General Lecture 3 (11:00–12:00, Thursday, May 30, 2019)

Wideband Beamforming Arrays for 5G Communications

Speaker: John L. Volakis, *Florida International University, Miami, FL, USA*

Chair: Andrea Michel, *University of Pisa, Pisa, Italy*

Abstract

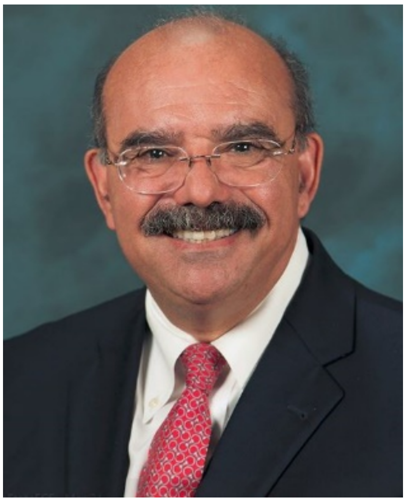
Future wireless communication systems will require much higher data rates. Such high rates require wideband arrays with beam forming capabilities. Concurrently, the RF spectrum is becoming more vulnerable due to intentional and unintentional interference. Therefore, interference cancellation and mitigation techniques as well as low cost wideband beamformers are required to ensure high gain secure communication for 5G and other wideband applications.

Conventional interference suppression techniques are based on fixed or adaptive filtering and are limited in terms of their spectral and spatial filtering. That is, in presence of high interference levels, these techniques fall short to achieving enough suppression. Also, most interference suppression techniques require previous knowledge of the interferer's position, channel, and signal identity.

In realistic scenarios, and when communicating across wide bandwidths, interferers are unknown. Therefore, more advanced techniques are required to suppress interference. Concurrently, with the goal to utilize additional bandwidth, a well-known technique is to enable Simultaneous Transmit and Receive (STAR). STAR offers the advantage of reusing the transmit/receive bands, and therefore double throughput via a method referred to as full duplexing. However, implementation of STAR requires significant isolation between transmit and receive signals. As much as -90dB and even -120dB of isolation between transmit and receive signals is required. To do so, we must 1) cancel interference caused by the transmitter itself (as the receiver is typically collated with the receiver), 2) remove multipath transmitted signals, 3) suppress harmonics from power amplifiers (PAs), and 4) cancel noise from the transmit chain. From the literature, earlier versions of STAR architectures are narrowband, and therefore not useful for wideband communications systems.

To address the abovementioned challenges, we discuss a new class of wideband antennas and RF back-ends, operating across a large bandwidth of 10GHz or more. Specifically, this presentation will discuss: 1) ultra-wideband (UWB) phased array with low angle scanning, bandwidth reconfiguration, and controllable band rejection, 2) broadband digital beamformer with reduced power requirements using a much smaller number of analog-to-digital converters (ADCs) with power and cost reduction by a factor of 8 to 32, 3) novel hybrid frequency and code division multiplexing (CDM) with channel coding for secure high data rate communications to cover a contiguous 10GHz bandwidth with up to 40dB of additional gain and interference mitigation, and 4) wideband STAR implementation using four stages of cancellation to realize >120dB reduction in self-interference across a bandwidth >1 GHz.

Profile



Prof. Volakis is a Professor and Dean of the College of Engineering and Computing at Florida International Univ (FIU). He is an IEEE and ACES Fellow. Prior to coming to FIU, he was the Roy and Lois Chope Chair in Engineering at Ohio State and a Professor in the Electrical and Computer Engineering Dept. (2003-2017). He also served as the Director of the Ohio State Univ. ElectroScience Laboratory for 14 years.

His career spans 2 years at Boeing, 19 years on the faculty at the Univ of Michigan-Ann Arbor, and 15 years at Ohio State. At Michigan he served as the Director of the Radiation Laboratory at U of Michigan (1998-2000). He has 36 years of experience and his research covers wireless communications, wearable textile antennas and electronics, antenna and arrays, ultra-wideband RF beamforming techniques, RF materials and metamaterials, EMI/EMC, multi-physics engineering, bioelectromagnetics, mm-wave front ends for GB communications, THz, radar scattering, RF systems integration, propagation, design optimization, and computational methods. He is internationally known for introducing hybrid finite element methods in electromagnetics, antenna miniaturizations techniques and textile electronics. In 2004, he was listed by ISI among the top 250 highly cited scientists/engineers. His publications include 8 widely used books, 425 journal papers and over 800 conference papers. As of Dec 2018, his google h-index=64 with over 22000 citations. He has mentored 93 Ph.Ds with 43 of them having won awards at international conferences.

His service to Professional Societies includes: 2004 President of the IEEE Antennas and Propagation Society, 2015-2017 USNC-URSI B Chair, twice the general Chair of the IEEE Antennas and Propagation Symposium, IEEE APS Distinguished Lecturer, IEEE APS Fellows Committee Chair, IEEE-wide Fellows committee member & Associate Editor of several journals. Among his awards are: The Univ. of Michigan College of Engineering Research Excellence award (1993), Scott award from The Ohio State Univ. College of Engineering for Outstanding Academic Achievement (2011), IEEE Tai Teaching Excellence award (2011), and the IEEE Henning Mentoring award (2013), IEEE APS Distinguished Achievement award (2015), and Ohio State Univ. Distinguished Scholar Award (2016), and the Ohio State ElectroScience Lab Sinclair award (2016).