Millimeter-Wave Integrated Phased Arrays for Wireless Communication and Imaging

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The short wavelengths and large available bandwidths at millimeter-wave frequencies are attractive for multi-Gb/s wireless links and high-resolution imaging. Advanced silicon technologies can incorporate thousands of transistors with unity-gain frequency in the millimeter wave region on a single IC, achieving high yields and excellent matching. The near-zero incremental cost of a transistor in CMOS or SiGe allows for mm-wave transmitter and receiver architectures and circuits that harness multiple devices to overcome insufficient transistor performance to achieve desired system/circuit performance. Leveraging other benefits of integration such as short interconnect length between devices and availability of multiple layers of metallization, further enables complex integrated millimeter-wave (mm-wave) systems that are beginning to transform wireless communication and imaging applications at these frequencies. Phased arrays are an example of such multi-element mm-wave systems, and in this talk I will describe mm-wave phased arrays in commercial CMOS and SiGe technologies, focusing on highly-integrated state-of-the-art SiGe 60GHz phased-array transmitter and receiver ICs targeted at multi-Gb/s wireless applications. I will address challenges associated with key integrated phased array building blocks and with packaging and interfacing the 16-element phased array ICs with antennas, and present an analysis of SNR improvement in the array receiver that is validated by measurements. The beamforming and beam steering capabilities of the packaged Tx and Rx are demonstrated by a 5Gb/s link at 60GHz that uses reflections from indoor surfaces to establish a link between the transmitter and receiver packaged ICs when the line-of-sight is blocked. Radar measurements also demonstrate the suitability of the array for imaging applications.

Biography: Arun Natarajan received the B.Tech. degree in electrical engineering from the Indian Institute of Technology, Madras, in 2001 and the M.S. and Ph.D. degrees in electrical engineering from the California Institute of Technology (Caltech), Pasadena, in 2003 and 2007, respectively. He joined IBM T. J. Watson Research Center in 2007, where he is currently a Research Staff Member in the communication and computation subsystems area. His research has focused on high-frequency integrated circuits for wireless communication and imaging, and on self-healing circuits for increased yield in sub-micron process technologies. Dr. Natarajan received the National Talent Search Scholarship from the Government of India [1995-2000], the Caltech Atwood Fellowship in 2001, the Analog Devices Outstanding Student IC Designer Award in 2004, and the IBM Research Fellowship in 2005, and serves on the Technical Program Committee of the IEEE Radio-Frequency Integrated Circuits (RFIC) Conference

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