Wireless Ad Hoc & Sensor Networks

Course Overview

A mobile *ad-hoc* network is a collection of wireless nodes that cooperatively form a network without using any fixed infrastructure of centralized administration. An ad hoc network is self-organizing and communications takes place mostly through multi-hop routing. Mobility of the network nodes, limited resources (e.g., bandwidth and energy supply) and potentially a large number of mobile nodes make the routing and management of ad hoc networks extremely challenging. Target applications for mobile ad hoc networks range from collaborative, distributed mobile computing (sensors, conferences, conventions) to disaster recovery (such as fire, flood, earthquake), law enforcement (crowd control, search and rescue) and tactical communications (digital battlefields).

A special class of ad hoc networks is that of a self-organizing network of power-sensitive sensing devices. *Sensor networks* coupled with the notion of ubiquitous computing have emerged as a new communication paradigm that promises to revolutionize information gathering and processing in urban environments and in inhospitable terrain. Integrated sensing devices permit remote monitoring in a variety of contexts: in the field (wild-life habitat monitoring; fire detection; seismic monitoring; remote monitoring & tracking of vehicles, equipment and personnel); the office and the factory (smart tags, inventory-control, motors, small robots); and, the home (automation and smart home).

The first part of this short course addresses the broader class of mobile ad-hoc networks. The general design principles are introduced and existing radio and networking technologies are reviewed. A special emphasis is put on the role that ad hoc networks will be playing in the forthcoming 4G communications infrastructure. The second part of the course focuses on the challenges faced by the resource-limited sensor networks. We briefly introduce the issues pertaining to the self-organization of large complex systems of sensing devices, review existing technologies and architectures and give examples of systems in operation.

Objectives

At the end of this course the participants will have:

- a broad overview of the state of wireless and mobile ad hoc networking
- a thorough understanding of the current and emerging applications
- an overview of the physical, networking and architectural issues of mobile ad hoc networks
- been introduced to the key technologies that will enable the next generation of ad hoc networks and the proliferation of ubiquitous computing
- been familiarized with sensor networks and the unique set of design challenges that they introduce

It is designed as an introductory/intermediate course on the topic.

Who should attend

This Short Course is addressed to:

- Telecom Engineers, Applications Developers
- Telecom Technical Managers

Prerequisites

Principles of telecom systems design.

Duration

3 full days.

Instructor

Dr. Gregory Yovanof (CV: http://www.ait.edu.gr/faculty/G_Yovanof.asp)

Course outline
The course contents per day (and half-day sessions). Optional homework assignments and quizzes will be available to interested groups and/or individuals.

Day 1 – Session 1:
- Ad-Hoc networking paradigm: The Art of Networking without a Network
  - The Past: Evolution from the Military Packet Radio of the 70's
  - Current Military and Civilian Applications
  - The Future: The Role of Ad Hoc Networking in 4G Communications
- Mobile Ad-Hoc Network Architecture
  - Fundamentals of ad hoc networking - Design Challenges
- Overview of Short-Range Wireless Communications
  - Overview of Short-Range Wireless Communications

Day 1 – Session 2:
- Enabling Technologies
  - Technologies, Standards, Regulations: WPAN, WLAN, WMAN
  - Ultra-Wideband (UWB), Smart-Antennas, MIMO systems

Day 2 – Session 3:
- MAC Layer Design
  - IEEE-802.11, ODMA, Delay-Tolerant Networking
- Ad Hoc Network Layer
  - Routing Algorithms (Unicast, Multicast, Location-Aware, Clustered)

Day 2 – Session 4:
- Cross-Layer Issues
  - Network Security & Cooperation, Quality of Service (QoS)
- Applications and Middleware
  - Universal communicator – Software Defined Radio (SDR)
  - 4G Internetworking – heterogeneous networks

Day 3 – Session 5:
- Sensor Networks – A Brief Overview
  - Applications: Monitoring systems, RFID, Manufacturing
- Architectures for integrated sensing devices
  - Design Challenges
  - Existing designs

Day 3 – Session 6:
- Network Design
  - Radio technologies, Standards (802.15.4)
  - MAC: Power-aware designs
  - Routing: Delay-Tolerant Networking
- Distributive Computing in Complex Networks
  - Self-organizing systems
  - Distributed Compression for highly correlated data sources