Power Amplifier Design and Linearization Techniques
Sunday January 21, 2024 (1:30 – 5:30 PM)

Organizers: John Dooley, Maynooth University and Pushkar Kulkarni, *Qualcomm*
Room: Crockett CD

Note: Every talk is about 45 mins

1.   **General overview of Wireless Systems, Maynooth University (Prof. John Dooley)**

Abstract : The evolution of mobile phone technology from 2G (2nd Generation) to 4G (4th Generation) represented significant advancements in communication capabilities and network performance. However, there are few countries that have 100% network coverage. As licenses for higher frequency bands are allocated for commercial use, the wide area coverage problem will become harder to address. Looking holistically at the transceiver in mobile phone base stations, we can start to uncover ways in which these systems can be improved to better meet user needs.

2.   **Current pinch-points for mmWave system design, Maynooth University / NXP (Rahul Mushini)**

Abstract : Each generation of mobile phone technology has brought about improvements in speed, efficiency, and functionality, enabling a broader range of services and applications. The transition from 2G to 4G marked a significant leap in mobile communication capabilities, supporting the increasing demand for data-intensive tasks on mobile devices. With the advent of mmWave 5G, there has been a considerable increase in the design challenges which have to be addressed. This talk will highlight the points in the mmWave transmitter line-up which have to be carefully considered to ensure accurate and reliable base station operation.

3.   **Reliable mm-Wave and Sub-THz PA Design, Qualcomm (Dr. Jefy Jayamon)**

Abstract : PA design paradigm changes from mm-wave to sub-mm-wave frequencies. We will look at the device technology (Si and III-V) capabilities and the amplifier architectures, derive compact transistor modeling and its translation to system figures of merit. The device level reliability mechanisms, its circuit-level impacts and the architecture-level mitigation techniques, including the case for PMOS based PAs will be discussed. We will survey the sub-mm-wave PA designs which tend to be simpler architectures with power combining and more stages, with class-A bias and lesser harmonic control. These exacerbate the reliability, stability and thermal concerns.

4.   **Agile Transmitters: Efficiency Enhancements using Digital Predistortion and Envelope Tracking Power Amplifiers, MaXentric Technologies LLC (Dr. Paul Draxler)**

Abstract : Modern digital communications signals require transmitter linearity and typically have a high peak to average ratio (PAPR), especially when more than one signal is being sent through the transmitter (Carrier Aggregation - CA and MIMO). Classic constant supply power amplifiers are most efficient when they run rail-to-rail, which causes distortion and happens only at the peaks, causing significant efficiency degradation. By adding digital predistortion (DPD) to the system we can drive the PA further into compression and achieve a high fidelity output with improved efficiency. Additionally, if we modulate the supply (power optimized envelope tracking - ET) we can reduce the impact of the waveform PAPR on the efficiency. Talk will walk through how changing the PA design assumptions can improve the transmitter efficiency for many transmitters.

5. **Neural Networks for DPD, Maynooth University/Analog Devices (Andrius Vaicaitis)**

Abstract : Neural networks have been applied for almost two decades, for power amplifier behavioral modelling and pre-distortion. The computational overhead in computing the weights for the neurons has always been large in comparison to alternative polynomial based solutions. In recent years however, the pace of development of AI/ML processing hardware has been staggering and the energy consumption of these processors constantly improved. The talk will provide an introduction to the early neural network structures, discuss training data collection and some popular algorithms for training. Finally, a novel segmented spline curve (SSCNN) structure will be presented.