3GPP TSG RAN Meeting #96
June 6-9, 2022
Agenda Item: 9.3.1.3

RP-221584

Power domain coverage enhancement scope

Qualcomm

5G

R18 Coverage Enhancement WID

Starts in 4th quarter 2022.

- **Specify following PRACH coverage enhancements (RAN1, RAN2)**
  - Multiple PRACH transmissions with same beams for 4-step RACH procedure
  - Study, and if justified, specify PRACH transmissions with different beams for 4-step RACH procedure
  - Note 1: The enhancements of PRACH are targeting for FR2 and can also apply to FR1 when applicable.
  - Note 2: The enhancements of PRACH are targeting short PRACH formats and can also apply to other formats when applicable.
- **Study and if necessary, specify following power domain enhancements**
  - Enhancements to realize increasing UE power high limit for CA and DC based on Rel-17 RAN4 work on “Increasing UE power high limit for CA and DC”, in compliance with relevant regulations
    - Note 1: The study starts after RAN4 work on “Increasing UE power high limit for CA and DC” is done depending on conclusions from RAN4.
    - Note 2: The objective will be revisited and further clarified in RAN plenary after RAN4 work on “Increasing UE power high limit for CA and DC” is done, and the discussion in WGs will not start before the objective is revised with a clearer scope.
    - Note 3: Both RAN1 and RAN4 are expected to be involved; to decide the order of either (RAN4, RAN1) or (RAN1, RAN4) later.
  - Enhancements to reduce MPR/PAR, including frequency domain spectrum shaping with and without spectrum extension for DFT-S-OFDM and tone reservation (RAN4, RAN1)
- **Specify enhancements to support dynamic switching between DFT-S-OFDM and CP-OFDM (RAN1)**

Increasing MOP for CA/DC (Rel-17)

- CR was agreed (R4-2210767 and R4-2210768)
  - Co-signed by Qualcomm Incorporated, Verizon, Vodafone, Deutsche Telekom, US Cellular, T-Mobile USA, AT&T, China Unicom, NTT DOCOMO, INC., China Telecom, Nokia, Nokia Shanghai Bell, CableLabs, Charter Communications, Inc., Dish Network, Skyworks Solutions, Inc., ZTE, Huawei, HiSilicon, SGS Wireless
- WID was approved at RAN #94e (RP-212622); Rapporteurs Qualcomm and China Telecom
  - WID modification needed at RAN #96 to add 38.101-3 in affected specifications

4.1 Objective of SI or Core part WI or Testing part WI

The objectives of the core part are as follows:

1) Consider the two options and study the feasibility and impacts for option 1.
   - Option 1: Improvement on power high limit
     - Allow UE to transmit the sum of the individual rated PA power classes by lifting the restriction from the Power Class for UL inter band CA or DC, i.e., $P_{PowerClass,CA}$ is replaced with 10*log10 Σ $p_{PowerClass,c}$
   - Option 2: Definition of a new power class for CA and DC
     - Introduce new power classes with necessary requirements
   - To respect the previous RAN4 agreement, option 1 and option 2 are prioritized, and other option is not precluded if it is justified.
2) If the consensus for 1) is option 1, then specify higher maximum output power for dual PA equipped UE's for CA and DC
   - Replace the power class with sum or modified sum in P_{CMAX_H} in CA/DC
   - All associated core requirements are also to be specified
   - SAR mechanisms are modified, if needed, to allow for higher transmit power
   - Example combination as CA_n1A-n78A (23dBm+26dBm) is considered when specifying the band-combination specific core requirements.
3) The target scenario is inter-band CA and inter-band DC

Details of the Rel-17 CR

- Capability signaling is introduced, per band combination [*HigherPowerLimitCADC*]
- Only specific CA configurations are eligible for this capability. The eligible CA configurations are indicated in RAN4 specification
  - Limited in scope to PC3 + PC2 when configured for CA or DC
- Both P_{CMAX_L} and P_{CMAX_H} are increased by $10\log10\sum pPowerClass,c$.
- MSD is not revised to account for higher output power
  - The MSD requirement is defined with each transmitter set to 3 dB below the declared CA power class (not to the increased power level)
- MPR and A-MPR are not revised
  - Only becomes a problem if 2UL IMD's violate emission limits. Single carrier UL power is unchanged.
  - Since MPR and A-MPR are not increased, additional burden to meet emissions becomes an implementation issue. The UE capability is optional in case the UE implementation is not able to meet emission requirements at higher power.
- SAR duty cycle reporting is not revised
  - P-MPR still remains as an option in case reported duty cycle is insufficient

Proposed WID Revision

Revisions: Motivation/Justification

- In addition to RF architectures and network configurations, UE transmit power is also governed by regulatory aspects related to SAR and MPE
- With RAN4's work on increasing the maximum output power for certain CA configurations, it is important to take a close look at how these higher power limits are utilized in practice
- For a meaningful impact on coverage improvement, it will be important to make sure that the gNB is better informed about the UE transmit power availability
- It is suggested that RAN1 take a closer look at this issue and offer potential solutions aimed at making sure gNBs are well positioned to exploit this additional power limit while also being able to anticipate UE transmit behavior in the upcoming slots
- Additionally, given the rather narrow scope of the agreements in RAN4 for the Rel-17 WI, it is useful to expand the scenarios where the UE may be allowed to transmit at a higher aggregated power. The scenarios may include two PC2 bands, MIMO-capable bands with 2 or more PAs, etc.

Revised R18 Coverage Enhancement WID

- **Specify following PRACH coverage enhancements (RAN1, RAN2)**
  - Multiple PRACH transmissions with same beams for 4-step RACH procedure
  - Study, and if justified, specify PRACH transmissions with different beams for 4-step RACH procedure
  - Note 1: The enhancements of PRACH are targeting for FR2 and can also apply to FR1 when applicable.
  - Note 2: The enhancements of PRACH are targeting short PRACH formats and can also apply to other formats when applicable.
- **Study and if necessary, specify following power domain enhancements**
  - Enhancements that achieve better utilization of increased UE power limit for CA and DC by improving gNB awareness of dynamic power aggregation by UEs (RAN1)
    - Techniques may include, for e.g., enhanced power headroom reporting such as dynamic reporting of sustainable duty cycle, P-MPR reporting for FR1 bands, etc.
  - Generalize Rel-17 RAN4 work on “Increasing UE power high limit for CA and DC” to other UE power classes, intra-band dual PA configurations, dual PA MIMO configurations, 3 PA configurations including intra-band and inter-band CA, UL MIMO and CA. Other configurations and extensions are not precluded from consideration. (RAN4)
  - Enhancements to reduce MPR/PAR, including frequency domain spectrum shaping with and without spectrum extension for DFT-S-OFDM and tone reservation (RAN4, RAN1)
- **Specify enhancements to support dynamic switching between DFT-S-OFDM and CP-OFDM (RAN1)**

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Thank you

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