The Untethering of Information: Wideband High Throughput Wireless Communication in the mm-Wave Bands

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The invention of the transistor and CMOS technology in particular led to a revolution in computation, communication, and ultimately to the Internet. Today, we see a revolution in wireless communication, driven by low-cost integrated circuits and the need to be always connected to the Internet. Mobile devices – tablets, smart phones, and netbooks – are beginning to displace traditional computers. These devices rely even more on a strong wireless backbone for functionality. If we project into the near future, we see these devices becoming more complex than today's desktop computers, especially in terms of their ability to connect to the Internet. A host of radio frequencies are employed for near-field communication and RFID, wireless personal area networks (PANs), wireless local area networks (WLAN/WiFi), and long-range mobile networks (3G/4G). While these radios cover a wide range of geographic diversity, they still do not address the need for a very high bandwidth link that can accommodate HD video or high-speed data exchange. In this talk we will demonstrate that mm-wave bands are extremely promising in this regard, allowing extremely wideband wireless links (10 Gb/s) to be employed at very modest energy consumption (10 pJ/bit).

CMOS technology scaling in many ways has been detrimental to analog circuits, producing devices with lower intrinsic gain and wider variability. One important and notable exception, though, is the speed of the scaled device, now exceeding 100 GHz. The 60 GHz spectrum, considered out of the reach of conventional technology only a few years ago, is now within the grasp of inexpensive digital CMOS technology. This talk will chronicle the BWRC effort to design and fabricate 60 GHz circuits and systems in CMOS technology. Operation at this high carrier frequency enables a host of new applications, such as ultra high-speed short range wireless communication and low cost portable radar systems. The talk will include design considerations for medium range gigabit-per-second WLAN system.

The talk will discuss the challenges of communication at mm-wave frequencies with wideband signals. Signal loss due to the small aperture of mm-wave antennas precludes long range communication using conventional single channel antennas. Antenna arrays, in particular phased-arrays, can improve the gain of the system and steer the beam in the desired communication direction. Architectures for phased-arrays will be discussed and a prototype ultra low power CMOS prototype will be discussed. While the focus of the talk will be on the RF building blocks to realize a mm-wave communication link, other topics will be briefly discussed. In particular, the baseband of a 60 GHz radio is particularly challenging. Signal dispersion due to multi-path propagation produces significant inter-symbol interference, requiring sophisticated channel equalization. A mixed-signal prototype baseband equalizer designed at BWRC will be presented.