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The value of space in wireless networks

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Abstract:

In this talk, we show how fundamental questions in large-scale wireless networks can be addressed by applying methods of information theory and electromagnetism. We focus on ad-hoc wireless networks in which nodes communicate without using any pre-existing infrastructure. We generalize the classic troughput scaling result of Gupta and Kumar using electromagnetic theory techniques. Departing from stochastic fading channel models of propagation and combining Maxwell's physics with Shannon's theory of information, we derive outer bounds to the scaling law of the bit-rate with the population size, and show that the scaling achieved by multi-hop operation is optimal in any constant density of nodes network with a total power constraint. The outer bound leads to the notion of "cut-set integral," measuring the diversity on the cut separating sources and destinations, induced by the possible richness of the scattering environment. The achievability scheme is based on a percolation argument, showing that the optimal network operation strategy is in the transition region between order and disorder of an underlying statistical physics system. Our results are information-theoretic, and also take into account physical limitations due to the limited spatial resource available in the network.

Biography:

Massimo Franceschetti is associate professor in the Department of Electrical and Computer Engineering of University of California at San Diego. He received the Laurea degree, magna cum laude, in Computer Engineering from the University of Naples in 1997, and the M.S. and Ph.D. degrees in Electrical Engineering from the California Institute of Technology in 1999, and 2003. Before joining UCSD, he was a post-doctoral scholar at University of California at Berkeley for two years. Prof. Franceschetti was awarded the C. H. Wilts Prize in 2003 for best doctoral thesis in Electrical Engineering at Caltech; the S. A. Schelkunoff award in 2005 for best paper in the IEEE Transactions on Antennas and Propagation; an NSF CAREER award in 2006, an ONR Young Investigator award in 2007; and the IEEE Communications society best tutorial paper award in 2010. He has held visiting positions at at the Vrije Universiteit Amsterdam in the Netherlands, the Ecole Polytechnique Federale de Lausanne in Switzerland, and the University of Trento in Italy. He is associate editor for communication networks of the

IEEE Transactions on Information Theory and has served as guest editor for two issues of the IEEE Journal on Selected Areas in Communication. His research interests are in communication systems theory and include random networks, wave propagation in random media, wireless communication, and control over networks.