

Multi-Dimensional RF Signal-Processing and Analog/Digital Circuits

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The Advanced Signal Processing Circuits (ASPC) laboratory at the University of Akron was established in 2010, to conduct basic research involving antenna array signal processing, reconfigurable systems, and multidimensional filters. The target applications span communications, cognitive radio, radio astronomy, microwave imaging, and radar. In this talk, we will discuss our areas of investigation, starting with an overview of the impending spectral scarcity problem. The accelerating growth of wireless systems is rapidly leading to scarcity of electromagnetic spectral bandwidth. The spectrum is a finite natural resource that is subject to oversubscription. Cognitive radio (CR) is an approach for mitigating spectral scarcity. In a CR, situational awareness is provided to a wireless network, allowing intelligent decisions on the use of electromagnetic spectral resources without being limited by licensing schemes. The technologies and approaches that would enable an unprecedented increase in wireless system capacity, data rates and connectivity is known as the $1000 \times$ *Game*.

In light of impending spectrum scarcity, we explore array processing techniques based on analog, digital and mixed-signal multi-dimensional systems. The directional enhancement of propagating radio waves is a fundamental requirement in many types of multi-antenna radios. From a wireless communications perspective, directional receivers play a key role in massively multi-input multi-output (MIMO) wireless networks, which are emerging towards a $1000 \times$ increase in capacity over current capabilities. In the talk, we will discuss our progress in achieving high performance array processors using antenna systems and digital signal processing that may lead to improved bandwidth, steerability and directional selectivity of beamformers. The discussion will include basics of spectrum sensing, followed by theory and hardware using microwave and mm-wave analog/digital IC technology. The talk would also cover our recent progress in array beamformers for radar and radio sensing applications targeting both military and scientific applications. Finally, we will discuss recent developments at the ASPC lab leading to new types of RF circuits for analog signal processing under software reconfigurability, high-definition video digital codecs, digital IC and FPGA design, and multi-dimensional signal processing for light-field imaging applications.

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