Green Approaches to Communications

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Communication networks now account for a growing proportion of data traffic around the world. This growth can be attributed to (a) advances in mobile communication that support high bit-rate data services with superior efficiency, and (b) proliferation of personal and commercial devices such as smartphones, tablets, televisions, cameras and industrial sensors that leverage these advances. Sustainability challenges from energy efficiency to recycling threaten the growth, enhancement, and proliferation of communication devices and systems. Green communications is an active research area exploring new technologies that advance sustainable and cost-effective design of advanced communication networks.

In particular, the scalability of wireless networks, whether commercial mobile networks or industrial sensor networks, is severely threatened by adverse energy-performance trade-offs and growing environmental footprints of associated systems such as cellular base stations, mobile devices and battery-limited autonomous sensors. Cellular base stations consume about ninety percent of the total energy in a cellular network with the air-interface (radio and power amplifier) utilizing about fifty percent and baseband processing another fifteen percent. As of 2014, there were over 7 billion mobile phones in the world, increasingly dominated by power-hungry smartphones that together account for a million metric tons of CO_2 produced annually. This session will explore advances in four important research topics in green communications, namely, power-optimized mobile processor designs, energy-efficient cellular architectures, software power management, and energy harvesting in sensor networks.

The first speaker, Vijay Reddi, will focus on mobile processor architectures and the design implications and challenges for energy efficiency. Vijay's talk will discuss how the power consumption of key components in a mobile device has evolved over the past few generations of devices with the mobile CPU becoming the dominant power consumer today. The talk will emphasize the critical need for superior energy-efficient CPU designs for future mobile devices to achieve desktop-level performance with marginal increases in battery capacity.

The second speaker, Radharishna Ganti, will discuss the issue of energy efficiency in cellular networks. In particular, the Long-term Evolution (LTE) standard will be contrasted with other existing standards in terms of energy and spectral efficiency. Existing techniques and challenges for improving energy efficiency, like base-station sleep modes and small cells, will be discussed.

The third speaker, Joseph Turner, will focus on commercial software design to improve the energy efficiency of mobile devices that support a growing list of supported services. Specifically, Joseph will talk about his work (and that of others) to create robust commercial software that reduces energy waste in mobile systems and the servers that support them through superior power management techniques. He will also discuss the energy efficiency challenges we face in the years to come.

The fourth speaker, Neelesh Mehta, will discuss the emergence of energy harvesting in wireless sensor networks. Energy harvesting capability promises to transform wireless sensor networks into maintenance-free, perpetual, energy-aware networks that are capable of sensing and communicating vast amounts of data. Neelesh will specifically delve into the design aspects of two promising applications of energy harvesting, namely, opportunistic multi-hop relaying in cooperative wireless networks and hybrid wireless sensor networks.