

## **CIS6930 Wireless Mobile Networks Design and Analysis, Spring 2007**

**Instructor:** Prof. Ahmed Helmy

Lecture meeting time: Monday 10:40am-1:40pm, place: NRN (Norman Hall) 0184

- **Course description:**

Mobile Adhoc Networks, Adhoc and geographic routing, resource discovery, medium access control, IP-mobility, mobility modeling, wired-wireless networks. Wireless LAN measurement, sensor networks, Mobile-IP, adhoc routing.

Major term project required.

- **Goals of the course:**

The purpose of the course is to expose students to emerging networking protocols and technologies in the field of wireless mobile networks. It also involves students in group projects to identify challenging problems in wireless ad hoc networks through extensive reading and discussion, to propose solutions to those problems, then conduct high quality research (through extensive simulations, analysis and implementation) to produce a term project report (of conference and journal quality) that is the final product of their work.

More precisely, the objectives of this course are for the students:

- To acquire hands-on experience of wireless and mobile networking technologies. To experiment with state-of-the-art networking technologies and tools that enable students to diagnose and perform measurements on a network.
- To get involved in research projects on advanced topics in mobile ad hoc networks (MANets), and be able to present and write high quality technical reports on protocol design, analysis and simulation.
- To be part of a team and to tackle challenging research problems in a semester-long project. To suggest solutions to these problems and to be able to demonstrate the feasibility and performance of the solution.
- To learn how to read and review publications in the wireless networking field from selected journal articles and conference proceedings.

Skills acquired in this class should emphasize and supplement deep understanding of actual protocol and network behavior. Students develop and enhance their understanding of the basics of wireless networking, mainly at the network and MAC layers, the behavior of the fundamental and evolving network protocols (e.g., unicast/multicast ad hoc routing protocols, media access control (MAC) protocol of wireless networks, among others). Students also study that the network behavior is a collective behavior of all such protocols (and others), their interaction among themselves, and with the 'faulty' and dynamic network environment. By integrating network dynamics, such as packet losses, link/node failures and mobility, and through diagnostic and measurement tools, students study and analyze the effects of various network conditions on the overall behavior of the network.

Such deep practical understanding, along with strong analytical skills, are essential for future networking research and industry, that would greatly help in understanding today's networks, and designing networks of the future.

The course consists of (i) a series of lectures, (ii) a set of assignments and experiments.

- (i) The lecture series starts by a set of ~3 weeks of lectures given by the instructor on fundamentals of mobile ad hoc networks, MAC, IP mobility and mobility models, followed by 2~3 three weeks of lectures on challenges and research directions in those fields. During those initial weeks the class will be broken into groups, and every group gets to choose a topic for presentation and formulates a problem for the project. Also, each group is assigned a topic presentation slot and a project presentation slot. The weeks that follow include presentations by the students to cover specific topics and problems based on lists of readings (provided by the instructor and proposed by the students) and based on the projects progress. The last lecture of class usually includes 10-15 minute slots for students to demo their projects and results.

The students learn basics of ad hoc routing protocols including the following list:

[\* This list is updated during the semester based on discussion and students' interest]

- Unicast routing using table-driven protocols (e.g., link state or DSDV), on-demand protocols with caching (e.g., DSR, AODV, TORA), hybrid protocols (e.g., ZRP, contact-based architectures), hierarchical protocols (e.g., cluster-based, landmark-based) and geographic routing (e.g., greedy routing, GPSR)
- Broadcast routing using naïve flooding, heuristics (e.g., probabilistic, counter-based), minimum dominating sets (e.g., MPR multi-point relays, CEDAR)
- Resource discovery and rendezvous routing using contact-assisted protocols (e.g., MARQ, CARD, PARSE), and consistent distributed hashing (e.g., Rendezvous regions, GHT)
- Multicast routing using tree or mesh-based protocols (e.g., ODMRP, CAMP, FGMP) or extensions of unicast adhoc routing (e.g., MAODV, MCEDAR)

In addition, students get exposed to various wireless medium access control (MAC) protocols, including CSMA/CA (802.11), MACA, MACAW), and power-aware MAC (e.g., PAMAS, SMAC).

The students also gain knowledge of various mobility models including random way point, group mobility, highway model, manhattan model, hybrid models, among others. Mobility metrics are defined for those models, including spatial correlation, temporal correlation, relative speed, link durations and path durations. These metrics enable us to differentiate these models, and have better understanding of their effects on protocol performance.

**Project:** The term project has four main milestones: (1) an initial project proposal (~2 pages) due around the 5<sup>th</sup> week of class, (2) a final project proposal (3~4 pages) due around the 8<sup>th</sup> week of the semester, (3) an initial draft of the project report (~8 pages) due around the 11<sup>th</sup> week of class, and (4) the final project report (~12 pages) due on the last lecture.

(ii) Assignments and experiments:

Students perform experiments around campus on measuring signal power strength, throughput, and delays of a wireless network using handheld PCs or laptops connected to base stations around the University of Florida campus.

The students also perform experiments for ad hoc routing in a multi-hop wireless network and experiments for a network of wireless sensor nodes and motes.

Examples of experiments/assignments include:

- Drawing a wireless coverage map and measurements (cross validation through various measurement techniques, GPS, encounters, etc.)
- Encounter based networks (discovering devices, building ad hoc net, increasing the coverage of the wireless net, using static or mobile nodes, etc.)
- The 'socializer' experiments: establishing friendship and interest group links in mobile societies (through analysis of traces, mobile device experiments, surveys, etc.)
- Simulation of disaster scenarios and establishment of networks for the relief and search/rescue missions.

The over-arching themes for the Spring '07 class for the project and experiments will be:  
- disaster relief networks, and mobile social networking.

The experiments are carried out in groups of '3' or '4' students with combined reports. Each individual should understand and be able to perform the experiments on his/her own (there may be random pop quizzes to test this ability). Students will also be required to design parts of new experiments. The students will also be asked to write reviews for papers that will be presented in class.

- Student responsibilities:
  - Attendance, class discussions, weekly reviews, paper readings
  - Participate in two presentations: topic presentation, project presentation
  - *High quality* final project report and demo
  - Team work, assignment and experiments evaluation

This course relies heavily on students' own effort and experimentation. It is a hands-on course where many presentations and experiments are conducted by the students. The students are also involved in working in teams on a semester project.

Students are expected to participate actively in various aspects of this course (such as, suggesting new experiments, carrying discussions on the class newsgroup, asking/answering questions on presented material, among others).

Instructions for the project proposal and report will be posted on the web in as much detail as possible. Similarly, instructions for performing experiments and samples of reviews will be posted.

- Pre-requisites:

In general, very good knowledge of fundamentals of computer networks is required.