 non-contiguous intra-band ULCA based on TxD architecture is not specified in R19

## 1.2 PCMAX,C

**Adhoc agreement:**

* For intra-band UL NC CA with dualPA-architecture, the upper bound of Pcmax,c is 26dBm per CC
	+ Whether or how to reflect the above agreement in spec is FFS
* For intra-band UL contiguous CA with TxD, the upper bound of Pcmax,c is 29dBm per CC
	+ Whether or how to reflect the above agreement in spec is FFS

## 1.3 PCMAX

**Online agreement with adhoc modification:**

* For intra-band contiguous ULCA with 2Tx-TxD, the upper bound of Pcmax is 29dBm
* For intra-band UL NC CA with dual PA architecture, the upper bound of Pcmax is 29dBm

# 2. 2-band Inter-band UL NR-CA/EN-DC with 2Tx and/or 3Tx

## Configuration

**Adhoc agreement:**

For PC1.5 inter-band UL CA/EN-DC, the work for the case PC2 FDD band as one of the constituent band would be triggered after example combo(s) is added in the WID

## 2.2 Spec organization

**Adhoc agreement:** Adopt same way as in Rel-18

## 2.3 3UL CC with 3Tx

**Adhoc agreement:** Don not consider 3ULCC with 3Tx CA\_nXA-nY(2A)/ DC\_XA\_nY(2A) scenario

# 3. Increasing UE transmission power

## 3.1 The methodology

**Adhoc** **agreement:**

* Use higherPowerLimit-R17 and higherPowerLimtMRDC-R17 capability
* No new power class is introduced

## 3.2 The scenarios to be considered in Rel-19

**Adhoc** **agreement:**

* For both 2Tx and 3Tx, higherPowerLimit-R17/higherPowerLimtMRDC-R17 is enabled for any specified inter-band band combination

# 4. General aspect

## 4.1 MSD rules

**Way forward:**

* RAN4 can discuss the MSD general rules, and strive to down-select among the following options
* PC2/PC1.5 MSD requirements are not specified. UE shall meet the Rx requirements of default power class, with default power class transmission
* Using some equations or look-up tables or other means to derive PC2/PC1.5 MSD from respective PC3 MSD
* Other solutions are not precluded

NOTE: RAN4 continues normal procedure specifying MSD for all PC’s band combination supports until down-selection is done

## 4.2 Duty cycle solution for SAR compliance

Proposals：

* + Proposal 1: Do not introduce ΔPPowerClass related specifications changes for PC1.5 inter-band UL CA/EN-DC with 2Tx or 3Tx configuration. (Apple)
	+ Proposal 2: 3GPP duty-cycle solution is not specified for any scenarios of this WI. (Samsung)
	+ Proposal 3: (Xiaomi)
* If follow the similar approach as current spec, for PC1.5 UE for two band NR inter-band uplink CA with 2Tx and/or 3Tx, the existing SAR mitigation solution for PC1.5 with 3Tx in Ts 38.101-1 could be reused. For PC1.5 inter-band EN-DC with 2Tx and 3Tx case, the duty cycle approach could be defined based on the existing dutycycle approach for PC2 case with some small changes as shown in the following table 2 for TDD+TDD case and FDD+TDD case.
* A unify approach on SAR solution for all possible HP UE scenarios can be considered. The detail approach could be discussed further. For example, only P-MPR is considered (i.e., Duty-cycle solution is not considered), or SAR solution just relies on per single band manner.
	+ Proposal 4: (Meta)
* RAN4 can reuse the max uplink duty cycle limitation of the single carrier SAR solution for PC 1.5 intra-band contiguous CA combinations UE.
* RAN4 can reuse the max uplink duty cycle limitation of the single carrier SAR solution for PC 1.5 intra-band non-contiguous CA combinations UE.
	+ Proposal 5: (LGE)
* Modify the existing PC2 duty cycle solution if PC2 FDD/TDD + PC2 TDD with 2Tx is introduced.
* For PC3 E-UTRA FDD + PC3/PC2 NR FDD, consider A new capability, for example, maxUplinkDutyCycle-interBandENDC-FDD-PC2 which comprises of maxUplinkDutyCycle-FDD-EN-DC1 and maxUplinkDutyCycle-FDD-EN-DC2
* For PC2 E-UTRA TDD + PC3 NR TDD, consider New duty cycle solution considering the possible E-UTRA TDD uplink-downlink configurations and the percentage of maximum E-UTRA/NR uplink transmission
* For PC2 E-UTRA TDD + PC2 NR TDD, considere New duty cycle solution considering the possible E-UTRA TDD uplink-downlink configurations and the percentage of maximum E-UTRA/NR uplink transmission
* For PC3 E-UTRA FDD + PC3/PC2 NR FDD (UL-MIMO or Tx diversity), consider a new capability, for example, maxUplinkDutyCycle-interBandENDC-FDD-PC2 which comprises of maxUplinkDutyCycle-FDD-EN-DC1 and maxUplinkDutyCycle-FDD-EN-DC2
* For PC2 E-UTRA TDD + PC3 NR TDD (UL-MIMO or Tx diversity), consider New duty cycle solution considering the possible E-UTRA TDD uplink-downlink configurations and the percentage of maximum E-UTRA/NR uplink transmission
* For PC3 E-UTRA FDD/TDD + PC1.5 NR TDD (UL-MIMO or Tx diversity), consider New duty cycle solution considering the possible E-UTRA TDD uplink-downlink configurations and the percentage of maximum E-UTRA/NR uplink transmission
* For PC2 E-UTRA TDD + PC2/PC1.5 NR TDD (UL-MIMO or Tx diversity), consider New duty cycle solution considering the possible E-UTRA TDD uplink-downlink configurations and the percentage of maximum E-UTRA/NR uplink transmission
	+ Proposal 6: (ZTE)
* Duty-cycle solution should be considered for limited scenarios of PC2/PC1.5 NR inter-band UL CA.
	+ - Only consider P-MPR scheme for the band combination including PC2 FDD band, i.e. FDD+FDD, FDD+TDD
		- Except P-MPR, duty cycle scheme is applied to the band combination including pure TDD bands, i.e. TDD+TDD
* For duty cycle based SAR solution, reuse the PC1.5 single CC capability for PC1.5 TDD UL intra-band contiguous and non-contiguous CA
	+ Proposal 7: (vivo)
* For PC1.5 of intra-band CA, the default threshold is 25% when maxUplinkDutyCycle-PC2-FR1 is absent, if 0.5\* maxUplinkDutyCycle-PC2-FR1 is exceeded, power reduction is expected.
* To compatible with PC2 of inter-band CA, for PC1.5 of inter-band CA, there is no default threshold when maxUplinkDutyCycle-interBandCA-PC2 is absent, if maxUplinkDutyCycle-PC2-FR1 is reported and 0.5\* maxUplinkDutyCycle-PC2-FR1 is exceeded, power reduction is expected.
* To compatible with PC2 of inter-band EN-DC(TDD+TDD), for PC1.5 of Inter-band EN-DC(TDD+TDD) , the default threshold is 15% when maxUplinkDutyCycle-interBandENDC-TDD-PC2-r16 is absent, if 0.5\*maxUplinkDutyCycle-interBandENDC-TDD-PC2-r16 is exceeded, power reduction is expected.
* For PC2 of inter-band EN-DC(FDD+FDD), on LTE side, there are two threshold 40% and 70% is hardcoded. On NR side, UE will report two thresholds: maxUplinkDutyCycle-FDD-FDD-EN-DC1 and maxUplinkDutyCycle-FDD-FDD-EN-DC2.
	+ Proposal 8: (CHTTL)
* Regarding the SAR solutions for LTE FDD + NR TDD with 1Tx PC3 + 2Tx PC1.5 configuration
	+ - At least the method that reusing PC2 LTE FDD + NR TDD signalling with 0.5 scaling is considered
		- The UE-implementation based methods (i.e. P-MPR) is still applied by default
* Regarding the SAR solutions for LTE FDD + NR FDD 2Tx/3Tx configurations
	+ - The UE-implementation based methods (i.e. P-MPR) is applied by default
		- RAN4 to discuss whether other solutions (ex: duty cycle method) can be considered
	+ Proposal 9: (China Telecom)
* For PC2 two band EN-DC with 2Tx and/or 3Tx, the legacy duty-cycle solution in 38.101-3 and corresponding capability and signalling shall be reused.
* For PC1.5 HPUE for intra/inter-band CA, the general SAR solution framework and the threshold of average percentage of uplink symbols should both refer to PC2 UE for CA and PC1.5 UE for single CC.
* For PC1.5 HPUE for intra/inter-band CA, if power class of one or both of the bands within the band combination is power class 1.5, the default value of maxDutyNR,x/y should be 25%.
* Start with taking half of PC2 default duty-cycle threshold and 0.5\*PC2capability as new trigger condition of SAR solution for PC1.5 of FDD+TDD/TDD+TDD.

**Way forward:** FFS