On 13 April 2018, the IEEE Solid-State Circuits Society (SSCS) Distinguished Lecturer Harish Krishnaswamy from Columbia University delivered the presentation “Integrated Nonreciprocal Components Based on Linear Time-Varying Circuits.” The lecture was attended by the IEEE SSCS Dallas Chapter (chaired by Huawen Jin) and the students and faculty from the University of Texas at Dallas (UTD) and Southern Methodist University (SMU). The afternoon seminar was hosted by the Department of Engineering and Computer Science at UTD to a crowd of more than 40 people, including on-site and remote attendees. It was a well-received lecture with detailed explanations on theory and real application. Krishnaswamy also visited local tech company Texas Instruments Incorporated, accompanied by Dr. Swami Sankaran, analog design manager of Kilby Lab, prior to the seminar.

The IEEE SSCS Dallas Chapter would like to express its appreciation to Dr. Kenneth O, professor of electrical engineering at UTD and the director of the Texas Analog Center of Excellence, and Dr. Ping Gui, professor of electrical engineering at SMU, for their generous help on facilitating this seminar.

Abstract

Lorentz reciprocity is a fundamental property of linear time-invariant passive circuits and systems constructed from conventional materials. However, nonreciprocal components, such as circulators, enable new wireless communication paradigms, such as full duplex wireless. Conventionally, nonreciprocal circulators have been realized using ferrite materials that exhibit the magneto-optic Faraday effect and are consequently incompatible with complementary metal-oxide-semiconductor (CMOS), bulky, and expensive. Recent research has shown that reciprocity can be broken, and nonreciprocal circulators can be built in CMOS using linear periodically time-varying (LPTV) circuits. This represents an interesting and unique property of LPTV circuits beyond the traditionally exploited tunable high-quality filtering in the so-called N-path filters. We will describe the fundamental physical principles as well as four generations of CMOS circulators and circulator-based wireless systems that target emerging full-duplex and fifth-generation millimeter-wave applications.

—Huawen Jin