Millimeter-Wave Wireless: A Cross-Disciplinary View of Research and Technology Development

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ABSTRACT

Millimeter-Wave (mmWave) wireless is experiencing an explosive growth in research and technology development. Several factors are fueling the growth: the need for Gigabit rates and low latency; advances in mmWave hardware, antennas, data converters, computational power, and prototyping platforms; and new paradigms for exploiting the large number of spatio-temporal degrees of freedom afforded by the large bandwidth and small wavelength. The challenges in harnessing the potential of mmWave wireless for communication and sensing are both physical and technological and inherently cross-disciplinary in nature. The tools available for research and technology development are rich and diverse, spanning signal processing and communication techniques, antenna, RF hardware and data converter design, prototype development and experimentation, and machine learning and data analytics. I will discuss the opportunities and implications with recent developments in hybrid beamforming architectures, the need for cross-layer networking protocols for exploiting the advanced physical layer capabilities, the importance of accurate channel models in network performance prediction and simulation, and the role of channel signatures in sensing applications. I will also highlight the dual and key role of prototype development in mmWave research: the cross-disciplinary challenges inherent in their design, and their facilitation of much needed channel measurements and experimentation. These findings and insights are informed by my group's involvement in mmWave research and technology development since 2010, and the outcomes of the first two workshops of the NSF Research Coordination Network on mmWave wireless.

CCS CONCEPTS

• **Computing methodologies** → **Modeling and simulation**; **Modeling methodologies**; • **Hardware** → **Digital signal processing**; **Beamforming**; **Emerging tools and methodologies**;

KEYWORDS

Millimeter-Wave; hardware; beamforming; signal processing; networking; testbeds; measurements

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Biography: Akbar M. Sayeed is a Professor of Electrical and Computer Engineering at the University of Wisconsin-Madison, and leads the Wireless Communication and Sensing Laboratory. He received the B.S. degree from the University of Wisconsin, the M.S. and Ph.D. degrees from the University of Illinois, and was a postdoctoral fellow at Rice University. He is a Fellow of the IEEE, and has served the IEEE in a number of capacities, including as a member of Technical Committees, Guest Editor for special issues, Associate Editor, and as Technical Program Co-chair for workshops and conferences. His research interests include wireless communications, channel modeling, statistical signal processing, communication and information theory, time-frequency analysis, machine learning, and applications. A current research focus is the development of basic theory, system architectures, and testbeds for emerging 5G wireless technologies, including millimeter-wave and high-dimensional MIMO systems. He also leads the NSF Research Coordination Network on Millimeter-Wave Wireless.