Greening the Edges

Abstract: A variety of bandwidth-hungry applications and services such as high-definition television, video streaming, and social networking are being deployed rapidly, leading to a continuous surge in bandwidth demand across networking infrastructure, notably the access portion. Thus, both wireline and wireless telecommunications operators are driven to upgrade their access networks to provide broader bandwidth for their subscribers. Upgrading the provisioning capacity of access networks leads to a dramatic increase in energy consumption. For example, to guarantee a sufficient signal-to-noise ratio at the receiver side for accurate recovery of high data rate signals, advanced transmitters with high transmitting signal power and advanced modulation schemes are required, thus consequently resulting in high energy consumption of the devices. Also, to provision a higher data rate, more power will be consumed by electronic circuits in network devices to facilitate fast data processing. Besides, high-speed data processing incurs fast heat buildup and high heat dissipation that further incurs high energy consumption for cooling. It is estimated that the access network energy consumption increases linearly with the provisioned data rate. It has also been reported that the LTE base station consumes more energy in data processing than the 3G UMTS systems, and the 10G-EPON system consumes much more energy than the 1G-EPON system. Moreover, owing to the direct impact of greenhouse gases on the earth environment and the climate change, the energy consumption is becoming an environmental and thus social and economic issue. Therefore, it is important to design and build energy efficient high capacity access networks. This tutorial will discuss roadblocks in designing energy efficient access networks, cover the state-of-the-art on greening wire and wireless access networks, present the research challenges on achieving energy efficient high capacity access networks, and allude to 5G implications with respect to the greening effort.

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Nirwan Ansari received BSEE (summa cum laude with a perfect GPA) from the New Jersey Institute of Technology (NJIT), MSEE from the University of Michigan, Ann Arbor, and PhD from Purdue University, West Lafayette, IN. He is Distinguished Professor of Electrical and Computer Engineering at NJIT. He has also assumed various administrative positions at NJIT. He has been Visiting (Chair) Professor at several universities.

Prof. Ansari authored *Media Access Control and Resource Allocation* (Springer, 2013) with J. Zhang and *Computational Intelligence for Optimization* (Springer, 1997) with E.S.H. Hou, and edited *Neural Networks in Telecommunications* (Springer, 1994) with B. Yuhas. He has also (co-)authored over 450 technical papers, over one third of which were published in widely cited refereed journals/magazines. He has guest-edited a number of special issues, covering various emerging topics in communications and networking. His current research focuses on various aspects of broadband networks and multimedia communications.

Prof. Ansari has served on the Editorial Board and Advisory Board of nine journals. He was elected to serve in the IEEE Communications Society (ComSoc) Board of Governors as a member-at-large (2013-2015). He has chaired ComSoc technical committees, and has been actively organizing numerous International Conferences/Symposia/Workshops, assuming various leadership roles. Some of his recognitions include IEEE Fellow (Class of 2009), several Excellence in Teaching Awards, a couple of best paper awards, NCE Excellence in Research Award (2014), ComSoc AHSN TC Outstanding Service

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