

Broadband Wireless Access Research

Mission

Broadband wireless access is the third wireless revolution, after cellphones (1990s) and Wi-Fi (2000s). It is viewed by many cable and telephone operators as a “disruptive” technology and rightly so. The broadcast nature of wireless transmission offers ubiquity and immediate access for both fixed and mobile users, clearly a vital element of next-generation quadruple play (i.e., voice, video, data, and mobility) services. Unlike wired access (copper, coax, fiber), a large portion of the deployment costs is incurred only when a subscriber signs up for service. The mission of this research is to advance real-world mobile broadband technologies.

Projects

(1) Municipal Wireless

An increasing number of municipal governments around the world are financing the deployment of wireless access networks with the overall aim of providing ubiquitous Internet access and enhanced public services. Over 300 (and growing) muni-wireless projects in the U.S. provide key evidence on the vast potential of this emerging field. Service providers and cable/telephone network operators can increase the number of subscribers significantly by competing or leveraging on muni-wireless (e.g., in areas not currently served or served by competitors). What are the right wireless access technologies that maximize ROI and tackle today’s ever-changing consumer demands? What are the enablers for mobile entertainment? How should these networks be designed and deployed with minimum overheads?

This project aims to investigate the key issues and technologies underpinning promising broadband wireless access solutions such as 802.16 (Wi-Max), long-range/multihop 802.11 (Wi-Fi), wireless DOCSIS, 3G/4G cellular, HSUPA/DPA, LTE, mobile TV, digital TV broadcast, 802.20 (mobile broadband), 802.21 (media independent handoff and interoperability), and the emerging 802.22 (wireless regional area networks) standard. Key research topics include:

- Licensed and unlicensed spectrum modeling;
- Multiple antenna systems;
- Multichannel medium access protocols;
- Wireless access topologies: point-to-point, point-to-multipoint, multihop (mesh);
- Wireless multimedia services: video, VoIP, peer-to-peer applications;
- Mobility, roaming, and handoffs;
- Advanced wireless security;
- Cognitive radio-based multihop networks;
- Intelligent and cross-layer multihop routing;
- Long-range wireless access;
- Wireless/wireline integration;
- Secure peer-to-peer wireless networking and content distribution;
- Software download for autonomous multihop (mesh) network deployment;
- Interactive mobile TV and digital video broadcast systems.
- VoIP and video bandwidth management

(2) Cognitive Radio for Ubiquitous Broadband Wireless Access

Satellite remote sensing is a popular method to observe the dynamic processes of the atmosphere and the ocean surface, including monitoring the health of coral reefs. However, a lack of direct line-of-sight path limits the effectiveness of satellites in observing specific problem areas. This project examines the technical aspects of creating a large-span terrestrial wireless network in a maritime setting, capable of bypassing the need for a backhaul satellite connection. To this end, we propose a UHF-band multihop wireless network with cognitive radio capability for ship-to-shore communications. The proposed network will provide a significant increase in range and capacity performance compared to many terrestrial broadband wireless

access solutions. In addition, the deployment costs will be a fraction of what it will cost using any existing terrestrial wireless system. The network will be suitable for data gathering functionality and transport, including support for heterogeneous data streams, monitoring and control, and real-time event detection and characterization. The initial span of the network is 1,000 square miles but the ambition is to cover an entire ocean. The key application will be real-time video transmission for environmental monitoring (e.g., earthquakes, violent storms, natural hazards, climate changes) and coral reef piracy prevention. However, the research outcomes can be easily extended to a wide spectrum of applications, not only in terms of creating a more pervasive broadband access network for education, telemedicine, teleworking, rural area communications, disaster preparedness, and economic development in underserved countries, but can also impact wildlife and forest conservation.

(3) Broadband Wireless Convergence and Next-Generation Broadcast and Mobile TV

High performance access networks promise the enabling of new services such as IP-TV, video-on-demand, and Web-based multimedia conferencing. This is in addition to cost-effective bandwidth-on-demand services where bandwidth pipes can be dynamically provisioned and released based on users' initiated demands. Next generation access networks will offer telecommunications, broadcasting, and Internet access from a wide variety of devices. Broad areas of convergence will take place namely, network convergence (wired and wireless, heterogeneous wireless, telecommunications and broadcasting, etc), service convergence, and applications convergence. At the core of this unified communications network is an IP and Ethernet infrastructure that supports pervasive, high-quality quadruple services. For efficient service provisioning, well-designed network operations and management functions with traffic engineering are crucial. This project aims to investigate the key challenges associated with broadband wireless convergence, including end-to-end QoS-guarantees, intelligent handoffs for seamless connectivity, peer-to-peer broadband access, implementation of capabilities within the network for state information management, resource allocation, and scheduling. Crosscutting research areas include:

- Wireless/wireline access integration
- Intelligent service provisioning with roaming and handoffs
- Regulatory and standardization issues
- Signaling for application sessions and networking
- Virtual networking and interoperability
- Integrated network control and management
- Inter-domain networking
- Intelligent resource and connection management
- End-to-end security, policy enforcement, and service level agreements
- Multilayer traffic engineering
- Overlay solutions between heterogeneous wireless access networks
- Broadband wireless integration with powerline networking