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# Views on UE RF Topics for Rel-19

Huawei, HiSilicon



# UE RF enhancements for FR1 & FR2

- High power UE for CA
- Power boosting and/or MPR reduction
  - > Power boosting or MPR reduction for FR1 PC2/PC3 with relaxed requirements (ACLR and/or EVM)
  - > Study and specify improved MPR for FR2 intra-band CA
  - > [MPR improvement with new PAPR reduction mechanism]
- 6Rx for handheld and FWA UE
- [Applicable ULFPTx modes reporting associated with changed power]

# High power UE for CA

- Motivation

- > The band combination for PC1.5 intra-band contiguous/non-contiguous CA was already proposed in Rel-18, and it has impact on general requirement
- > Operators show interest for UE supporting this feature to accommodate the deployment demand
  - Example band combination could be n77C, n78C, n79C, n77(2A), n78(2A), n79(2A)
- > Strong demand for companies to consider a HPUE framework for NR CA

- Objective

- > Specify UE RF requirement for PC1.5 intra-band CA with 2Tx, including scenarios of
  - Intra-band contiguous CA w/ or w/o UL MIMO
  - Intra-band non-contiguous CA
  - Example band combinations: n77/78/79C, n77/78/79(2A)
- > Specify generic UE RF requirement for PC1.5 inter-band CA with 2Tx and/or 3Tx in two bands for handheld and FWA UE
- > Study and define generic framework of support increasing UE power high limit for inter-band CA HPUE for different power classes

# Power boosting and/or MPR reduction with relaxed requirements

- **Motivation**

- > UL performance is one of key enablers for 5G-advanced. One of the key evolution directions is to enhance the uplink coverages or performance for different transmission schemes including single carrier or UL CA aggregation, different modulations including QPSK, 16QAM, 64QAM, 256QAM, and different waveforms. The improvement could be generic for both FR1 and FR2.
- > It is critical to increase UE uplink transmission power in order to enhance uplink coverage or performance. There are two evolution directions: one is to define the higher power class; the other is to boost transmission power for existing power classes. In our view, the latter one is more cost-efficient and RAN4 should focus on it for Rel-19 non-spectrum item.
- > One aspect below can be further improved for existing power classes considering the work in Rel-18 HPUE items and Rel-18 coverage enhancement WI:
  - Reduce MPR or boost UL transmission power by conditionally relax the main limiting factors including ACLR or EVM for power boosting
    - Relax ACLR for lower modulation orders: ACLR could be relaxed to allow MPR reduction or power boosting under the following conditions:
      - ✓ When considering and aligning the absolute tolerable OOB emission mean levels across PC3, PC2 and PC1.5.
      - ✓ When narrower UE RB allocation/CBW is located around the center of the wider system bandwidth, e.g., RPB allocation on the edge of 100MHz single CC but still almost in the center of the whole system spectrum i.e., 160MHz ~200MHz spectrum capable for intra-band CA.
      - ✓ When there is no other adjacent operator in the same band.
    - Relax EVM for higher modulation orders: EVM could be relaxed by using lower PAPR schemes without or with less demodulation degradation.

# Power boosting and/or MPR reduction with relaxed requirements

- **Objective**

- > Specify the UE RF requirements of MPR reduction and/or power boosting for the existing power classes by conditionally relaxing ACLR or EVM requirements:
  - For QPSK and 16QAM, specify the conditions and signaling to relax ACLR and the corresponding relaxed ACLR requirements
  - For 64QAM and 256QAM, specify the conditions and signaling to relax EVM and define the relaxed EVM requirements
  - NOTE: the enhancement is applicable to OFDM and DFT-s-OFDM waveform

# MPR improvement for FR2 intra-band CA

- Motivation

- > MPR for intra-band CA is quite large, which is defined not based on the UL carriers, but also the DL carriers. The MPR could be improved with further evaluation.

- Objective

- > Study and specify improved MPR for FR2 intra-band CA

# [MPR improvement with new PAPR reduction mechanism]

- **Motivation**

- > UL performance is one of key enablers for 5G-advanced. One of the key evolution directions is to enhance the uplink coverages or performance for different transmission schemes including single carrier transmission or UL CA, different modulation schemes including QPSK, 16QAM, 64QAM, 256QAM, and different waveforms.
- > It is critical to increase UE uplink transmission power in order to enhance uplink coverage or performance. There are two evolution directions: one is to define the higher power class; the other is to boost transmission power for existing power classes. In our view, the latter one is more cost-efficient and RAN4 should focus on it for Rel-19 non-spectrum item.
- > The aspect below can be further improved for existing power classes considering the work in Rel-18 HPUE items and Rel-18 coverage enhancement WI:
  - Further reduce PAPR for DFT-s-OFDM and CP-OFDM especially with QPSK, 16QAM
    - There are some solutions like ACE (active constellation extension) or soft-clipping for single carrier, which are network transparent and may have better performance than existing schemes in Rel-18.
    - For UE supporting 2Tx, PAPR can be further reduced by using two Tx with different narrower RBs allocated on one CC or separate CCs for intra-band contiguous CA, and thus the MPR can be reduced or in other words the power can be boosted.
    - There are some leftover issues from Rel-18 especially for outer region.

- **Objective**

- > Specify the improved MPR requirement with new PAPR reduction mechanism
  - The PAPR reduction mechanism is expected to be transparent to network and with less impact on existing physical layer design
  - MPR improvement at least for inner RB allocation region, study and specify the improved MPR for outer RB allocation regions
  - Targeted power class is PC3
  - Candidate modulation schemes include QPSK, 16QAM

# 6Rx for handheld UE

- Motivation

- > 6Rx for handheld UE was discussed extensively at the beginning of Rel-18 for RAN4 scope
- > Operators show strong interest to enable the feature for handheld UE

- Objective

- > Investigate and enable 6Rx on higher frequency bands targeting at support of smartphone
- > Investigate the feasibility whether 6Rx can be extended to the smartphone, and decide which UE type (smartphone and/or FWA/CPE) will be considered
  - Feasibility study includes performance gain and form factor
- > Consider NR TDD bands higher than 1.8GHz and example bands are n41, n77, n78 and n79 (other bands to be introduced in the release independent way later)
- > Specify the requirements to support 6Rx subject to the conclusion of feasibility study
  - Specify the UE RF requirements to support 6Rx
  - Specify RLM test cases with 6Rx
  - Specify UE demodulation performance and CSI requirements to support 6Rx
  - Support at least up to 4 MIMO layers, FFS for layer larger than 4
- > Insertion loss (IL) imbalance reporting for SRS antenna switching
  - Enable static and/or dynamic IL imbalance reporting with consideration of possibly partial UE compensation of the power imbalance
  - No impact to RF requirement i.e.  $\Delta T_{RxSRS}$  and RAN1 uplink power control and power headroom report mechanism
  - The optional SRS IL imbalance reporting could be applicable to 4Rx, 6Rx and 8Rx

# [Applicable ULFPTx modes reporting associated with changed power]

- **Motivation**

- >  $\Delta P_{\text{PowerClass}}$  reporting and ULFPTx modes reporting associated with changed power have been discussed extensively in Rel-18. Due to limited time and possible RAN1 impact, ULFPTx modes reporting was dropped from Rel-18
  - $\Delta P_{\text{PowerClass}}$  reporting agreed in Rel-18 is only for the case where  $\Delta P_{\text{PowerClass}}$  change resulting from duty cycle exceedance (power reduced) or return from duty cycle exceedance (power return)
  - The power reduction could also occur for other cases, e.g. Pmax configured to the UE
  - RAN1 confirmed in the reply LS (R1-2310518) that inclusion of  $\Delta P_{\text{PowerClass}}$  in a report to network has no RAN1 impact, but no conclusion on the RAN1 impact for supporting uplink full power MIMO transmission dependency on  $\Delta P_{\text{PowerClass}}$  report
- > During RAN4 discussion, some companies have identified that UE may be capable of different ULFPTx mode in order to satisfy RF exposure conditions or handle human tissue blockage.

- **Objective**

- > Enable semi-static and/or dynamic reporting for ULFPTx applicable modes associated with changed power (RAN1, RAN2, RAN4)
  - Applicable ULFPTx modes reporting could be companioned with  $\Delta P_{\text{powerclass}}$  reporting, but not limited to the case that power reduction is resulting from duty cycle exceedance